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THE IDENTITY OF THE ANT GENERA GESOMYRMEX MAYR AND DIMORPHOMYRMEX ERNEST ANDRE.[1]

By William Morton Wheeler

During the examination of a considerable number of ants collected by Dr. L. G. K. Kalshoven in the teak-forests of Java, I have come upon an undescribed species of Gesomyrmex, represented by a graded series of workers, all taken from a single colony and demonstrating that the singular Formicine genera Gesomyrmex and Dimorphomyrmex are synonymous. I have long surmised this identity, because there are no significant differences among the worker phases, except in the proportions of the head, eyes, clypeus, frontal carinæ and mandibles. Even the antennæ are the same and consist of only 8 joints in the worker, instead of 12, which is the number observed in the great majority of Formicidæ. But hitherto so few specimens of the two genera have been seen and the sexual forms have been so imperfectly known that no definite statements could be made in regard to their affinities.

Gesomyrmex was established sixty years ago (1868) by Mayr for a peculiar, large-eyed ant, *G. hoernesi,* which he found in the Baltic amber, of Lower Oligocene Age. In 1892 Ernest André described two extant species of ants taken by Chaper in the Kapoewas Basin, North Borneo. One of them, which he called *G. chaperi,* was evidently very closely related to the amber form; for the other, which was larger and had a much larger and more rectangular head and smaller eyes, he erected a new genus, Dimorphomyrmex. This form, *Dimorphomyrmex janeti,* he described as possessing dimorphic

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University No. 308.

workers, with heads of similar structure but of different sizes. Then Emery, in 1906, discovered in the Baltic amber a form which closely resembled the Bornean *janeti* and described it as *D. theryi.* While reviewing the ants of the Baltic amber in 1913 I was able to recognize several specimens of *G. hoernesi* and *D. theryi* and two intermediate forms which I described as *G. annectens* and *D. mayri.* Two years later (1916) I described a winged female from the Island of Luzon, in the Philippines as *Dimorphomyrmex luzonensis,* and in 1921 another species, *Gesomyrmex howardi,* from a couple of workers taken by Prof. C. W. Howard near Canton, China. These workers I interpreted as major and minor workers respectively and noted that the former resembled the worker of Dimorphomyrmex. The new species from Java now shows that the specimens of *howardi* are really media and minima workers, that those of *G. hoernesi* and *chaperi,* described by Mayr and André are minimæ, that those of *D. janeti* are maximæ and mediæ of *G. chaperi,* and that the workers of *D. theryi, D. mayri* and *G. annectens* are in all probability the maximæ, large mediæ and small mediæ respectively of *G. hoernesi.* This will be clear from the following description and figures of the new species brought to light by Dr. Kalshoven.

Gesomyrmex kalshoveni sp. nov.

Worker maxima. (Fig. 1, a-d) Length 5-6.6 mm.

Head subrectangular, about 1 1/4 times as long as broad, slightly narrower in front than behind, with the sides distinctly concave in front of the middle; the posterior border feebly concave, the posterior corners convex and rounded; the dorsal and gular surfaces rather flat. Eyes elongate, convex, scarcely reniform, with straight or very nearly straight internal and impressed posterior orbits, one-third as long as the head and well up on its dorsal surface. Ocelli minute, unpigmented, the anterior smaller than the two posterior, which are on a level with the posterior orbits of the eyes. Mandibles stout, convex, with strongly rounded external borders, 8-toothed, the first, second, fourth, sixth and eighth tooth, counting from the apex, larger than the others and rather blunt. Clypeus short and flat, its anterior

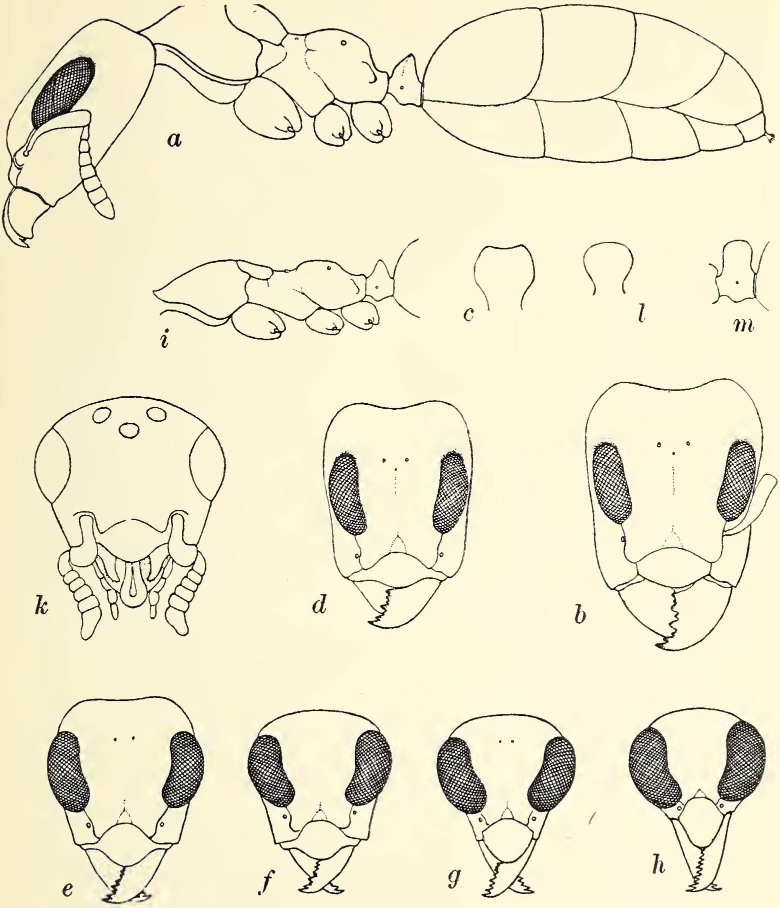

Fig. 1. *a*. *Gesomyrmex kalshoveni* sp. nov. Maxima worker in profile; *b*. head of same; *c*. petiole from front; *d*. head of small maxima; *e*. head of large media; *f*. of small media; *g*. of large minima; *h*. of small minima; *i*. thorax and petiole of same; *k*. head of male semipupa; *l*. petiole of *G. howardi* Wheeler from front; *m*. same in profile.

border slightly and evenly rounded, scarcely projecting in the middle; its lateral portions not reaching the anterior corners of the head, convex but not auriculate. Frontal area distinct, moderately large and triangular; only a portion of the frontal groove developed in the middle of the head just anterior to the ocelli; frontal carinæ widely separated, subparallel, rather erect and slightly lobular anteriorly, continued back to the anterior orbits of the eyes. Antennæ 8-jointed; scapes curved basally, gradually thickened distally, their tips reaching somewhat beyond the middle of the eyes; funiculi distinctly enlarged apically, first joint twice as long as broad; second and third 1 1/2 times as long as broad, remaining joints nearly as broad as long, except the terminal joint which is somewhat longer. Thorax stout anteriorly, the pro- and mesonotum convex, forming together a hemispherical mass, separated by a distinctly impressed suture, rounded above in profile, the former as broad as long with a faint median longitudinal impression behind; the latter as long as broad, subcircular with straight posterior and rather deeply impressed anterior and lateral sutures. Behind the mesonotum the thorax is divided into two regions by a transverse dorsal furrow; the shorter anterior portion, representing the metanotum is depressed and bears the somewhat projecting metanotal spiracles at its sides; the posterior portion, representing the epinotum, is as broad as long, with the base somewhat convex and bearing the epinotal spiracles at the middle of its sides. Posteriorly it passes into the distinctly shorter, sloping declivity, with which it forms a distinct, obtuse angle. Petiole small; its node from above transversely elliptical, nearly 1 2/3 times as broad as long; in profile distinctly cuneate, with convex anterior and posterior surfaces, the moderately sharp superior border transverse, feebly and broadly excised or sinuate in the middle. Gaster large, elongate-elliptical. Legs stout; all the femora somewhat thickened; spurs of middle and hind tibiæ very short; tarsal claws large and stout.

Smooth and shining; mandibles coarsely punctate, with a few incomplete longitudinal rugules; head more finely punctate; median portion of clypeus, front and cheeks finely and longitudinally striate as far back as the eyes.

Thorax, petiole, gaster and appendages very minutely and sparsely punctate, the gaster also very delicately and indistinctly, transversely coriaceous.

Hairs yellowish white, absent on the body, except at the tip of the gaster and on the mandibles, clypeus and front. On these latter regions they are numerous, short, erect, stubby and obtuse. Scapes with short oblique hairs. Pubescence undeveloped, except on the tibiæ where it is very short, dilute and appressed.

Honey yellow; gaster and legs paler and more whitish yellow, the several gastric segments very faintly infuscated posteriorly; frontal carinæ and mandibles red, the latter with black teeth and dental border; impressions of the posterior orbits dark brown; claws and tarsal articulations reddish.

Worker media. (Fig. 1 e and f) Length 3.5-4.5 mm.

Differing from the maxima mainly in the characters of the head, which is proportionately smaller and only 1 1/6 to 1 1/5 times as long as broad; its posterior portion shorter and more rounded, its anterior portion more narrowed, with proportionally larger eyes, which are more convex, and reniform, i.e. with concave internal orbits and one half as long as the sides of the head. Posterior ocelli represented by minute pits in the larger, usually absent in the smaller specimens. Mandibles 7-8 toothed and more elongate and less convex than in the maxima, with less convex external borders and only the first, fourth and fifth tooth enlarged and more acute, the third, seventh and eighth very minute. Median portion of the clypeus longer, more convex posteriorly, its anterior portion more advanced and lobular, depressed. All the funicular joints longer than broad, except the penultimate. Thorax somewhat more slender than in the maxima, pronotum without longitudinal impression; mesonotum longer than broad, with more nearly parallel sides; its surface flattened and even slightly concave in profile. Petiole as in the maxima, but slightly more narrowed above.

In the larger media there are distinct striæ and short stubby hairs on the front, though the latter are less numerous; in the small media these hairs are absent and the striæ are very indistinct or obsolete. Color like that of the maxima, except that the mandibles are yellowish, with only the teeth blackish.

Worker minima. (Fig. 1 g-i) Length 2.8-3.2 mm.

Differing from the media in having a still shorter head, in the smallest minima scarcely longer than broad including the eyes, which are more convex and laterally projecting, decidedly reniform and taking up more than 3/4 of the sides of the head, so that the cheeks and postocular regions are greatly reduced, the latter without distinct corners and with slightly and evenly convex median border. Clypeus much longer and anteriorly projecting, more convex behind and somewhat more concave in front, than in the media. Ocelli represented by a pair of very minute pits or completely absent. Mandibles more elongate, flattened, with straight external borders, the teeth forming a more even crowded series, the apical longer than the basal. Frontal carinæ very short and indistinct. Antennal scapes extending to the posterior third or fourth of the eyes. Thorax more slender, pro- and mesonotum much less convex, with nearly straight outlines in profile, the latter feebly concave as in the media. Legs slender, but with the femora distinctly enlarged basally.

Mandibles pale yellow with reddish teeth; posterior orbits not tinged with brown. In other respects like the small media. The larger minima is intermediate between the small minima and the small media even in the structure of the mandibular teeth.

Described from 15 workers taken by Dr. L. G. K. Kalshoven in a teak-forest at Semarang, Java. The following are the lengths of the individual (alcoholic) specimens:

Maximæ: 6.6 mm.; 5:7 mm.; 5.3 mm.; 5 mm.
Mediæ: 4.5 mm.; 4 mm.; 4 mm.; 4 mm.; 3.8 mm.; 3.8 mm.; 3.5 mm.; 3.5 m.m.
Minimæ: 3.2 mm.; 3 mm.; 2.8 mm.

The variations in structure in all the castes are so finely graduated that there is no hiatus between the smallest specimen measuring 2.8 mm. and the largest measuring 6.6 mm.

G. kalshoveni must be very close to the form described by André as *G. chaperi* from the minima and "*D. janeti*" from the maxima and media worker. He gives the length of the minima as 3.5 to 4 mm., of the media as 3.5 mm. and the soldier as 6 mm. If his descriptions were drawn from cabinet specimens the fact that the largest minima was longer than the media may be explained on the supposition that the gasters of the two specimens had contracted unequally on drying. Such differences are, of course, frequent also in the gasters of living or alcoholic specimens of the same caste, owing to variable distension of the crop. The maxima of *kalshoveni* differs from that of *chaperi* in lacking the lateral auriculate expansions of the clypeus, in possessing longer funicular joints and nonpigmented ocelli, a decidedly more convex pronotum and in having the stubby hairs on the front and clypeus simple and truncate instead of bifid or multifid at their tips. André describes these hairs as "appearing as if surmounted or even crowned with minute spines." Emery has cited *G. chaperi* (as *D. janeti*) from Sumatra, but it is not improbable that his specimens belonged to the Javan rather than to the Bornean species.

The new Gesomyrmex differs from *G. howardi* in the shape of the petiolar node, which in the latter (Fig. 1, l and m) is much thicker above, with rounded, entire border, in the epinotum which is shorter in *howardi*, with much less convex base and with the base and declivity subequal. The sculpture of *howardi* is decidedly coarser, especially on the epinotum and pleuræ, so that the surface is more opaque. The color is also darker and more brownish or sordid than in *kalshoveni* and *chaperi*. There are distinct striæ on the front in the media and minima of *howardi*. It is, of course, not improbable that all four living species of Gesomyrmex, including *G. luzonensis*, which is known only from the female, may prove to be merely so many local races (sub-species or varieties), when sufficient material of these forms has found its way into our collections.

It would be interesting to revise the fossil species of Gesomyrmex in the light of the preceding discussion. Of the material which I studied in 1913 and soon afterward returned to the Königsberg museums, I retained only a single block of amber containing a large and a small worker of "*D.*

theryi" side by side and designated as K. 6397, in my paper on the "Ants of the Baltic Amber" (1914). The large worker, which measures fully 7.5 mm., is very clear, but the head of the small worker, which measures only 4 mm., is obscured by a film and some bubbles of air. I have now had the block cut down and repolished, so that the head of the small individual is more clearly visible. It proves to belong to the form which I called *D. mayri,* and is really a media of the same species as the large (maxima) worker. The latter has small but very distinct ocelli, but none can be detected in the companion specimen. Since *G. annectens* is clearly intermediate between *D. mayri* and *G. hoernesi,* the former is, in all probability the large minima, whereas the latter represents the small minima of Mayr's species. I am, therefore, of the opinion that all the specimens of Dimorphomyrmex and Gesomyrmex in the Baltic amber belong to a single polymorphic species, which should be known as *G. hoernesi* Mayr.[1] This is of considerable interest, because it shows that as far back as the Lower Oligocene one Formicine ant had not only reached a high degree of specialization in the reduction of the number of antennal joints of the worker from 12 to 8, but that this caste had become as polymorphic as it is in the living species of the genus now confined to Indonesia and Southern China. And conversely, the very rare and sporadic occurrence of these forms shows that they are really living fossils which have undergone no significant modification since the Early Tertiary.

The workers collected by Dr. Kalshoven were accompanied by several milk-white larvæ of different sizes and a single semipupa. The larvæ resemble those of other Formicinæ in shape, but are almost hairless. The head is very small and subglobular, the mandibles minute, with only an apical tooth, which is drawn out into a slender, acute point. The semipupa measures a little over 7 mm. and is not enclosed in a cocoon. We must infer, therefore, that the pupæ of Gesomyrmex are naked as in a few other genera of Formicinæ. (Œcophylla, Prenolepis, Paratrechina). The semipupa is clearly a male. It has well-developed wing-pads and rudiments of the genital valves, and the imaginal head (Fig. 1, k)

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[1] Compare my figures 50-53 in "The Ants of the Baltic Amber."

is sufficiently developed to enable me to determine its main peculiarities. As will be seen from the figure, it is broader than long, with evenly rounded, convex, postocular region; the eyes are very small, for a male, not longer than the cheeks, not very convex and situated at the sides of the head; the ocelli are moderately large but flat; the antennal insertions are very far apart and near the anterior orbits; the antennal scapes are short and abruptly bent outwards at their tips (probably a pupal character), the funiculi short, thick and distinctly 6-jointed (!), instead of 7-jointed as in the worker; the clypeus is rounded and slightly projecting in the middle; the mandibles small, narrow, edentate and rather blunt. The specimen is of considerable interest because no other male of the genus is known, though Mayr carefully described and figured what he took to be the male of *G. hoernesi* from a rather poorly preserved specimen in the Baltic amber. Although we must allow in my description of the male semipupa of *G. kalshoveni* for later pupal changes (especially, perhaps, in the number of funicular joints), it is clear, nevertheless, that the male of this species is decidedly different from Mayr's specimen. This has enormous eyes, constituting the greater portion of the head, very minute pointed mandibles, very slender 11-jointed antennæ and very minute genital appendages. Although the wing-venation agrees closely with that of the female *G. luzonensis,* I believe that Mayr's specimen must belong to some other hitherto unidentified Formicine genus.

Two other fossil ants supposed to be allied to Gesomyrmex may be briefly considered in this connection. The first of these is a large-eyed worker which Emery described from the Sicilian amber of Miocene age, as *Gesomyrmex corniger.* His description and figures, however, show that this insect cannot be included in the genus Gesomyrmex. The shape of its head, mandibles and petiole, the presence of long oblique spines on the epinotum, the very long maxillary palpi, the abundant pilosity, peculiar rugosity of the head, pro-and mesonotum, the blackish coloration and the possibility that its antennæ may be really 9 or 10 instead of 8-jointed, led me to place it in a distinct genus, Sicelomyrmex. Apart from the peculiar recurved horns at its posterior corners, the head of this ant is more suggestive of the Neotropical

Gigantiops and the Congolese Santschiella than of Gesomyrmex. The other ant is *Prodimorphomyrmex primigenius* which I described from the Baltic amber. It approaches Gesomyrmex much more closely, but has smaller eyes, 10-jointed antennæ and a shorter thorax. Only a single imperfect specimen was observed.

The following would now be the corrected synonymy of the known species of the genera I have been considering:

Living Species

Gesomyrmex chaperi Ern. André. Borneo, Sumatra.

Gesomyrmex chaperi Ern. André, Mém. Soc. Zool. France 5, 1892 p. 47, Figs. 1-3, worker minima; Emery, Gen. Insect. Formicinæ 1925, p. 47, Pl. 2 Fig. 3, worker media.

Dimorphomyrmex janeti Ern. André, Mém. Soc. Zool. France 5, p. 51 Figs. 4 and 5; worker maxima and media.; Emery, Ann. Soc. Ent. Belg. 43, 1894, p. 494, worker maxima.; Emery, Gen. Insect. Formicinæ 1925, p. 47, worker maxima and media.

Gesomyrmex luzonensis (Wheeler). Philippines.

Dimorphomyrmex luzonensis Wheeler, Proc. New England Zool. Club. 6, 1916 p. 16, Fig. 4, female; Emery, Gen. Insect. Formicinæ 1925, p. 47, female.

Gesomyrmex howardi Wheeler. China.

Gesomyrmex howardi Wheeler, Psyche 28, 1921 Fig. 2, worker media and minima; Emery, Gen. Insect. Formicinæ 1925, p. 47, worker media and minima.

Gesomyrmex kalshoveni Wheeler. Java.

Described above p. 2 from the maxima, media and minima worker and male semipupa.

Extinct Species.

Gesomyrmex hoernesi Mayr. Baltic Amber.

Gesomyrmex hoernesi Mayr, Beitr. Naturk. Preuss. 1, 1868 p. 52, Fig. 38 to 41, worker minima; not the male; Dalla Torre, Catalog. Hymen. 7, 1893 p. 176; Ern. André, Bull. Soc. Zool. France 20, 1895 p. 82; Handlirsch, Foss. Insekt. 1908 p. 859; Wheeler, Ants, etc. 1910 p. 170, Fig. 100; Wheeler, Schrift. physikal-ökonom. Gesell. Königsberg 55, 1914, p. 108, Fig. 53, worker minima.

Dimorphomyrmex theryi Emery, Bull. Soc. Ent. France 1905 p. 188 Fig. 1, worker maxima; Handlirsch Foss. Insekt. 1908 p. 868, worker maxima; Wheeler, Ants, etc. 1910 p. 173, Fig. 98, worker maxima; Wheeler, Psyche 17, 1910 p. 132; Wheeler, Schrift. physical-ökonom. Gesell. Königsberg 55, 1914, p. 104, Fig. 50, worker maxima.

Dimorphomyrmex mayri Wheeler, *ibid.* p. 106, Fig. 51, worker media (large).

Gesomyrmex annectens Wheeler, *ibid.* p. 107, Fig. 52, worker media (small).

Prodimorphomyrmex primigenius Wheeler. Baltic amber.

Prodimorphomyrmex primigenius Wheeler, Schrift. physikal-ökonom. Gesell. Königsberg 55, 1914, p. 112, Fig. 54, worker.

Sicelomyrmex corniger (Emery) Sicilian amber.

Gesomyrmex corniger Emery, Mem. Ist. Bologna (5) 1, 1891, p. 581, Figs. 33-35, worker; Wheeler, Ants, etc. 1910, Fig. 101, worker.

Sicelomyrmex corniger Wheeler, Schrift. physikal-ökonom. Gesell. Königsberg 55, 1914, p. 111, worker; Wheeler, The Social Insects, etc., 1928, Fig. 27, worker.

The affinities of Gesomyrmex and Dimorphomyrmex to other Formicine genera have been discussed by Forel and Emery. In his revision of the subfamily Formicinæ (1925), Emery places the two genera in his sixth tribe, or first tribe of the section Euformicinæ, which he bases on characters drawn from the gizzard (proventriculus). Unfortunately, he named this tribe Dimorphomyrmicini (his Dimorphomyrmii of 1895). Since the genus Dimorphomyrmex now passes into the synonymy, the tribe will have to be called Gesomyrmicini (Ashmead, 1905). This tribe, according to Emery, would contain besides Gesomyrmex only the genera Brachymyrmex, Aphomomyrmex and Cladomyrma. The three latter are supposed to be so closely interrelated that they form together the subtribe Brachymyrmicini, leaving Gesomyrmex to represent a subtribe by itself, to which Emery gave the same name as the tribe (Dimorphomyrmicini). He evidently based his tribe on the small number of antennal joints (8-9 in the worker, 8-10 in the female) instead of the 12 observed in both of these castes in all Euformicine genera, except certain fossils (Dryomyrmex and Prodimorphomyrmex). But the general habitus of Gesomyrmex is so different from that of Brachymyrmex, Aphomomyrmex and Cladomyrma, that its relationships would seem to be better expressed by regarding it as the representative of an independent tribe (Gesomyrmicini). This would necessitate raising Emery's subtribe Brachymyrmicini to tribal rank. I believe that the tribe Gesomyrmicini would thus be more naturally placed as one of the series of tribes, including the Santschiellini Forel, Gigantiopini Ashmead and Œcophyllini Ashmead, which are all based on single archaic, relict genera of large-eyed ants. The fossils Prodimorphomyrmex and Dryomyrmex may, perhaps, be assigned to the Brachymyrmicini, but *Sicelomyrmex corniger* should be regarded as the representative of an extinct tribe, the Sicelomyrmicini.

We are still in the dark in regard to the habits of Gesomyrmex. The well-developed claws in the worker and female and the not infrequent occurrence of *G. hoernesi* in the Baltic amber, suggest that the genus is arboreal. Moreover, the structure and sculpture of the anterior portion of the head in the maxima and female and the peculiar stubby hairs on the clypeus are reminiscent of some species of Colobopsis and allied subgenera of Camponotus, which live in hollow twigs or small cavities in bark or wood.

PRESENT TRENDS IN SYSTEMATIC ENTOMOLOGY.[1] GENERAL DISCUSSION.

By Charles T. Brues,

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When I was asked recently to address a group of entomologists on the present activities in taxonomic entomology, I had grave doubts that the tendencies evident in the work of this large but frequently despised group of zoologists would be of any interest to students of insects in other fields, or even to the taxonomists themselves. The latter expectation seemed especially probable as systematists have become quite callous to derogatory remarks from biologists not versed in taxonomy, and have tended to lapse into a condition of *laissez faire* with reference to the relations of taxonomy to the other branches of zoology. Also I can by no means lay claim to that broad familiarity with insect taxonomy which should be expected of one who essays to outline its tendencies. Nevertheless there is some advantage in viewing such matters after frequent visits into other fields, for every return brings a new series of impressions which serve to throw into relief the changes that are gradually taking place.

Systematic entomology is growing old, and like a living organism it exhibits the usual signs of age in the development of fixed eccentricities of behavior. Fortunately for the ultimate progress of biology it has not persisted as a single entity, for it has produced during its long lifetime a series of distinguished, but not always harmonious offspring. These are now so vigorous and some of them so self-satisfied that they occasionally betray their disapproval of the motives and accomplishments of the other members of the family. At the present stage of our science their actions would seem to presage a lively future for entomology as

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[1] This and the paper that follows were presented as part of a symposium at the annual meeting of the Entomological Society of America in New York City, Dec. 27, 1928.

younger and less strongly inhibited generations come into being.

Like the poor old overworked phylogenetic tree of life, systematic entomology has developed many branches, each of which engages the attention of a series of zealous searchers for truth. Its growth has been purely spontaneous, and it has so far suffered few serious setbacks. For some millions of years Nature has pruned the phylogenetic tree until any second-rate gardener would shudder at its appearance. Decadent branches have been ruthlessly lopped off without respect to symmetry, age or prestige. Its twigs have developed millions of bud variations; it is enveloped in a tangled mass of parasitic vines and further beset with galls, excrescenses, and tumors. If it were anything more than a convenient diagram for evolutionary progress, it must have needs long since crashed to the ground. Its more ancient aerial parts have literally crumbled to the earth for we now find bits of them preserved as fossil remnants. These are being slowly reclaimed and furnish the setting for an historical background. At the present time the primary basis of systematic entomology consists of the greater part of a thin horizontal section through this tree at its upper level—the living insect fauna. It appears as a hopelessly complicated mass of details; nevertheless we know that its ten million species form no haphazard assemblage, but that they exist as an integrated whole, so thoroughly integrated in fact, with reference to its component parts, to other living organisms and to physio-chemical conditions that we stand at present utterly helpless before it, unable to analyze the smallest part of its complicated structure.

As personalities tend to become similar after long association, entomologists might be expected to become so thoroughly integrated in their work that they could enter this biological maze with understanding. That would be the milennium. We may justly ask if systematic entomology as represented by its many adherents is entering upon a stage where it will pave the way, through an understanding of the taxonomic affinities of insects, for entomologists as a whole to fathom their biological interrelationships. In other words, are the present trends of systematic entomology leading to this goal which represents the biological Mecca?

I am fully aware that the present Mecca of many biologists lies in quite another direction—in the reduction of the phenomena of life to physics, chemistry and mathematics, but am not willing to concede that this will prove to be either the final goal, or the methodology which will lead to it.

This attitude has arisen through the more or less tacit assumption that biology will finally find its place among the exact or mathematical sciences. This is regarded by the systematic biologist as a wholly undesirable if not impossible attainment. They have already cast aside any substitution of numerical notation and symbols for binomial names and higher groups, as in no way simplifying the expression of taxonomic relationships. The reactions of organisms to light and heat, their growth and metabolism, the interactions of their genes in inheritance and many other phenomena which are due to similarities of their make-up are capable of mathematical expression as entities, so perhaps might be the combinations and permutations of these. Evolutionary change which is of primary importance to systematics and phylogenetics on account of its historical aspect is a process of differentiation, recombination or emergence, and to believe that this has proceeded upon uniform or predictable lines does not aid in organizing the mass of data which taxonomy has so far accumulated.

To observe the way in which one is viewed by his colleagues is generally a fair method of discovering one's shortcomings and it may sometimes even lead us to discover our virtues. In either case it aids in the development of the submissive spirit which is a formidable asset in approaching the altar of Nature. As taxonomy is the oldest branch of natural history we may regard the newer branches as younger brothers and sisters whose criticisms are tinged with juvenile jealousy and largely to be discounted. Of these younger branches morphology is the first child of taxonomy; indeed she is already becoming so Victorian in the eyes of the rising generation, that I hesitate to be seen smiling at her in public. Comparative morphology may be regarded either as the tool of taxonomy, or as a by-product of the latter; unfortunately it is sometimes pursued independently which greatly limits its field of usefulness. Many of the contacts of systematic entomology with morphology relate to matters of nomenclature and these are perhaps the most unfortunate ones. The majority of morphologists hold the idea that the present instability in nomenclature as it relates to generic names is a disgrace which entomologists may be expected immediately to remedy. Most entomologists agree with them heartily and some have offered to supply remedies. As the affliction becomes chronic, many kind friends suggest new remedies and we are urged to learn by trial and error the benefits of each. At the present time we are powerless to stem the rising tide of names resurrected from oblivion by a few industrious searchers who follow this pursuit as a pastime or mental discipline during their leisure hours. By the rediscovery of some long-forgotten pamphlet it is possible with very little effort to cause an uproar whose echoes ring for many years. When a series of such commotions in rapid succession fails to drown out the small voice of the non-combatants who believe that the face of Nature is being changed too rapidly, deeply pitched cerebrations on the part of others bring forth new interpretations of previous literary researches, and so far as we can foresee, this process may go on forever. At the present time almost no branch of systematic entomology is free from this incubus and it is difficult to view with equanimity the future of entomological nomenclature, in spite of the protestations of those who insist that they are submerging their personalities for the good of science. There is of course some hope that the International Commission on Zoological Nomenclature may be able to restore order. They are struggling valiantly toward that end, but they need good honest support. I think that most of us are willing to give this, both actively and passively. The latter is particularly easy for it saves vast quantities of energy, breath and printer's ink, all of which find a ready market for other purposes. Perhaps no group of entomologists have suffered so long and painfully from nomenclatorial unrest as the lepidopterists[1] but their colleagues in other fields are facing the rapid approach of an equally distressing situation.

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[1] Dr. Forbes' discussion on a later page (p. 21) of the present issue of Psyche deals in an admirable way with this question.

Another criticism of systematic entomology that comes from the morphologists is that we do not take their work sufficiently into account as a basis of classification, and some have even gone so far as to elaborate new classifications of their own. Their contention does not seem to be well founded and a canvass of the present situation in this regard seems to justify the statement that never before have taxonomists (with a few notable exceptions) been so keen in their treatment of characters for the limitation of higher groups and in attempting to indicate phylogenetic relationships. Only those who have labored thus to bring order out of chaos appreciate (to borrow a very self-satisfying political expression) the "intricate complexity" of modern taxonomy, which by the way has the science of government skinned a mile when it comes to complexity. This very fact has developed another trend which is the continuous movement toward great specialization among taxonomists. Its necessity and advantages are obvious, but its drawbacks are very serious and unfortunately not always appreciated by the individual worker. There are at present really two types of specialists in taxonomy. One may be considered to include those who early acquired a general knowledge of insects and later settled upon some particular group to which they have devoted their energies. The other class includes those who have very early undertaken to specialize on a small group. The latter series is made up mainly of college students who have been assigned to taxonomic problem by some indulgent professor who hopes that he may rapidly impart to them the general familiarity with insects that he has acquired from long and tedious experience. Incidentally he knows that it will keep them busy. This method is not always entirely successful since it frequently develops such enthusiasm that all other fields of general value to taxonomists may be neglected. This class of workers has been rapidly augmented during recent years by the great urge to enter early into productive research, a condition which prevails in all departments of biology alike. It is fostered by marked changes which are occurring in our colleges and universities and particularly by the many luscious plums that are dangled before the noses of prospective research workers in the form of research endowments and fellowships. From the many temptations toward too early specialization systematic entomology suffers more severely than the more recently developed branches since its literature has grown to be far more extensive and the details with which it deals are not only more varied but more complex as, they do not appear to be reducible to simplified expression or generalization. Can we say that we are honestly giving these problems the attention they require in the training of taxonomists?

The contributions of genetics are providing a great amount of material which is of broad importance to systematic entomology and this is gradually being utilized by taxonomists to broaden their ideas concerning specific relationships, veriability, polymorphism, etc. Genetics sometimes complains that taxonomy should make wider use of its methods and discoveries. We can only reply that we hope to do so more fully in the future after we have again corralled all the insects that Noah let loose on Mount Ararat, together with any new species, hybrids and mutations that may have come into being since that time. Certainly the discoveries of genetics have already greatly modified the taxonomic treatment of species and intraspecific forms, but so far it has been impossible to utilize them to modify the current methods of comparative morphology in dealing with larger groups.

One present trend of systematic entomology is difficult to see in a clear light. Physiology, together with its child ecology, which is really a nursery of young children not yet quite capable of socializing their behavior, is a department of biology whose methods and outlook are rapidly changing. So far the contacts of physiology and ecology with taxonomic entomologists have been few and mainly confined to the utilization of the taxonomic laboratory as a workshop where trained mechanics could repair and get into understandable form certain lists of names representing the materials investigated by biologists to whom taxonomy and nomenclature is a totally unknown, thickly populated, but nevertheless utterly barren field. Fortunately, through the intervention of ecology it appears that physiology and taxonomy have come to regard each other with greater respect and there are indications that taxonomy may in the future greatly profit by the investigations of her co-workers in physiology, who in turn would not suffer any great degradation from a slight knowledge of systematics.

Taxonomy and phylogenetics are of course so inseparably united that it is impossible to deal with any aspect of one without considering the other. The structure of the phylogenetic tree is such that it brings into taxonomy a fourth dimension which is difficult to deal with nomenclatorially at least. This condition is by no means restricted to entomology, but as we shall see in a moment it promises to become more acute with insects than with other groups of animals. The development of insect paleontology has until quite recently been very slow and restricted to a small series of fossil forms, most of them comparatively recent and some of the others dating back to what appears to be the earlier pages of entomological history. Naturally most of these ancient forms are more or less annectant between modern orders, and have been grouped taxonomically as a very generalized extinct order, Palaeodictyoptera. The recent discovery of undoubted precursors of particular living orders or families and a vast series of genera and species before the mesozoic indicates that very soon we shall have numerous annectant forms between families and even orders that will form a number of taxonomic anomalies. Moreover many of the Persian fossil insects are so well preserved that their relationships may be very accurately determined. So far these fossil forms have generally been placed in separate orders, families and genera, but as these rapidly multiply and overlap one another they will produce an intolerable condition in the nomenclature of higher groups. This is more especially true as some groups have persisted over long geological periods while others have undergone a much more rapid evolution. It is also evident from studies of the beautifully preserved insects of early Tertiary age in Baltic amber that the same difficulty is arising here among the genera of the more recent groups of insects. Some entomologists still cling to the idea that fossil insects can be dealt with as a series apart. Naturally we can deal separately with a Permian and an Oligocene fauna but we cannot regard them taxonomically or nomenclatorially as any more independent than the present day faunas of New England and Italy.

An entirely different aspect of systematic entomology that has advanced by rapid strides during the last few years is our knowledge or the preparatory stages of insects. A number of very successful attempts have been made to deal taxonomically with the larval stages of diverse groups; many Lepidoptera, Diptera, Hymenoptera, Coleoptera and Trichoptera have been studied with great care and if the human race persists long enough this task will increase until it becomes larger and undoubtedly more difficult than that presented by imaginal insects. So far it has corroborated many of the conclusions reached from taxonomic studies on adult insects and has served to give us faith in the principles of entomological classification. Considering, as we have said, the intricate complexity of the insect fauna, entomologists can point with pride to their accomplishments during the past 70 years of the post-Darwinian regime; and that is one very good reason why none of us wishes to return to the fundamentalist doctrine that we can never understand organic relationships. It must be admitted that some scandalous discrepancies as well as many minor errors of judgment have been exposed by this work on the preparatory stages, and these are proving a great aid toward clarifying systematics in various groups, especially those where characters of dubious validity have been widely used.

Throughout all the most recent work in systematic entomology there is a most pronounced tendency toward great specialization, and a growing worship of the species and the type specimen. The former is nurtured as we have said by the desire to enter very early into productive research, and the latter is fostered most assiduously by the modern museum curator. There is also evidence on every side that systematics is being systematized and standardized, just as business, teaching, manufacture and every other human activity has been mechanized at the hands of the efficiency expert. The last has been lately transmuted into the administrator or popularly as the modern executive. So far few entomologists have fallen under this spell, for most of them are more interested in their work than in aspirations to the mahogany desks, telephones and the other furnishings that are prerequisites of such a job. Some of them at least may be trusted to remain as free lances who are ready to drop an occasional fly or other specimen in the entomological cream as it emerges in a velvety stream from the systematic separator. It is only such behavior that will prevent a too great uniformity in our product.

PRESENT TRENDS IN SYSTEMATIC ENTOMOLOGY. SCIENTIFIC NAMES.[1]

By Wm. T. M. Forbes

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Of the several millions of kinds of plants and animals in the world, there are some hundreds that any one of us may wish casually to refer to. These have received "common" names and if they alone existed, scientific names would be unnecessary. My present concern is only with the remaining millions. How shall we tag each one of those millions so that on the rare occasion when one of us must mention it to another we can make ourselves understood?

In ancient times the problem was hardly visualized. The hundreds received each a name. Any other creature was a "creeping thing after his kind." In the next stage, the idea "his kind" was represented in some way and we have the beginning of our scientific scheme. At this stage we have a name—a group name—that any one can understand, and the distinguishing word or words that mark a single member of that group:—a butterfly, "Papilio" and *that brown* butterfly, "Papilio fuscus," or the particular brown one with eyespots, "Papilio fuscus ocellatus."[2]

Linnæus began with this plan, which had grown up gradually, and took a step further. Instead of a series of adjectives he chose—arbitrarily—one single word to designate a particular kind of butterfly. He did it casually, it was just a convenient tag,—a *nomen triviale.* And with this step the present cycle begins. That "trivial name" was so convenient that it overshadows our whole system of names. The oldest name (the common name) was known to all and needed no rules; the second type was descriptive, at least in rudiment, and took care of itself, but the new "trivial" kind was arbitrary; it carried no meaning in itself, but only by agreement; so it was necessary to find a basis of agreement.

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[1] See footnote on page 11 of this issue.
[2] My examples are imaginary.

There are three bases of agreement:—

AUTHORITY
PRIORITY
JUDGMENT

The assignment of names may be put in the hands of some *Authority*. During Linnæus's life, by a sort of general consent he was recognized as the Authority: when he used a name that name stood, when he saw fit to change it, the world changed too. And when Linnæus died, his successor, Fabricius, stepped into his place (I am speaking of entomology). Fabricius seems to have claimed this mantle of authority, but it was not unanimously conceded to him, and as disputed authority without power is no authority, this policy fell into abeyance until the formation of our International Commission.

The second obvious plan was *Priority*. Let the oldest name rule, beginning with the book in which Linnæus first proposed this scheme of things.[1] This sounds excellent, but complications soon arose. Let us consider merely the "trivial name." Two workers recognize or discover a species about the same time in different countries. Each gives it a trivial name, and each name gets currency in its own country before it is recognized that both are the same creature. Then the question is raised: Which is prior? If there is doubt, and there well may be, each country favors its own worker, and we have two or more rival names.

At the time that Fabricius retired from the field we have a further complicating factor that *we* can appreciate better than the last generation. That was the time of the Napoleonic wars, and literature did not always travel freely. Also there was a nationalism that interfered with the application of the law of priority when a national difference of usage appeared. We have one outstanding case in the Lepidoptera, where all these difficulties fell together—Hübner. Hübner was a rival of the authority of Fabricius; his works were irregularly used and carelessly dated if at all; and he was

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[1] For a long period the tendency was to reserve Linnæus' own authority, and begin the rule of priority at the point where Linnæus laid it down.

publishing in Germany at a time when it was cut off from France.[1] As a result names he gave have been a bone of contention from the beginning. And from the beginning there has been a tendency to give the other party the benefit of the doubt, whenever there was any uncertainty of priority of date.

Now appears the third policy, *Judgment*. From this period of confusion and for a century more, most authors gave up hope of agreement on any *authority*, or of any certainty of *priority*, and merely used the name they thought most likely to be correctly understood by their readers.

So much for the "trivial" name.

Next is the genus; in this case we have all the factors we have been displaying in the matter of the trivial name, affecting the name as a *name*; and superposed on this we have a second, confusing factor. Besides *nomenclature*, we have *classification*. At first the genus name was merely the vernacular (Latin) name, familiar to every one who read Latin. Every butterfly was Papilio, every moth, Phalæna. But even in Linnæus' time it seemed necessary to divide this mass, for instance to have a name by which we could tag all the "four-footed" butterflies; and there gradually came, with an emphasis on more and more abstruse characters a steady subdivision of the original genus.

This raised the question: when you divide a genus, which part takes the old name, and which gets the new one? Here we have two choices,—or three. We may try in one way or another to find which the original author thought most characteristic of his name, and center our new group about that species (the type), or we may leave it to the man who divides the genus to use his judgment. There is a third method, largely used, I believe by ichthyologists, but also by a few entomologists—to cut the Gordian Knot, and arbitrarily choose the species the author happened to mention first. Some would qualify this choice in one way or another; a few have applied it even where the author expressly says his first species is not typical, or where his first species, in contrast to others, violates his definition.

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[1] My friend Benjamin finds his "Tentamen" (issued in 1806) was used or referred to in practically every country but France.

Our present code orders us to use the type method. For the past half century the other two methods were almost consistently in vogue. And this change—in origin a compromise between these two in themselves wholly contradictory methods—is the basis of a large proportion of the recent violent shifts in names.

The code supplies a nominal loophole in the "conservanda principle." If a name is in general use, though it violates the code it may be validated (in one or another way) by the Commission in suspension of rules. Unfortunately this method breaks down, because the preparation of a case and the validation is a long and tedious matter, and in the meantime code-enthusiasts take up the technically valid but dormant name, so that long before a decision is reached, the unanimity on which a decision should be based has vanished. And where there is any real uncertainty, with a resulting real confusion of use, the process has generally broken down completely.

There is a complication which seems at first minor, but works out near the bottom of most of our practical difficulties. This is where the two names have been given to what is practically the same list of species. In that case shall we treat the two names strictly as synonyms, or if the group is later divided, shall we use each of these names for one of the later groups? The latter has been rather the tendency, but the practical result of our present code is highly inconsistent, and the earlier practice (so-called elimination method, actually giving the right to the first reviser) produced a high per cent of ambiguous cases, mainly because the two authors who had originally proposed the rival names hardly ever had just the same assortment of species before them. In practice we cannot be quite sure whether they meant the same thing or not.

Take Danaus, Pieris, Pontia, etc.,—these half a dozen names were all intended primarily for the cabbage butterflies. Yet each author had doubtless a different conception. Linnæus, who included the monarch, certainly did not have quite the same conception as the later workers.

Thirdly we have the names of groups. This is also a very old category, as Aristotle if not even earlier philosophers, had their groups of animals and plants, Entoma and the rest. Where our recent history of genera and species has been a war of policies and codes, the group names till very recently have been nearly free from all this. Practically our present code only requires two things, (1) if the group name is based on a genus, it must be a genus-name recognized as valid by the writer; (2) it must not be a homonym. Outside of this we have merely the policy of "judgment" formerly in use for all names, and still in use for morphological nomenclature and the like.

Just before the war began a movement to bring these group names also under a strict law of priority. It was sponsored in the fields best known to me by people who had a unique code somewhat different from the official one, and resulted in some weird changes as they applied it. This first attempt was to require that the name of each family must be based on the *oldest* genus-name in it, regardless of whether that name had ever been used as the basis of a group-name before.

Another worker has (for family names) considered those names which end in the present conventional ending for family names (-idæ), and applied the law of priority strictly on that basis. Others give priority to the oldest group-names involved, regardless of its exact form, and modify it to the conventional present-day form for the category concerned.

Most recently there has appeared a group who wish to extend the "type" principle to these group names, and have a certain species (or genus) chosen as type of each higher group, which shall always be in the group. In this case if the type genus changes its name the family will also change to the corresponding name.

An example: Our *Ctenucha virginica* belongs to a certain family, long known as the *Syntomidæ*. The genus Syntomis is a synonym of Amata, so (unless the present hopelessly slow conservanda mechanism comes into play), we must abandon Syntomidæ even under the present brief provisions of the code. The type of the Syntomidæ may be considered *Syntomis phegea*, the type of Syntomis as generally used, now become *Amata phegea*. Shall then the name of the new family be *Amatidæ*, as used by Hampson? or shall we resurrect the old name of Packard, Grote and others and call it *Euchromiidæ*, Euchromia being a perfectly valid genus, but in another subfamily?

What then, is the *tendency* in nomenclature? I see two, definitely at war with each other. One is in nearly complete control of one field (the specialists in nomenclature), the other has nearly as strong a hold in another (the general workers). *First* we have an attempt to rectify law by more law,—to improve, supplement and clarify our present code by further legislation. I know the weight of colleagues of mine behind this point of view, which is exceedingly plausible, for it would seem as if by either rule or judicial decision a million names might be managed as well as a million people. But new people are born, and new problems arise, and personally I see no end. There is the further difficulty that we have only one court for first and final resort alike. Its docket is hopelessly crowded now, and yet it only passes on a minute proportion of the cases in urgent need of decision. If we wait for this method the millenium will see us waiting; if we apply the rules informally and unofficially on each doubtful case that comes our way, experience has already shown that we will come to about as many conclusions as there are entomologists.

Finally we may return to the practice that arose in the days of the Napoleonic wars, when the old custom of Swedish authority broke down. Let each man choose the name that he thinks least likely to be misunderstood by his readers, regardless of rules, precedents and priorities. This will obviously lead to inconsistencies, to current synonyms side by side, and, perhaps most serious, to divergent national uses. But experience seems to indicate that there will be a gradual drift toward uniformity, for after all, the name most in use is the one most likely to be correctly understood, and a name already in dominant use will with steadily increasing momentum, tend to occupy the field.

It seems to me that in the field of major groups, where there has never been a formal code, and confusion is not really great at present, this is the only true good policy.

When we come to genera and species, where we have complex existing codes, the matter is less simple. I believe it is best to follow the code wherever we can do it without confusion; but to anticipate the likelihood of a conservanda decision in many cases where a strict interpretation of the code would seem to overturn a well-known name, and continue to use the current name in the interim, till the preparation and decision of a case before the Commission is possible. But *when a definite decision leads to a definite name,* to accept the decision as promptly as possible. A decision which leaves a residual ambiguity, as in a recent notable case, I should not interpret as a final decision.

We end, then, much as we began under Linnæus; with *Authority,* qualified by *Judgment,* especially where authority does not lead to an unambiguous result; following *Priority* as far as practicable, but not making it the final arbiter.

ON CERTAIN FORMS OF COMMON AMERICAN BUTTERFLIES.

By Austin H. Clark

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In any large series of butterflies of any single species the individuals are seen to be divisible into various forms. These forms are of two types, those due to a response to environmental conditions, that is, to a response to the chemistry and physics of their environment, and those due to physiological indiosyncracies on the part of certain individuals, that is, to their internal chemical and physical condition.

Examples of the first are cold and hot and wet and dry forms and local varieties. Examples of the second are alternative forms in either sex or in both sexes, and most of the variants usually classed as "aberrations."

There is no sharp distinction between these two classes, for a species may have, for instance, a long range of alternative forms in one region and none in another, or variants of one or several types may be frequent in one area and rare or unknown elsewhere, or may occur only in certain years, which clearly has to do with environment.

In the following pages attention is called to a few forms from among our common native butterflies which, by analogy with corresponding forms elsewhere, seem susceptible of interpretation as wet and dry forms.

It is presumable that a wet form of a butterfly is a form adapted to developing in the presence of an amount of moisture equalling or in excess of the maximum requirements. This moisture may be furnished either in the form of abundant water in the food, or abundant water available for ingestion with the food. A dry form would be a form living in the younger stages on food with an amount of water at or near the minimum requirements. This might be due (1) to seasonal variation in the precipitation, (2) to differences in soil conditions, as between bogs and well drained dry uplands, or to seasonal variation in the condition of the food plant, as for instance the moist condition up to the time of flowering and the dry condition after flowering or toward the end of the growing season.

Wet and dry forms are more or less independent of temperature. For instance, all the forms of *Eurymus eurytheme* about Washington in the summer are clear yellow on the under surface of the wings and in the autumn are heavily infuscated. But wet forms seem to be very sensitive to dessication in the extreme cold of winter if they hibernate as adults or as pupæ.

Here as elsewhere there is to be remarked a considerable difference in habits between wet and dry forms, the latter being always the more active.

Junonia cœna.—The common buckeye occurs in the District of Columbia in two quite different forms.

In the usual form the fore wings measure about 27 mm. in length in the females and about 24 mm. in the males. The ground color above is a medium brown. Beneath the ground color of the hind wings and of the apex of the fore wings is light gray, usually slightly tinged with buff, and there are two conspicuous oval black spots about as broad as, or narrower than, an interspace which are narrowly ringed with buff not far from the outer margin of the hind wings.

The wings are dry and brittle, and nearly all the individuals caught are nicked or more extensively damaged.

This form is exceedingly alert and active and a very strong flier. If alarmed it flies rapidly away, often not pausing before it is out of sight. It is fond of flowers, especially white flowers rising well above the grass, and for resting it always chooses the summit of a tall weed or of a tall dead stem or the bare ground from which it can easily dart away in any direction.

It is found throughout the District, most abundantly in dry open country, and is not infrequently noticed in the parks and about the streets of Washington.

In the other form the fore wings are about 30 mm. long in the females and about 28 mm. long in the males. On the upper surface the ground color is dark and the brown of the fore wings and of the outer half of the hind wings sometimes shows dark green metallic reflections. On the under side the whole of the hind wings and the apical portion of the fore wings is dull pinkish red, often quite uniform, but usually darkest in a long irregular narrow triangle bordered by irregularly crenulate lines running from a base near the outer angle to an apex near the anal angle. This triangle often includes two small oval blue spots narrowly ringed with lighter, or some traces of such spots. The wings are somewhat fuller and less angulated than the wings of the preceding form.

The wings are curiously soft, and are rarely broken or torn, though they may be rubbed. The insect always feels as if it had recently emerged from the chrysalis.

It is sluggish and rarely flies for more than fifty feet or so, alighting usually on the ground in thin grass or weeds. It is not shy and is easily captured. I have never seen it on a flower.

It is exceedingly local and is confined to boggy lowlands with an abundant growth of *Agalinis purpurea* on which the larvæ feed. It is very numerous in the restricted areas where it occurs, appearing in late summer.

Not infrequently in late summer individuals of the small light form are taken in moist areas which show an approach to the large dark form in a greater or lesser development of pink markings on the under side of the hind wings. But as a rule the two forms are quite distinct, at least in this region.

As the large dark indolent form is strictly confined to wet meadows while the small light form is the only one occurring in dry situations, it is logical to consider the former as a "wet" and the latter as a "dry" form. Moreover, the differences between these two forms are essentially the same as those between the wet season and the dry season forms of the Asiatic *Junonia orithya, J. almana* and *J. iphita.*

In Asia the wet and dry forms of *Junonia* alternate. With us the wet form develops from eggs laid by the dry form, as in India. But it only develops in water-logged localities, the young of the dry form elsewhere being a new dry generation.

So far as known the wet form in the District of Columbia dies out completely during the winter.

The wet form of our *Junonia cœna* in this region, therefore, is represented by local colonies leaving no descendents which originate from dry parents.

Cynthia atalanta.—Like the buckeye, the red admiral occurs in the District in two quite different forms. In boggy areas with an abundant growth of the false nettle (*Bohmeria cylindrica*) there appear in late summer large individuals which above are blackish instead of brown with the border of the hind wings redder than in the usual form and the band on the fore wings redder and narrower and crossed by black veins, and below are much darker, especially on the hind wings.

This form differs from the usual type just as the "wet" form of *Junonia cœna* differs from the "dry" form, occurs in the same localities, and appears in the same way in late summer.

It seems not to survive the winter, as all the numerous spring individuals caught in the places where the dark form is later to be found are of the small brownish form. It is to be interpreted as a "wet" form descended from "dry" parents and leaving no progeny.

Cynthia cardui.—Within the District, and throughout the whole of New England except for the southern coast, the painted lady when it occurs is represented by a large form with the fore wings slightly shorter than usual and sometimes very short, and the hind wings slightly broader and more rounded. The color is dark and brilliant, and the upper surface and the inner portion of the lower surface of the fore wings is strongly tinged with pink. The submarginal spots on the hind wings are usually large, and not infrequently on the upper surface show conspicuous blue centers.

This form, which is the only one found in the District and in most parts of New England in the summer and autumn, seems to be the "wet" form of this species which, like the corresponding forms of *Junonia cœna* and of *Cynthia atalanta*, cannot survive the winter.

So far as I have been able to learn, wherever this form occurs exclusively this butterfly is of uncertain and more or less irregular appearance. It survives the winter only where the smaller, duller, longer winged form is to be found in the late summer.

The more or less irregular occurrence of this insect in great numbers over wide areas not permanently inhabited by it and its complete disappearance during the succeeding winter are readily explained if we recognize the existence of a "wet" form comparable to that of *Junonia cœna* and *Cynthia atalanta.*

The "dry" females in the spring are very active and wander in every direction, scattering their eggs over a wide extent of territory. If they are numerous and if conditions are favorable they will become dispersed over regions far beyond the area where they passed the winter.

This species differs from the two just considered in being normally an inhabitant of semi-arid regions. Under the conditions found in the District and in the greater part of New England the young from over-wintered females develop into the large and brilliant "wet" form, which appears in July. The young of these summer butterflies, appearing on the wing in late August and September, are of the same form as their parents. But in the District spring individuals, which are not at all common and are only to be seen in the low ground near the river, are always of the "dry" form.

So apparently the reason for the irregular appearance of this butterfly is that in most of the area from which it is known its caterpillars develop into a form unable to survive the winter and its occurrence therefore is dependent on regular, more or less irregular, or occasional incursions of overwintered females from elsewhere.

Polygonia interrogationis and *P. comma.*—The foregoing interpretation of the forms of *Junonia cœna, Cynthia atalanta* and *C. cardui,* and analogy with *Polygonia c-album cognata* and *P. c-a. agnicula* of the Himalayan region and *P. c-a. hamigera* of Japan, Corea and northern China, suggest a corresponding interpretation of the seasonal forms of *Polygonia interrogationis* and *P. comma.*

In the District of Columbia the light form of *P. interrogationis* is variable in color, some of the individuals being much darker than others, especially in the female. In *P. comma* the light form seems usually to be darker than in New England with more extensive infuscation of the hind wings, some individuals, indeed, being almost as dark as the dark form. In both species the shape of the wings is constantly different in the two forms, so that such indications of intergradation as occur are wholly in the color.

The autumn brood of these butterflies is invariably of the light form. The summer brood is of the dark form, with which there are usually to be found a few individuals of the light form.

These forms probably reflect wet spring and dry summer conditions acting on the food plants.

In both species there is a wide difference in the habits of the two forms, the dark form tending to remain within a restricted area in or near woods and the light form scattering widely over open country. This recalls the difference in habits of the two forms of *Junonia cœna.*

Eurymus eurytheme.—From the description of the succession of forms of the orange clover butterfly in Texas and elsewhere in the southwest it would seem that *ariadne* is a dry form of this species, *keewaydin* an intermediate form, and the deep orange *eurytheme* with a more or less brilliant violet iridescence in the males the extreme wet form.

In the District the earliest individuals to appear are of the extreme wet form, *eurytheme.* In July the *keewaydin* form appears, flying with the other until the end of the season and intergrading with it. Early in August the *ariadne* form appears, but it is scarce until after the middle of September when it becomes frequent, though not very common. It flies with the other two until the end of the season in October or November.

About Washington there is noticeable a difference in the distribution of these three forms. The deeply colored *eurytheme* is most numerous in the lower areas, especially along the river. The most intensely colored and the largest individuals are to be found in the wet meadows beyond Cabin John. In the higher country the individuals appear never to reach such a large size as they do here, while the relative proportion of the forms *keewaydin* and *ariadne* appears to be greater.

The forms *ariadne*, *keewaydin* and *eurytheme*, which appear in seasonal sequence in the southwest, about Washington seem to appear in response to very local conditions, permanent wetness in the boggy pastures and progressive drying in the higher areas, which accompany the general trend from wet spring to dry autumn.

COLORATION IN *POLISTES PALLIPES.*

By Phil Rau,

Kirkwood, Mo.

A careful examination of a half-dozen cedar trees revealed four small, partly disintegrated nests of *P. pallipes* and only one new nest which contained living adult wasps. This nest was well protected by the close foliage. The entire family was taken. All the cells of the nest were empty, showing, of course, that all of the occupants had emerged. Furthermore, there were no partly constructed cells, an indication that pulp gathering as well as egg laying stops long before the cold weather begins; at least in this nest the wasps had not gone on blindly making cells when the cold would have cut short the life of the young.

The nest was of the usual round type, and had 106 cells with 59 adult wasps upon it. All of the cells appeared to have been used but once. The population comprised 23 males, 28 workers and 8 females. The latter were larger in size and were therefore believed to be queens. That conviction was sufficintly strong to warrant the heading "Coloration in *Polistes*," for if these queens had not been present, I certainly should have identified all the others in the colony as *P. variatus;* the queens only were typical *P. pallipes.*

This entire colony of 59 wasps was taken just because it contained what I thought were two distinct species (according to the taxonomists). At first sight one would say this was a mixed colony, probably the result of its having been founded by two queens of the respective species, except for three reasons:

1. We already know the antagonism between these species.[1]

2. We often find the males of *P. pallipes* abundantly marked in yellow so that they resemble *variatus.*

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[1] Paper in course of publication.

3. If I had found only the males marked in yellow, I could have accounted for it on the ground of the usual condition of the greater tendency of the males to vary (see Enteman), but here I found that the workers, 28 in number, actually showed the coloration which is characteristic of the male; in fact, the similarity was so strong that only by counting the abdominal segments could the sexes be distinguished. The male *pallipes* showed the conspicuous yellow bands about the segments, some of which extended around to the dorsal surface; precisely the same condition obtained in many of the workers, only the degree of marking varied in the individuals of both sexes. I submitted to an expert some of these workers so colored, and he identified them promptly as *P. variatus*. Hence this is in all probability a colony of *P. pallipes*, with the males showing variation toward *variatus* and the workers too resembling the males. Dr. C. H. Turner[2] has shown that the workers of *Vespa carolina* resemble the males in coloration.

Whether this perplexing condition is the result of the founding of the colony by two mothers of distinct species, which is improbable, or whether it is a case of pure variation within the colony, it shows one very important aspect of the study of variation, viz., that it is of supreme importance to make studies from a sufficiently large number of entire colonies taken directly from the nest near the end of the season, especially in the preparation of such works as Enteman's "Coloration in Polistes." There she states (p. 21); "*P. variatus* merges into *P. pallipes* as we pass eastward, and into *P. aurifer* as we cross the plains to the southwestward," and again (p. 37) "It is hardly probable that we have in *P. variatus* a primitive species which has differentiated in two directions, but as we shall see from a study of a geographical distribution of the species, *P. aurifer* and *P. pallipes* are two originally distinct species which, from the course of their migrations northward, have come together in the Mississippi Valley and by their co-mingling produced a species having in some measure the characteristics of both."

Yet I believe that the 59 insects taken from this nest were all of one species, and possibly the reader will agree

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[2] Psyche, February 1908, page 1-3.

with me, relying on the evidence presented by Miss Enteman (p. 43) where she speaks of the development of the pattern of *P. pallipes;* "In the dark variety of *P. pallipes* characteristic of New England, the early developmental stages, as studied in a great many specimens, are identical with those described for *P. variatus.* The only difference between the two species is that the typical *P. variatus* stops, so to speak, at an earlier stage than does *P. pallipes,* which advances to the same melanic condition of *P. variatus,* and in most cases passes far beyond it."

If in this nest all are variations of one species, then we see that in the workers and males pigmentation stopped too soon and created the condition of *P. variatus,* while in the eight queens something queenly in their make-up "caused" advances to the extreme melanic condition which is taxonomically known as *P. pallipes.*

NEW SPECIES OF DOLICHOPODIDÆ FROM THE WEST INDIES, (DIPTERA).

By M. C. Van Duzee,
Buffalo, N. Y.

Psilopus salti, new species.

Male: length about 5 mm., head broken off in the type. Thorax and abdomen dark green, their bristles short; more than half of the abdominal segments opaque black, apical part of segments and whole of last one green; venter and sides of first segment with long pale hairs. Hypopygium (Fig. 2) small, its lamellæ black, fringed with hair and with several flattened, clavate bristles on one edge.

Coxæ black, anterior pair with rather long yellow hairs at tip; femore green with long white hair below; fore and middle tibiæ yellow, anterior pair with two long bristles below, the one near the middle nearly one-third as long as the tibia, middle ones with two rather long bristles on lower anterior edge; posterior tibiæ black; first joint of fore tarsi mostly yellow, middle tarsi brown almost to their base, posterior pair wholly black; last four joints of fore tarsi with only short hair below; all tarsi plain, except that the fifth joint of middle tarsi is nearly as wide as long; length of fore tibiæ about as 70, joints of fore tarsi as 50-18-14-8-6; those of middle ones as 65-22-14-6-5; joints of posterior ones as 65-26-15-6-5. Calypters yellowish brown with the tip and cilia black; halteres yellow.

Wings sligthly tinged with brown in front of second vein; last section of fourth vein from the cross-vein to the fork 32, from fork to wing margin about 30, cross-vein 31 and last section of fifth vein about 27 fiftieths of a millimeter long; fork of fourth vein almost a right angle, the upper bend broadly rounded.

Described from one male, taken at Mina Carlota, Trinidad Mountains, Cuba, March 21, 1925, by George Salt, for whom the species is named.

Type in the Museum of Comparative Zoology, in Cambridge, Mass.

Psilopus albihirtus, new species.

Male: Length 5 mm. Face broad, green with a little white pollen; palpi black; proboscis brownish yellow; antennæ black, short, longest bristles on second joint above and as long as the antenna; front blue-green with a few pale hairs on the sides; lower orbital cilia white, not long or abundant.

Thorax and abdomen green; segments of the abdomen broadly opaque black at base; the white hairs on the venter not very long; bristles of thorax and abdomen short. Hypopygium (Fig. 1) black, rather small; its lamellæ forked, one branch fringed with slender hairs, the other branch, which is cut off straight at tip have a fringe of shorter and stiffer hairs at tip.

Coxæ black; anterior pair fringed with long, whitish hair on outer surface; femora green with long white hair below; tips of fore and middle femora and their tibiæ yellow, the latter with rather short bristles; hind tibiæ black; fore tarsi (Fig. 3) with the first joint yellow, remaining joints black, second, third and fourth joints with blunt spines below, fifth joint short and nearly as wide at tip as long; middle tarsi brown, posterior pair black, both plain; fore tibiæ as 72, joints of fore tarsi as 60-17-10-6-4; of middle pair as 67-18-15-6-5; joints of posterior tarsi as 53-18-13-8-5. Calypters brown with black cilia; (halteres broken off in the type).

Wings grayish, very slightly tinged with brown in front of third vein; venation about as in *salti* new species.

Described from one male, taken near Troy, Jamaica, May 23, by A. E. Wight. Type in the Cambridge Museum.

The tarsi are formed very much like those of *patibulatus* Say and *pilicornis* Aldrich, but differs from both in having the wings without cross-bands and the fore and middle tibiæ pale yellow, it also differs in other characters. It is very nearly like *salti* new species, but differs in the form of the fore tarsi.

Pelastoneurus furcatus, new species.

Male: length 4 mm. Face and front in the type greasy so I could not tell their color; antennæ yellow, third joint small, rounded, scarcely as long as wide, apical edge black;

arista inserted at upper basal corner, it is broken off in the type but still adheres to the head and has several long hairs along the middle, it might be much more fully feathered if in perfect condition; lower orbital cilia white.

Dorsum of thorax blue on apical half, more coppery along the front and median line; scutellum reddish coppery with a depressed area on each side of a median ridge, it has one pair of large marginal bristles and a pair of small hairs outside of them. Abdomen green with black hair and with the hind margins of the segments coppery. Hypopygium (Fig. 4) with the upper part black, the lower portion yellow, it has a short perpendicular segment which is scarcely as long as high, the hypopygium reaches nearly to the second ventral segment, its lamellæ yellow on basal half, blackish on apical portion, somewhat triangular, or rounded, they have many slender hairs on apical margin and also several short, bent, flattened, blunt ones; on the lower corner of the hypopygium are two long, branch, pale hairs, these are nearly as long as the lamellæ.

All coxæ, femora and tibiæ yellow, outer surface of basal half of middle coxæ and all tarsi from the tip of the first joint brown; fore coxæ with a few black hairs and bristles; joints of fore tarsi as 40-25-19-11-10; two first joints of hind tarsi as 29-40. Calypters and halters yellow, the cilia of the former appears yellowish.

Wings grayish; first vein reaching but little more than half as far as the cross-vein; third vein nearly straight, last section of fourth vein bent near apical third; slightly concave posteriorly beyond the bend, its end near the tip of third vein; cross-vein 15, last section of fifth vein 23 fiftieths of a millimeter long.

Described from one male, taken by George Salt, February 25, 1925, at Soledod, Cuba. Type in the Museum of Comparative Zoology, in Cambridge, Mass.

This like *neglecta* Wheeler, *fasciatus* Roeder and *wheelri* Melander has the hypoygium about half yellow, but it is separated from these by the form of the hypoygial appendages. *Neglectus* like this species has a few branched bristles on the hypopygium, but they are much shorter than in this form.

THELYTOKY IN *SCLERODERMA IMMIGRANS.*

By Clyde E. Keeler

The Problem.

For some time I have been interested in the presence and absence of wings in the Bethylid, Scleroderma, and the possible mode of hereditary transmission for these conditions. We know that in this form apterous females and alate males are the rule, while winged females and wingless males occur rarely. In these facts we have evidence that the question is related in some fashion to sex determination.

Among the Apidæ and Bombidæ, sex determination appears to be capable of a quite simple explanation. A single complement of chromosomes bearing a certain ratio of male and female producing factors sets up a metabolic developmental rate characteristic of males.

When a double complement is present, as in the fertilized ovum, a new ratio of metabolic tendencies is established and the result is a female.[1]

Nachtsheim postulates for the honeybee *Apis mellifica* a sex determination similar to the following:

Results.

$$\begin{aligned} \text{♀} &= 2X + 2A = -4 + 2 = -2 \\ \text{♂} &= X + A = -2 + 1 = -1, \end{aligned}$$

where A = autosome set = $+1$, and

where X = sex chromosone = -2.

The same method of analysis may be applied to other Hymenoptera such as the parasitic form *Microbracon (Habrobracon) juglandis*, where numerous investigators have found that virgin ♀♀ produce males only.

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[1] Upon the same theory, by assigning hypothetical weights to sex chromosomes and autosomes, Bridges has been able to account for sex determination in normal Drosophila melanogaster as well as the several types of experimentally produced forms bearing aberrant chromosome numbers. Likewise, Goldschmidt account for intersexual forms of *Limantria dispar* produced by interracial crosses.

Sex determination in the Bethylid, *Scleroderma immigrans*, was formerly thought similar to that of the Apidæ where unfertilized females produce males.

The Material.

My stock of *Scleroderma immigrans* was obtained in Hawaii through the kindness of Dr. Swezey, to whom I am very much indebted.

Having been acquainted with the fact that in Prof. Wheeler's study of the Texan *Scleroderma macrogaster*, he was able to use quite a variety of food material, I expected to employ the larvae of the mediterranean meal moth Hephestia of which I had a large stock prepared for Microbracon culture.

My Sclerodermas refused bark borers and longicorn beetle larva and did well only upon larvæ and pupæ of the pine weevil *Pissodes strobi.* My stock finally perished when the latter food became unavailable.

In the spring of 1928 several vials containing cocoons were received from Dr. Swezey. The parents (which we shall call P_1 generation) were probably born shortly before April 10th, when some of the eggs were laid. They consisted of apterous females and alate males.

The results of my breeding experiments are shown in Table I.

TABLE I.

P_1	F_1	F_2	F_3	F_4
winged ♂♂	3 winged ♂♂	2 winged ♂♂	1 winged ♂	1 naked wingless ♀ pupa (from wingless ♀ x wingless ♂)
			1 wingless ♀	14 wingless ♀♀ (from 3 virgin wingless ♀♀ b. Oct. 31)
wingless ♀♀	44 wingless ♀♀	25 wingless ♀♀	12 wingless ♀♀	19 wingless ♀♀ from 1 virgin wingless ♀ b. Nov. 1)
				1 wingless ♀ (from 3 virgin wingless ♀♀ b. Nov. 12; dead in cocoon)
				3 wingless ♀♀ (from 3 wingless ♀♀ x winged ♂)
				9 wingless ♀♀ pupæ (from 1 virgin wingless ♀) (cocoons opened Dec. 8)
Hatched before April 10	Hatched May 13	Hatched June 28	Hatched Aug. 4 to Sept. 16	

The first filial generation (F_1) consisted of 3 winged males and 44 wingless females.

The second filial generation (F_2) was composed of 2 winged males and 25 wingless females.

The third generation (F_3) contained 1 winged male, 1 wingless male, and 12 wingless females.

Eight of the 12 wingless females of the F_3 generation were kept virgin, while three females were mated to the winged male. A single female was mated to the wingless male.

In the F_4 from wingless female x wingless male one naked wingless female pupa was produced. It died before maturity.

Three virgin wingless females produced 14 wingless females.

In another vial one virgin wingless female produced 19 wingless females.

Again 3 virgin wingless females produced one wingless female. It died in the cocoon.

The three wingless females mated to the winged male produced 3 wingless females which died in their cocoons.

A wingless virgin female produced 9 wingless female pupæ. These I removed from the cocoons alive.

In all, wingless females x winged males produced 6 winged males, 1 wingless male and 84 wingless females. Wingless females x wingless males gave one wingless female. Virgin wingless females produced 33 wingless females.

Conclusion.

From the fact that virgin females in general produced females, we see that we are dealing with a mode of sex determination differing from the Apis type which must be worked out before the question of the inheritance of wings may be comprehensively attacked. Could I have been dealing with a parthenogenetic strain or has change of conditions produced a functional difference in reproductive mode? It is hoped that someone, working where suitable food supply is available the year round, may take up with Scleroderma this interesting problem of sex determination and its allied question of wing inheritance.

NEW ASILIDÆ FROM MEXICO (DIPTERA).

By S. W. Bromley

In a shipment of Asilidæ from Mexico received from Dr. Alfonse Dampf, the following new species were found.

Plesiomma atrum n. sp.

Length 21-23 mm. A deep black species with black wings.

Male. Head black. Face brown pollinose. Mystax, beard, occipital bristles, antennal bristles and palpal hairs, black. Thorax deep brown with a slender double median line of black and black side spots. Vestiture black. Legs deep brown, femora and hind tibiæ black. Knees lighter brown. Scutellum with 2 black marginal bristles. Wings black without irridescent reflections. Abdomen black. Genitalia black with black hairs.

Female. Similar.

Holotype, ♂, no. 70 Coatepec (Ver.); allotype, ♀, no. 69 Coatepec (Ver.) paratype, ♂, no. 28. Jaltipan, Istmo (Ver.)

Deromyia bellardii n. sp.

Length, 20-26 mm. A rather large reddish species with contrasting deep black lines on the thorax, the abdomen slightly coarctate in the male but not so in the female, and the abdomen in both sexes being uniformly deep reddish without black markings on the sides of the segments.

Male. Mystax sparse, whitish. Face pale yellow pollinose. Antennæ light reddish with black hairs. Palpi deep reddish brown with black hairs. Occipital bristles black. Thorax yellowish pollinoses with three deep black velvety lines on the mesonotum, the median line extending to the anterior margin. Bristles of mesonotum black. A few black bristles in front of halteres. Coxal hairs pale yellowish. Legs reddish with black bristles. The upper surfaces of the femora and tibiæ are darker. The distal portion of the posterior tibia is brown. Scutellum reddish gold with 2 black marginal bristles. Wings nearly hyaline, apex and posterior border grayish. Halteres reddish brown. Postscutellum with a median dark marking. Abdomen reddish, the sides lighter. Genitalia reddish with yellow hairs.

Female. Similar, but legs more uniform reddish in color. Abdomen not coarctate. Pronotum with black bristles.

Holotype, ♂, no. 55 Distrito Federal (?).

Allotype, ♀, no. 156 Colima, Col.

Deromyia bimaculata n. sp.

Length 22 mm. A slender reddish species, with three velvety black lines on mesonotum, the abdomen coarctate, reddish, with two black spots on the 5th tergite, one on each side.

Male. Antennæ reddish with black hairs. Face pale yellow pollinose. Mystax scanty, white. Palpi reddish with black hairs. Occipital bristles black. Beard sparse, pale yellow. Pronotum with black bristles. Thorax golden pollinose. Mesonotum with three deep black lines, the median line reaching the anterior border. Bristles black. Scutellum reddish with 2 black marginal bristles. Coxal hairs pale yellow. Legs reddish with black bristles. A black line on the anterior portion of the side of the hind femur. Wings long and wide, pale yellowish, apex and posterior margin grayish. Abdomen reddish, coarctate, the 4th segment the widest; the fifth with a black spot on each side. Genitalia reddish with yellow hair.

Holotype, ♂, Cuernavaca. Aug. 11?.

Andrenosoma igneum n. sp.

Length, 21 mm. A black species with all black legs, the 6th and following segments of the abdomen reddish, rest of abdomen black with a deep reddish hue in the median area of the first 3 segments.

Male. Proboscis, antennæ (3rd segment missing), palpi and palpal hairs, antennal hairs, the two ocellar bristles, black. Beard, hairs on sides of face and occipital hairs, whitish. Mystax composed of many, thickly-placed, short, stout bristles, mostly black, but a few pale yellowish ones in the upper part. Thorax black, grayish pruinose, the mesonotum with two black median lines and two lateral spots on each side. Pleura gray pollinose and white haired. Mesonotal bristles black with a few white hairs anteriorly. Anterior portion of scutellum grayish pollinose, with black hairs and marginal bristles. Halteres pale reddish. Wings nearly hyaline, the apex and posterior border lightly grayish. Legs black, the femora and tibiæ covered thickly with long fine white pile. A few black hairs and bristles present; those of tarsi all black. First five segments of abdomen black with a black bristle and fine white hairs on each side of the segments. The first three segments have the median area of a deep reddish hue, and the 6th and following segments are light reddish with reddish hairs. Genitalia small, reddish with concolorous hairs.

Holotype, ♂, no. 63. Coatepec (Ver.)

Mallophora albicincta n. sp.

Length, 22 mm. A rather slender species, related to *M. nigritarsis* Wied. and *M. scopifer* Fabr. having a white beard, yellow face and mystax, brown thorax, yellow legs (except tarsi which are black) and a black abdomen with snow-white hairs on the first 2 segments. There is a tuft of white hairs on the scutellum also.

Female. Antennæ black with black hairs. Palpi black with yellow hairs except on tip where hairs are black. Beard white. Mystax and face golden, a number of black bristles in lower portion of mystax. Occipital bristles black, hairs pale yellow. Thorax dark brown. Pleura and pronotum with white hairs. A few black bristles over base of wings. Scutellum yellowish brown, thickly set with white hairs. Coxæ piceous; femora and tibiæ (except tip of posterior tibiæ which is blackish) bright yellow with concolorous hairs. A few black bristles at base of hind femur. Tarsi piceous with black hairs and bristles. Abdomen black, ventral hairs white. First two tergites with white hairs, rest with short black hairs. Ovipositor with fine white hairs.

Holotype, ♀, no. 57. Coatepec (Ver.)

FURTHER NOTES ON THE HABITS OF *HARPAGOXENUS AMERICANUS.*[1]

By Wm. S. Creighton

The social parasitism of *Harpagoxenus americanus*, Em., has been discussed by Sturtevant in a paper published in 1927. This investigator found that the behavior of an artificially deälated *Harpagoxenus* female placed in a nest of *Leptothorax curvispinosus*, one of its natural hosts, agrees in all essential respects with that of the females of the *sanguinea* group in *Formica*. The strange queen is at once attacked by the *Leptothorax* workers but she eventually cripples most of her assailants, disorganizes the remainder and takes possession of the brood.

During the summer of 1928 I was stationed on Naushon Island (Woods Hole), Mass., the only place in New England where *Harpagoxenus* is known to be at all plentiful. I was fortunate in securing several mixed colonies and in rearing from one of these numerous males and females. There was consequently abundant opportunity to repeat the experiment previously made by Sturtevant. Our results differ only in minor details which may be due to the fact that he used *L. curvispinosus* as the host while I employed *L. longispinosus*. Sturtevant introduced his deälated *Harpagoxenus* female into a nest containing seventy workers of *L. curvispinosus* and secured good results. I found it necessary to strip the host nest of all but about fifteen workers in order to prevent the death of the *Harpagoxenus* queen. If a larger number of *longispinosus* workers were present they invariably pulled down and killed the intruder by force of numbers. The worker of *longispinosus* is slightly larger than that of *curvispinosus* and its greater size may give it an advantage in attacking the invader. It was also necessary to wait for one hour after deälating the *Harpagoxenus* female before placing it in the nest of the host. If placed therein immediately after deäla-

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 311.

tion it behaved in a most apathetic manner and was quickly dispatched by the *Leptothorax* workers before it showed any signs of pugnacity. Since the wings are very easily removed it does not seem probable that this initial quiescence can be due to the shock of the operation. A more likely explanation appears to be that the high degree of excitability so characteristic of the actions of many of the queens of the social parasites is in some way connected with the degeneration of the wing muscles. Such a process would require an appreciable lapse of time before it could become effective.

The results of nine experiments in which an artificially deälated *Harpagoxenus* female was introduced into a nest of *Leptothorax longispinosus*is may be summed up as follows:

The strange queen almost immediately approaches the brood and is at once attacked by the *Leptothorax* workers. She defends herself with extreme ferocity, biting off the antennae and legs of her assailants with quick, jerky movements and giving them little opportunity to seize her. Whenever possible the *Harpagoxenus* queen returns to the brood and drives away the *Leptothorax* workers who are moving the larvæ and pupæ. Her bursts of savageness are sometimes interspersed with periods of apathy during which she remains completely inactive and allows the *Leptothorax* workers to drag her about the nest. Eventually she maims or kills all the *Leptothorax* workers and takes possession of the brood. The *Leptothorax* queen is seldom attacked, since she avoids the intruder, but usually dies at the end of a few days, apparently from starvation. It is interesting to note that the *Leptothorax* callows very rarely show animosity or fear for the *Harpagoxenus* queen and are never molested by it.

In addition to the experiments with deälated females a few observations were made on *Harpagoxenus* brood. One mixed nest which was taken on June 15 contained a large number of larvæ, most of which subsequently proved to be *Harpagoxenus*. The length of the larval period could not be determined but the pupal period of the males and females is from twenty-three to twenty-five days. That of the worker is a day or two longer. There is no callow period for either worker or sexual forms. All are deeply colored at the time of emergence.

On Aug. 4, at 3:30 p.m. I witnessed a raid of *Harpagoxenus* and subsequently saw several others from the same nest. The raids differed in only one respect from those which I described in a previous paper ('27). The tendency of the raiders to move in columns, which I saw only once during former observations, was a regular feature of these raids. There were never more than six ants in a column. They moved in single file and kept quite close together. Their antennæ were rapidly vibrated and constantly brought in contact with the substratum or the ant ahead.

It may be of interest to note that *Harpagoxenus americanus* is now known to occur as far north as Boston, Mass. In the spring of 1927 I took a single female in the Blue Hills Reservation. The nest was small and contained, beside the queen eleven workers of *L. longispinosus* and a small amount of brood. No *Harpagoxenus* workers were present. The known range extends from Massachusetts through southern New York, New Jersey and eastern Pennsylvania as far south as Washington. It is likely that in the future our knowledge of its southern range will be considerably extended but the scarcity of the insect in Massachusetts points to this state as the northern limit of its distribution.

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NOTES ON *APHROPHORA SALICIS* DE GEER IN AMERICA.[1]

By Z. P. Metcalf and G. W. Barber

This common European Cercopid (*Aphrophora salicis* De Geer) was first discovered in the United States by Dr. Harold Morrison, who collected specimens in the Arnold Arboretum on various species of willow (*Salix petiolaris, S. nigra,* etc.) in July, 1921 and submitted them to Dr. Herbert Osborn, who identified them as above.

According to Lallemand[2] this species is widespread in Europe. According to Oshanin[3] it ranges from Hispania to "Sidemi bei Vladivostok" and from Suecia to Turkestan. This species was originally described by De Geer[4] as a variety of *Cicada spumaria.* It has been discussed by nearly all the European writers on the Homoptera from that time on. So far as we can discover, however, none of these writers give any notes on the life history. Therefore, since this species seems not to have been recorded before from North America and since it may prove to be of economic importance, we think it advisable to record our notes on distribution and our fragmentary notes on life history. The notes on life history were made chiefly during the summers of 1923 and 1924 and since these observations did not begin until after the middle of June and closed in late September, they are necessarily incomplete.

So far as our observations go the eggs are laid in the terminal twigs of willow, usually quite near the tips. (Fig. 8). The eggs are forced into the wood and frequently there are a number of egg punctures close together. These egg punc-

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 310.

[2] Lallemand, V. Homoptera Fam. Cercopicæ, Genera Insectorum, Fac. 143. p. 62, 1912.

[3] Oshanin, B. Verzeichnis der palæarktischen Hemipteren. p. 28, 1908.

[4] De Geer, C. Mémoires pour servir a l'histoire des insectes, 3. p. 180, 1773.

tures contained two eggs although many contained but a single egg. These egg punctures are frequently so closely crowded that it is impossible to determine to which puncture an egg belongs. The anterior end of the egg usually lies near the surface of the twig with the ventral side of the developing embryo toward the outside of the twig.

The eggs (Fig. 4) are elongate, sharply pointed at the anterior end, bluntly pointed at the posterior end and greatly flattened. The egg is embedded in a whitish substance which usually adheres to the egg at the anterior end and to the wood at the posterior end. The color is pearly white when first laid with the anterior ventral border brown. As the embryo develops the egg turns darker and the anterior ventral border becomes dark brown, with the pinkish eye spots showing distinctly. The surface is smooth. The length varies from 1.6—1.9 mm., greatest width 0.35—0.40 mm., greatest depth from 0.60—0.65 mm.

The nymphs apparently hatch early in May. By early June they are all in the third instar and by mid June in the fourth instar.

The nymphs of the third instar (Fig. 5) measure about 6—6.5 mm. in length. The head, thorax, legs, wing pads and anal segments are brown; the rest of the abdomen creamy white; eyes reddish brown; head large; frons inflated; antennæ with nine segments.

Nymphs of the fourth instar (Fig. 6) measure from 7.5—8 mm. in length. Nearly uniform pale yellow in color. Eyes reddish brown; wing pads well developed.

The nymphs have the habit of clustering together and forming large masses of spittle. (Figs. 2 and 3). These masses are more abundant on the terminal twigs and the water sprouts at the base of the tree than anywhere else. The spittle is secreted in large quantities and frequently runs down the branches to the trunk and then to the ground. Where the nymphs become abundant the liquid frequently drops from the trees in large drops, causing inconvenience to the people sitting under the infested trees. When the nymphs are full grown and ready to moult to adults they have the habit of crawling out on the under surfaces of the leaves where they form smaller spherical masses of

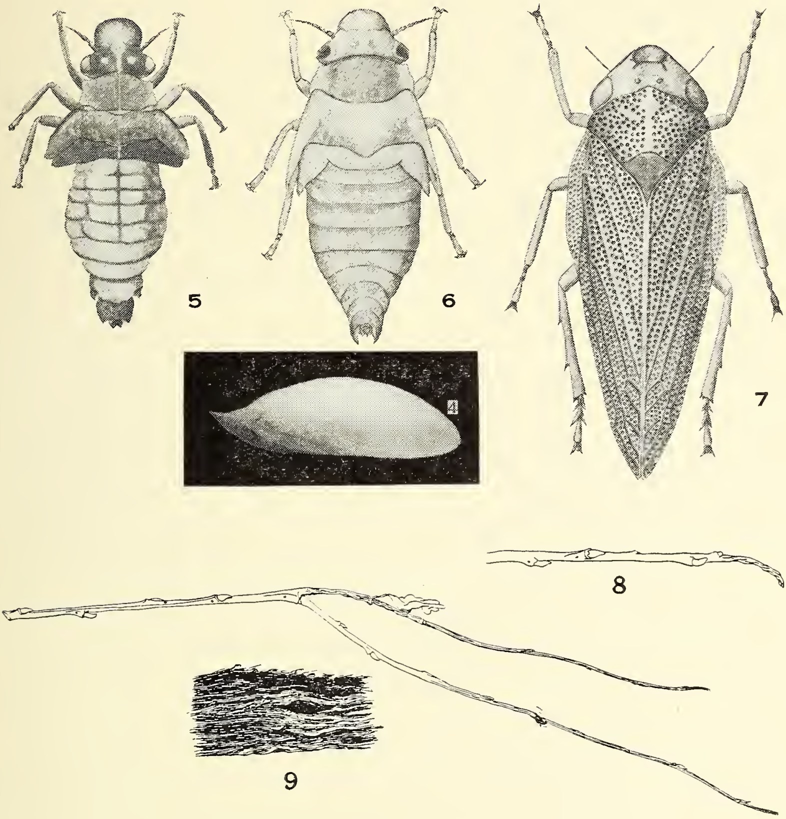


Fig. 1. 4, Egg of willow spittle bug, X 25; 5, Third instar nymph, X 8; 6, Fourth instar nymph, X 8; 7, Adult, X 8; 8, Terminal portion of willow twig killed by egg punctures; 9, Egg-laying puncture enlarged.

spittle, a single individual to a mass. (Fig. 1.) The froth dries somewhat, forming an arched vault in which the nymph transforms to an adult. The young adult remains in the vault until the skin becomes hard

The first adults (Fig. 7) were observed in late June and were common during July and August. Only a very few adults were still alive in late September when our observation ceased. After emerging the adults commence to feed and egg laying, according to our notes, begins in mid July.

This species may be distinguished from our native eastern Aphrophoras by its uniform yellowish color, with the prothorax, scutellum and elytra closely and uniformly punctate with small black punctures, each set with a fine golden yellow hair. Length, including wings, 10.5 to 11.0 mm.

Vertex twice as broad as median length; the anterior margins forming a right angle; median length one-half greater than length at eye; median carina well elevated; tylus more than twice as broad as long, uniformly punctate. Frons flat. Pronotum not elevated posteriorly; punctate spots fine anteriorly, coarser posteriorly; median carina distinct.

Genitalia: female, last ventral segment nearly twice as long as penultimate, convex, with the posterior margin roundly concave; ovipositor barely exceeding the pygofers. Male, eighth ventral segment twice as broad as long, anterior and posterior borders parallel; genital plates longer than broad at base; the ninth segment with lateral recurved hooks.

General color yellowish brown without conspicuous markings; numerous black punctures dorsally; the edge of the tylus bordered with black; eyes dark brown; tip of rostrum, claws and tibial and tarsal spines black; abdomen blackish, the segments bordered with brown and the genitalia brown.

Known in the United States from Arnold Arboretum, Boston, and from Mystic Lakes, Medford, Massachusetts.

So far as observed there was no injury from the feeding of the nymphs or adults. The only injury was caused by the egg laying of the adults. These punctures are sometimes placed several inches from the tips of branches and the entire terminal portion of the twig dies. This is apt to be of considerable importance on young trees that are used for ornamental purposes.

A survey of the willows in the Arboretum showed that this species infests 53 named species and varieties of *Salix*. Almost every plant in the collection was infested. The infestation varied somewhat in severity among the various plants, but this variation could not be attributed to any varietal difference. It was usually worse on the young plants. The geographical distribution of the origin of these plants is as follows:

25 species and varieties native to Europe:

11 species and varieties native to Europe and Northern Asia.

8 species and varieties native to China.

3 species and varieties native to Asia.

3 species and varieties native to Japan.

3 species and varieties native to North America.

The chances are that this species will attack all of our native species of *Salix* and all the introduced ornamental species and that eventually it will become distributed throughout the country wherever willows are grown, unless measures for its control are undertaken now when it is limited to a small area in Eastern Massachusetts.

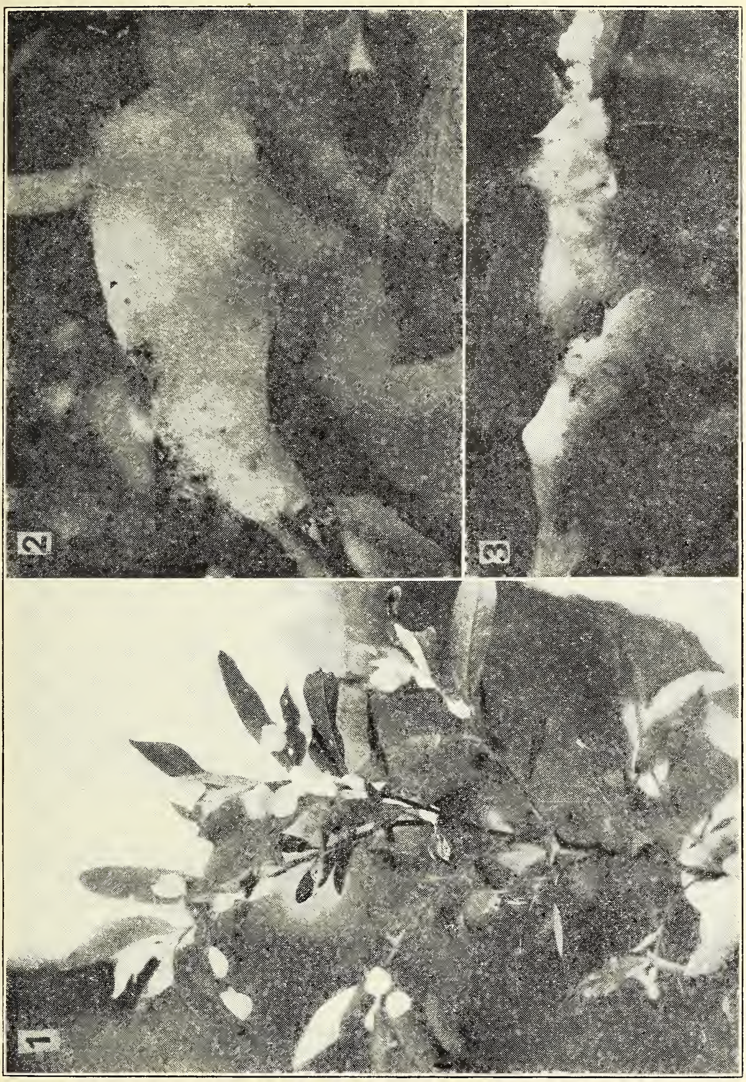
Preliminary observations indicate that this spittle bug may be controlled by hydrated lime dust containing 4 to 6 per cent of nicotine sulphate applied to the spittle masses.

DESCRIPTION OF PLATE I.

Figure 1, Twig of willow tree showing mature nymphs in individual masses of spittle.

Figure 2, Large mass of spittle containing many nymphs.

Figure 3, Same as Figure 2, not so much enlarged.



METCALF AND BARBER—APHROPHORA SALICIS

PROCEEDINGS OF THE CAMBRIDGE ENTOMOLIGAL CLUB.

Ten meetings were held in 1928, including one special meeting in September. The programs were as follows: Jan. 10: Dr. O. E. Plath, "Bumblebees, their Life History, Habits and Economic Importance." Feb. 13: Professor J. C. Bradley, "Scoliidae, with Particular Reference to the Development of Antigeny of Some Species." March 13: Dr. George Salt, "A Year in Colombia, South America." April 10, Mr. J. H. Emerton, "Notes on Spiders Collected in 1927"; and Mr. A. P. Morse, C. W. Johnson, and C. A. Frost, "The Distribution of Insects in New England." May 8, Mr. S. M. Dohanian, "Eighteen Months in Europe." June 12, Dr. J. Bequeart, "Vespidæ of the West Indies." September 11, Summer collecting notes. October 9, Mr. W. J. Clench, "Collecting Experiences in Cuba." November 13, Dr. George Salt, "Strepsiptera." December 11, Dr. F. M. Carpenter, "The Fossil Ants of North America."

Eleven new members were elected during 1928, bringing the total membership to ninety-one.

J. W. Wilson, *Secretary.*

THE UNEXPECTED ACID TEST.

While wandering along the banks of the Shawsheen River in Andover, Mass., one pleasant spring day I found a specimen of *Carabus vinctus* Web. under a piece of board. I at one pounced upon it as a prize, for at that time I had taken but few of them, and brought it closer to my face for another gloating look. As I did so I experienced the sensation that might have been caused by half a dozen red-hot needles striking my face, and at once lost all interest in the beetle until I had wiped my face with alcohol and stopped the painful smarting. I then investigated and came to the conclusion that the pressure of my thumb and finger had caused the apices of the elytra to impinge one against the other and, acting like a released spring, threw the acid secretion from the beetle into the air eight inches or more. I was greatly surprised at the strength of this acid and would fear rather severe results if it should enter the eyes.

C. A. Frost.

CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p.m. at the Bussey Institution, Forest Hills, Boston. The Bussey Institution is one block from the Forest Hills station of both the elevated street cars and the N. Y., N. H. & H. R. R. Entomologists visiting Boston are cordially invited to attend.

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PSYCHE

VOL. XXXVI JUNE, 1929 No. 2

A NEW PSEUDOMASARIS FROM CALIFORNIA, WITH SOME CONSIDERATIONS ON THE MASARID WASPS (HYMENOPTERA)

BY J. BEQUAERT.

Department of Tropical Medicine, Harvard University
Medical School, Boston, Mass.

While in Southern California, last spring, Professor W. M. Wheeler collected a large number of masarid wasps belonging to two species, one of which appears to be new. I have used the opportunity offered by the description of this insect, to present a few remarks of a more general nature on the Masaridinæ, by far the most interesting subfamily of diplopterous wasps. As I hope to show, their structure, habits and distribution exhibit a number of remarkable features that render the group worthy of consideration by the biologist.

Pseudomasaris (Pseudomasaris) wheeleri, new species
(Fig. 1)

A large, minutely sculptured, dull species; black, with numerous and rather variable sulphur-yellow markings, the mesonotum with two complete or interrupted longitudinal stripes, the abdomen often with a *Vespa*-pattern.

Length (h. + th. + t. 1 + 2): ♂, 10 to 10.5 mm.; ♀, 9 to 12 mm. (total length, approximately 13 to 17 mm.); of wing ♂, 12.5 mm. and ♀, 11 to 12.5 mm.

MALE.—Head broadly elliptical in front view, about one and one-fifth times as wide as high; seen from above, about twice as wide as long, much narrower than the thorax. Occipital margin of vertex far from the eyes, with a distinct inward curve, margined by a blunt carina which does not continue on the cheeks. Cheeks narrow, though distinct, about one-fourth the width of the eye in profile, gradually narrowed toward the vertex and evenly rounded in the lower half. Oculo-malar space short, but distinct, a little over one-fourth as long as the width of the mandibular articulation. Eyes more bulging than usual in the subgenus *Pseudomasaris,* proper. Inner orbits more than three times as far apart at the clypeus as on the vertex, where the eyes are separated by about three times the diameter of a posterior ocellus. Frons flat, not carinate, very faintly raised between the insertions of the antennae, with the merest trace of a median tubercle in the center, shallowly concave below the anterior ocellus. Ocular sinus deep, bluntly rounded at apex. Ocelli large, in a flattened triangle; the anterior ocellus much larger than the others, subcircular; posterior ocelli about twice as far apart as their diameter, barely separated from the inner orbits, distant from an imaginary line connecting the posterior borders of the eyes by a little over twice their distance from each other. Interocellar area flat. Vertex strongly sloping posteriorly, slightly concave in front view. Antennæ about four times as far apart as they are removed from the inner orbits. Clypeus strongly and evenly convex throughout, in outline flattened hexagonal with rounded upper angles, nearly one and one-half times as wide as long; the anterior, free portion about one-fourth shorter than the basal, interocular part; the upper margin slightly convex; the upper lateral margins slightly oblique, very broadly separated from the eyes, the intervening space wider than the length of the oculo-malar space; the lower lateral margins slightly concave, forming almost right angles with the upper lateral margins; the truncate apex a little over half the maximum width of the clypeus, deeply, arcuately emarginate; the apical angles very broadly rounded, with a translucent border. Antenna of 12 segments, very long, shaped much as in *P. occidentalis,* but the third to seventh segments more slender than in that species; the third to sixth not at all enlarged at their apices; the seventh slightly and evenly widened toward the apex, where it is less than half as wide as long; the terminal club of five very superficially separated segments, seen from above regularly short oval, sharply set off, much wider than thick, a little over one-half as wide as long, slightly longer than the sixth and seventh segments together, somewhat flattened dorsally, more convex ventrally where there is a slight

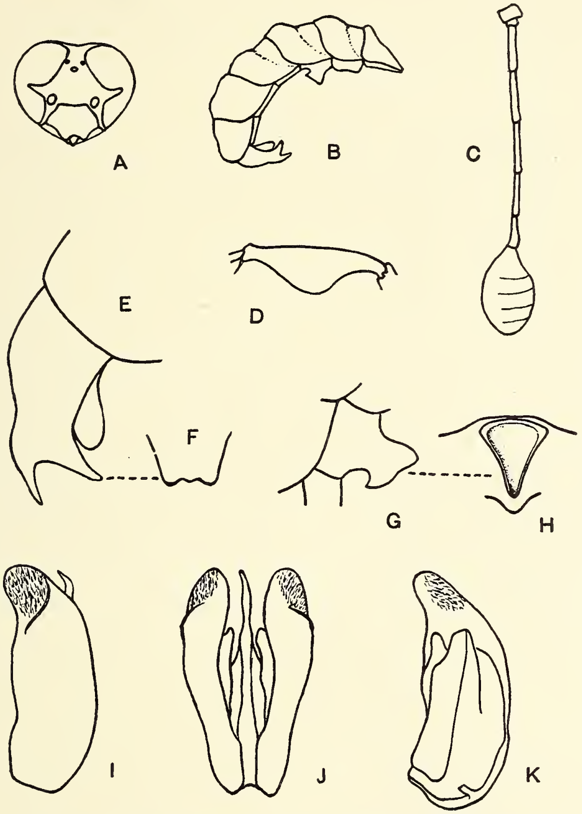

Fig. 1. *Pseudomasaris wheeleri* J. Bequaert. Male: A, head in front view; B, abdomen in profile; C, left antenna from above; D, right middle tibia in front view; E, seventh tergite in profile; F, apical margin of seventh tergite in dorsal view; G, third sternite in profile; H, apex of process of third sternite in ventral view; I, right side of genitalia in profile, showing external view of valva externa (squama of Bradley); J, genitalia in dorsal view; K, internal view of left valva externa (Bradley's squama), showing valva interna (Bradley's sagitta and volsella).

transverse depression close to the base. Mandibles folded beneath the labrum, smooth on the outer surface, ending in a long, finger-shaped, blunt apex, the inner margin with two faint denticulations before the apex. Thorax elongate rectangular, about one and one-fourth times as long as its greatest width, distinctly narrowed anteriorly and very slightly posteriorly, much lower than wide. Anterior margin of pronotum almost straight, rounded off, without carina or rim, slightly depressed in the middle; humeral angles slightly raised into blunt, broadly rounded humps. Mesonotum distinctly longer than wide, almost hexagonal in outline, the anterior margin forming a very low outward curve; slightly and uniformly convex in its anterior half, flattened in its posterior half; without traces of parapsidal furrows, but with a fine, incomplete furrow on each side in the posterior half (above the tegula) and a fine, median somewhat raised line in the anterior half. Tegula about two and one-half times as long as wide; the outer margin shallowly notched before the middle; the apex covering the base of the scutellum on the side. Scutellum very large, semi-elliptical, with a broadly rounded apical margin which does not entirely cover the postscutellum in a dorsal view; evenly convex throughout, with a very low, blunt, somewhat elongate, median tubercle close to the anterior margin; mesonotal suture not foveolate. Postscutellum very short; its median portion semi-elliptical from behind, divided into a very short, slightly swollen, anterior, horizontal portion (visible behind the scutellum from above) and a much longer, vertical, posterior area (in a plane with the concavity of the propodeum). Mesepisternum divided from the epimeron, but without a suture between the upper and the lower plates, without prepectal carina or suture and not depressed anteriorly into epicnemia for the front legs; the usual impressed line marking the sternopleural suture, distinct. Propodeum short, squarely and vertically truncate behind, very slightly convex on the sides from above; dorsal areas broadly separated from each other by the postscutellum, sloping gradually into the concavity (superior ridges not developed); lateral ridges blunt; inferior ridges carinate, sharp; concavity wide, very shallow, with a deeper median depression which is divided by a low, blunt, longitudinal ridge starting behind the postscutellum and not reaching the abdominal articulation; lateral angle produced into a straight, broadly triangular, blunt, flattened tooth, directed posteriorly; the tooth continuous with the lateral ridge but set off rather sharply from the inferior ridge. Abdomen much elongate, of the shape usual in males of *Pseudomasaris;* the second, third and fourth tergites strongly constricted and depressed at the base. Armature of seventh tergite much as in *P. occidentalis,* but the preapical pair of tubercles longer and more finger-shaped, with a sharp carina at the base dorsally (in some specimens this carina is slightly more raised basad, behind a transverse depression of the tergite, on the spot where the fifth or sixth tubercle is situated in *P. vespoides*) ; the tubercles of the apical pair are also narrower than in *P. occidentalis* and are separated by a slight median projection of the hind margin. Second sternite slightly raised anteriorly, where there is a median notch separating two low tubercles (much less pronounced than in *P. occidentalis* and not continued posteriorly into blunt, oblique ridges as in that species). Process of third sternite in profile rather low and broad; its truncate summit forming an almost equilateral triangle, with a broad, shallow depression; its anterior angles bluntly rounded, without teeth; its posterior angle forming a short, but rather sharp tooth directed posteriorly (in general shape the process is more like that of *P. vespoides* than like that of *P. occidentalis*). Legs long and stout. Front femur and tibia slightly flattened beneath, their surfaces regular; the tibia slightly swollen; all the segments of the front tarsus ciliate along the outer margin. Middle femur regular, slightly flattened beneath where the posterior margin shows a faint indication of a notch before the base; middle tibia in front view strongly widened on the inferior edge, the dilatation semi-elliptical in outline, broadly rounded off, placed about the middle of the length of the tibia, slightly flattened on the inner side. Hind femur and tibia regular; the tibia gradually and moderately widened toward the apical half; hind basitarsus regular, slender, straight, not appreciably flattened. Middle tibia with one apical spur; larger spur of hind tibia bifid at apex. Tarsal claws simple. Wings with the usual venation of *Pseudomasaris;* radial cell rather long and narrow; second cubital rather large, its length on the radius variable, often as long as the distance between the ends of the two recurrent veins on the cubitus; second intercubitus strongly bent below the middle. Genitalia (Fig. 1 *I-K*) essentially as in *P. occidentalis.*

Body mostly dull, densely and fairly uniformly covered with medium-sized and smaller punctures (visible with a hand-lens). Center of the frons more coarsely punctured. On mesonotum and scutellum the punctures are of two sizes, the larger ones especially numerous over the posterior portion of the mesonotum. Puncturation stronger on the basal constricted areas of the first three tergites than on the remainder of the abdomen. The following parts are impunctate and shiny: most of the outer surface of the mandible; the median depressed area of the concavity of the propodeum; a median, more or less triangular area at the base of the second to sixth tergites; and the middle of the seventh tergite very extensively at the base. Pubescence short, but rather abundant on head and thorax, sparser on the abdomen; mostly grayish, a little darker on mesonotum and vertex. Posterior edge of middle femur with dense, somewhat silvery brown pile on the under side.

Black, with the following areas sulphur-yellow: mandibles (except the long black apices); labrum (except the ferruginous tip); clypeus (except the upper margin very narrowly and minute dots in the center); a double spot on the frons above the insertions of the antennæ; the inner orbits from the base of the mandibles to the posterior ocelli, filling the ocular sinuses and widening on the frons to connect with the median spots; a small spot above each of the posterior ocelli; outer orbits, the yellow not reaching the vertex; most of the pronotum (except for a black, more or less triangular spot in the posterior half); a large spot in the upper part of the mesepisternum; tegulæ; a spot on each side of the mesonotum close to the hind portion of the tegula; four elongate spots over the middle of the mesonotum (forming two interrupted, diverging stripes); broad hind margin and extreme sides of scutellum; extreme sides (lateral angles and ventral areas) of propodeum; broad apical bands on all tergites, those on the first to fourth very wide on the sides and abruptly narrowed, the median anterior margin wavy; all the sternites (except for the bases and the apical depressed area of the process of the third sternite); and most of the legs (front coxæ, trochanters and femora partly black above; middle and hind coxæ and trochanters black beneath; under side of middle and hind femora with a narrow black line; tarsi partly ferruginous). On the fifth abdominal tergite the yellow is very extensive and partly divided in the middle by a sharp projection from the black base, while there is a free, ovate, black spot on each side in the yellow; the yellow band of the sixth tergite is similar to that of the fifth, but there are no free black spots; the four tubercles of the seventh tergite are black and the two of each side are connected by a narrow black line. Antenna ferruginous to black; scape with a yellow apical band; third segment extensively yellow above; the fourth to sixth with some yellow streaks on the upper side; the club spotted with yellow at the base both above and beneath. Wings subhyaline, very slightly suffused with ferruginous brown in the costal, radial and first cubital cells and along some of the veins; the veins reddish brown, the stigma bright fulvous. The variations of the color in the males are slight: sometimes the frontal spots are much reduced or even lacking; the anterior margin of the postscutellum may be yellow in the middle; or the concavity of the propodeum may show two or three small yellow spots; the apical fasciæ of the first four tergites instead of being wavy, may be more angularly emarginate anteriorly.

FEMALE.—Agrees in most respects with the male, except as indicated below. Occipital margin almost straight. Eyes not bulging. Inner orbits distinctly, though very little farther apart at the clypeus than on the vertex. Frons entirely flat, without even a trace of median tubercle. Ocular sinus broader. Ocelli subequal, in a flattened triangle; the posterior ocelli a little closer to each other than to the eyes. Vertex flat, not sloping, without fovea. Antennæ about five times as far apart as they are from the inner orbits. Clypeus relatively longer, about one and one-third times as wide as long; the apical, free portion a little less than half the length of the basal, interocular part. Antenna as in the female of *P. occidentalis,* of 12 segments; scape more elongate than in the male; second segment very small; third to sixth short, narrower than the remainder, which form an elongate-elliptical swollen club not abruptly set off at base; third segment slightly longer than the three following together. Mandible with a very broad, bluntly rounded apex and the merest indication of two preapical denticulations on the inner margin. Humeral angles very evenly rounded, not humped. The lateral angles of the propodeum sharper than in the male. Abdomen of the normal shape, without constrictions or processes; the second and third tergites slightly depressed transversely near the base. Legs normal.

Abdomen uniformly covered with minute punctures, without shiny areas at the bases of the tergites. Clypeus very coarsely punctate, the punctures even coarser than on the frons. Pilosity of the clypeus denser and longer than in the male.

Yellow markings more extensive and more variable than in the male. Tip of labrum, under side of antennal club and last segments of all tarsi partly ferruginous. The following areas are sulphur-yellow: mandible (except the broad black apex); most of labrum; clypeus (except for a median black mark in the form of a ring, a horse-shoe, or two half rings, sometimes reduced to four dots); inner orbits from mandibles to vertex, broader above the ocular sinuses, but separated from the frontal spot; a triangular spot on the frons, resting on the clypeus (sometimes reduced to two lines or to indefinite spots); outer orbits, not connected with the inner orbits; most of pronotum (a black stripe on each side, of variable width, often running from the anterior to the lateral margin, sometimes broken up in spots); most of mesopleura; tegulæ; four longitudinal stripes on the mesonotum, one above each tegula (sometimes much shortened) and two in the middle, diverging and somewhat hooked anteriorly (very rarely broken up); broad hind margin of scutellum; postscutellum (in one specimen mostly black);

most of the propodeum (sometimes with two or three black spots, rarely extensively black in the concavity) ; very broad apical margins to tergites one to five, variously marked with black as noted below; most of the sternites; and the legs (except for spots on the coxæ and occasional spots or streaks at the base of some or of all the femora). In an extreme yellow example, the dorsal surface of the abdomen is almost wholly yellow, only the bases of the tergites being black and emitting black projections into the yellow; on the first and second tergites these projections are median only; on the third, fourth and fifth there are three black notches, one in the middle and one on each side; on the sixth a black median line connects the base with the apex of the tergite. In the extreme black specimens, the apical margins are slightly narrower and in addition to the black notches there is a transverse black spot in the yellow on each side of the first three tergites; these spots may be free or connected with the lateral notches; sometimes they are barely indicated or present on the first tergite only.

Male, holotype, and female, allotype, in the Museum of Comparative Zoölogy, at Cambridge. Paratypes of both sexes will be deposited at the United States National Museum, the American Museum of Natural History, the Philadelphia Academy of Natural Sciences, the California Academy of Sciences, and the British Museum.

CALIFORNIA: Seven males (including the holotype) and fifty-four females (including the allotype), from Palm Springs, Riverside Co., collected by Professor W. M. Wheeler at flowers of Yerba Santa, *Eriodictyon tomentosum* Bentham, in April 1928.

Although the eyes of the male are much more bulging than is customary in the subgenus *Pseudomasaris*, proper, with the posterior ocelli almost touching the eyes which are only separated by three times the diameter of a posterior ocellus, it is impossible to include *P. wheeleri* in the subgenus *Holopticus*, since the upper orbits are still far removed from the occipital margin. Moreover, the new species is very closely allied to *P. occidentalis* (Cresson), as shown by a comparison of specimens.[1] Both species have practically the same peculiar structure of the legs in the male. Bradley (1922, Univ. of California Publ. Ent., I, No. 9, p. 424) writes of the male of *P. occidentalis*: "the middle tibia seen from in front with its inferior edge at the basal third strongly dilated and angulate." As a matter of fact, in that species the middle tibia is almost exactly as I describe and figure it for *P. wheeleri*. The two species are, nevertheless, readily separated in the males by the shape of the head (eyes not bulging in *P. occidentalis,* separated on the vertex by at least five times the diameter of a posterior ocellus, which is distinctly removed from the inner orbit), of the four tubercles of the seventh tergite (the preapical tubercles much shorter in *P. occidentalis* and not sharply carinate at the base), and of the process of the third sternite (in *P. occidentalis* the summit is very narrow, with a longitudinal groove which is abruptly widened anteriorly). The slight differences in the genitalia to be noted between my figures of *P. wheeleri* and those given by Bradley for *P. occidentalis* (1922, *Op. cit.*, Pl. X, figs. 62-64) are probably accidental and due to the method of preparation. On the other hand, the females of the two species are structurally so much alike, that after a very careful comparison I can only point out the following differences: in *P. occidentalis* the vertex is wider, the inner orbits being there about as far apart as at the clypeus and the posterior ocelli being also distinctly more removed from the inner orbits than from each other; the clypeus is decidedly longer, being but little wider than long. Of course the coloration of the two species is strikingly different in both sexes.

Incidentally it may be noted that the character used by Bradley in his working key (1922, *Op. cit.*, p. 381) to separate *Masaris* from *Pseudomasaris, viz.,* postscutellum covered or not covered by the scutellum, is not very reliable. In *P. wheeleri* the postscutellum may distinctly be seen in a dorsal view, protruding beyond the apex of the scutellum, although this is more marked in the male than in the female.

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[1] I have been able to examine a pair of *P. occidentalis,* kindly loaned to me by the United States National Museum, through Miss Grace Sandhouse.

The true distinguishing features between the two genera are, however, correctly given by Bradley in his synoptic table of the genera (1922, *Op. cit.*, p. 389).

ADDITIONAL RECORDS OF PSEUDOMASARIS

The following records extend the known range of the genus and of some of the species. Some of the specimens belong to the collections of the Museum of Comparative Zoölogy at Cambridge (M. C. Z.).

1. *P. vespoides* (Cresson).—ARIZONA: Grand Canyon. 1 ♂ (G. P. Engelhardt). COLORADO: Cripple Creek Rd. (Corley Mt. Highway), Teller Co., 8,930 ft., at flowers of *Pentstemon glaber* Pursh, 3 ♀ and 1 ♂, July 1, 1928 (J. Bequaert) the females disappear entirely within the flowers; the males, however, were flying very swiftly from flower to flower in search of the females; it was noted that the smaller *Pentstemon confertus* Douglas, although much more abundant in that particular spot, did not attract any masarid. Plainview, Jefferson Co., 8 ♀ and 1 ♂, July 9 to 14, 1922 (G. P. Engelhardt). Boulder, 1 ♀ (M. C. Z.). Platte Canyon, 1 ♀ (M. C. Z.). Hall's Valley, 2 ♂, August. UTAH: Eureka, 1 ♂ (T. Spalding) (M.C.Z.). CALIFORNIA: Lakeside, 1 ♂ (E. P. Van Duzee) (M. C. Z.). Tallac, Eldorado Co., 6,000 ft., 1 ♀ (W. M. Giffard) (M. C. Z.).

2. *P. texanus* (Cresson).—TEXAS: Waco, 2 ♀ (M. C. Z.).

3. *P. zonalis* (Cresson).—COLORADO: Plainview, Jefferson Co., 4 ♀ and 1 ♂, July 9 to 14, 1922 (G. P. Engelhardt). CALIFORNIA: Alta Mesa, 1 ♀. WASHINGTON: Skagit Valley, 1 ♂ (M. C. Z.). BRITISH COLUMBIA: Princeton, 1,800 ft., 1 ♂ (M. C. Z.).

4. *P. edwardsii* (Cresson).—UTAH: Logan, 1 ♂ (E. S. G. Titus) (M. C. Z.). CALIFORNIA: Alpine, San Diego Co., 1 ♂ (E. P. Van Duzee) (M. C. Z.). Palm Springs, Riverside, Co., 8 ♀, at flowers of *Phacelia* sp., April 1928 (W. M. Wheeler).

5. *P. marginalis* (Cresson).—COLORADO: Granite Peaks Camp on the Pine River, near Bayfield, La Plata Co., 9,000

ft., 18 ♀, at flowers of *Phacelia heterophylla* Pursh, July 16 to 21, 1928 (J. Bequaert). These insects were active only during the warmest hours of the day and in bright sunshine. Most of the specimens were observed between 9 A. M. and 1 P. M. Although many other flowers were carefully watched for insect visitors and some species of *Pentstemon* were growing in that locality, *P. marginalis* was seen visiting only *Phacelia heterophylla.* No male was ever seen near the flowers.

CHARACTERS OF THE MASARIDINÆ

The subfamily Masaridinæ is one of the best-defined groups among the Vespidæ, or folded-winged wasps. It agrees with the other Diploptera in having the first discoidal cell (M^4) of the fore wing at least as long as the submedian ($Cu+Cu_1$), the only peculiar character that holds good throughout the entire family Vespidæ. Yet it should be observed that this peculiarity of the wing is not as strongly marked, as a rule, in the Masaridinæ as in most other subfamilies of Diploptera (with the exception of the Gayellinæ and Euparagiinæ). The lengthening of the first discoidal cell is evidently correlated with the longitudinal plaiting of the wing, a feature not or but faintly shown by most Masaridinæ. In this connection it is noteworthy that in the few masarid genera *(Quartinia* and *Celonites)* in which the fore wings are strongly plaited, the first discoidal cell is very long. The wing of *Celonites,* for instance, differs hardly in this respect from that of *Vespa.*

The one distinguishing character of all Masaridinæ, not found elsewhere among the Diploptera, is the simplified venation of the hind wing, in which the transverse median vein (M^3) is straight and not angulate, the discoidal vein ($m+M_2$) being apparently wanting. But, as shown by Bradley (1922, *Op. cit.*, p. 374), the position of the preaxillary excision seems to warrant the conclusion that the apical section of the anal vein (M_4+Cu_{1+2} + 1st A + 2d A) has become lost, and not the true discoidal vein ($m+M_2$). The hind wing must therefore be regarded as highly specialized and not as primitive.

In the remaining characters, the Masaridinæ exhibit a strange mixture of primitive (or generalized) and of specialized features. The inner orbits are, as a rule, deeply emarginate; the most notable exceptions being the Australian *Paragia*, in which they are merely sinuate (they are, however, distinctly emarginate in the allied *Metaparagia*, likewise of Australia), the South African *Ceramioides*, in which the emargination is very broad and shallow (the related *Ceramius* and *Paraceramius* have it quite deep), and the South American *Ceramiopsis*. Since the emargination of the eyes is commonly found in other related families of Hymenoptera, such as Scoliidæ, Sapygidæ, and Mutillidæ, it is most probably a very old character, inherited from the common ancestral stock of all Diploptera. In this case the sinuate or subentire inner orbits should be regarded as a secondary or specialized condition.

The mandibles are generally broad and short, folding over each other beneath the labrum or very slightly decussate. This may be regarded as the primitive condition retained by many Vespidæ (except Eumeninæ and Stenogastrinæ).

The clypeus is either truncate at apex or very broadly rounded, the more common and evidently primary condition among the Diploptera, where the pointed clypeus is only found as the rule in Ropalidiinæ, Polistinæ, Polybiinæ, and Stenogastrinæ, and very exceptionally elsewhere.

The antennæ are always composed of twelve segments in both female and male, although the terminal segments are often coalescing and hard to differentiate in the male.[1] In almost all other Vespidæ (including Gayellinæ and Euparagiinæ) the number of segments differs in the two sexes: as a rule it is 12 in the female and 13 in the male; in certain genera (*Belonogaster*, *Polybioides*) it is 11 in the female and 12 in the male. Another exception to the rule is the genus *Pachodynerus*, among the Eumeninæ, where both sexes have 12 segments. Many Masaridinæ show a marked tendency to a shortening of the scape and to a

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[1] Bradley (1922, *Op. cit.*, p. 389) states that in the female of *Trimeria* the antenna has only 11 segments. He had, however, not examined a specimen of that sex. In a female of *T. buyssoni* before me the antenna is distinctly 12-segmented.

swelling of the terminal segments of the flagellum into a club. But this is far from being the rule, since the antennæ of *Trimeria, Microtrimeria, Ceramius, Paraceramius, Ceramioides, Paragia,* and *Metaparagia* have the flagellum not more swollen than many members of the other subfamilies. The equal number of antennal segments in both sexes should, I believe, be regarded as primitive.

The mouth-parts are of two distinct types. In *Paragia* and *Metaparagia,* they have retained the more primitive condition, as is also the rule among the other subfamilies of Vespidæ: the ligula is short and not retractile, composed of two short glossæ which are but little longer than the paraglossæ; the palpi are well developed, the maxillary palpi 6-segmented, the labial palpi 4-segmented. In the remaining genera of Masaridinæ, the mouth-parts are highly specialized, being modified into a proboscis, or sucking tube, composed of the elongate, retractile glossæ which are much longer than the paraglossæ; when withdrawn in the buccal cavity, the labium forms a loop which may enormously distend the membrane of the neck; the maxilla, however, remains short, and there is often a reduction of the number of segments of the palpi. This modification of the trophi is, as we shall see, correlated with the highly specialized, anthophilous diet of these wasps. Unfortunately the habits of *Paragia* and *Metaparagia* are as yet entirely unknown, but it is possible that they may show some relation to the different structure of their mouth-parts. It should be noted that the proboscis of the anthophilous Masaridinæ, although having the same function as that of the Apoidea, or bees, has a different morphology, since the maxillæ and labial palpi never form any part of it.

The most striking feature of the thorax is the unusual development of the scutellum which shows a tendency to overlap and crowd out the postscutellum. This character is, however, present in *Euparagia* also. The parapsidal furrows are completely preserved in some genera (*Trimeria, Microtrimeria, Paragia, Masariella, Ceramius*) ; in others they are indistinct (*Paraceramius, Jugurtia*) or absent (*Masaris, Pseudomasaris, Celonites*). The mesepisternum may either show the primitive division into an upper and a lower plate (*Trimeria, Microtrimeria, Masariella, Ceramioides*) or have the plates partly (*Ceramius, Paraceramius*) or completely (*Masaris, Pseudomasaris*) fused.

H. de Saussure attached a considerable importance to the number of spurs of the middle tibia, which he believed to be two throughout the subfamily. Later observations have, however, shown that this number is not a subfamily character. In the Masaridinæ it is very variable, although fixed in each species and in most of the genera. Two spurs are found in *Microtrimeria, Paragia, Ceramius, Masaris, Masariella, Jugurtia, Celonites* and *Quartinia*; but in some cases, as in certain species of *Masariella*, the second spur is very small. On the other hand, *Trimeria, Paraceramius, Ceramioides*, and *Pseudomasaris* have but one spur. The two spurs probably represent the primitive condition. The tarsal claws likewise are variable, toothed in most genera, but simple in *Trimeria, Microtrimeria*, and *Pseudomasaris*.

Some of the peculiarities of the wing venation have been discussed above. As a rule the fore wing shows none of the longitudinal plaiting so characteristic of the Vespidæ when these insects are at rest. It should be observed, however, that the plaiting is likewise lacking or vestigial in the Euparagiinæ and Gayellinæ; while some Masaridinæ, such as *Ceramius*, show a distinct indication of it and others, such as *Celonites* and *Quartinia*, have the wing as strongly plaited as *Vespa*. Resting *Celonites* place the folded wings against the under side of the abdomen, as observed by J. Lichtenstein for the Mediterranean *C. afer* and by H. Brauns for several South African species. Throughout the subfamily there are but two closed cubital cells, the second and third (R^4+R^5) of the other Vespidæ being fused. To judge from the course of the two recurrent veins, it would seem that this feature of the wing was derived from the more common type of vespid venation, in which the second cubital cell (R_5) receives both recurrent veins, and not from the (perhaps more primitive) condition of the Euparagiinæ, Gayellinæ, and Raphiglossinæ in which the second and third cubital cells each receive a recurrent vein. Among the other subfamilies of Vespidæ the fusion of the second and third cubital cells is exceptional (as in

Paraicaria, where it is possibly the rule, and *Paramasaris,* where it is variable) or abnormal. In the hind wing the anal lobe is well developed as in most other Vespidæ (except Vespinæ), but is a small, circular or oval flap; the preaxillary excision is a mere undulation of the hind margin.

The number of segments of the abdomen is the same as in the other Diploptera, six in the female and seven in the male; but the posterior segments are not or only partly retractile within the second. The abdomen is always elongate and depressed, the venter being often flattened; in *Celonites* it is even slightly concave beneath and sharply margined on the sides (as in the Chrysididæ). The first segment is, as a rule, broadly truncate and "sessile" (that is articulated with the thorax without intervening stalk). Some of the South African *Ceramioides* have the first segment somewhat set off from the remainder of the abdomen or subpetiolate, and *Ceramiopsis* has the first segment narrowed into a short petiole.

HABITS AND LIFE HISTORY OF THE MASARIDINÆ

As stated above, the highly specialized trophi of most Masaridinæ are correlated with their peculiar habits. So far as known at present, these wasps differ from all other subfamilies of Diploptera in being exclusively plant-feeders in both the larval and adult stages.[1] The adults are anthophilous in both sexes and the females supply the larvæ with honey and pollen only. All other Vespidæ are at least partly predaceous and their larvæ feed exclusively or mostly upon animal prey. The only possible exception is *Nectarina,* a genus of honey-storing social wasps; but I have been unable to find definite observations showing that the larvæ of these wasps are fed on honey only. Even the Raphiglossinæ store insects for their larvæ, although the adults are

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[1] *Euparagia* is not a masarid wasp, but belongs to a distinct subfamily, Euparagiinæ, as shown by Bradley (1922, *Op. cit.*, p. 379). F. X. Williams (1927, Pan-Pacific Entomologist, IV, pp. 38-39) found that it is predaceous and stores its cells with curculionid larvae.

highly anthophilous and have the trophi as much modified into a proboscis as the Masaridinæ.[2]

That the Masaridinæ assiduously visit flowers has been observed in various parts of the world, but the genus or species of plant selected has not often been mentioned. This is, however, a point of some biological importance to which the attention of future observers should be called. From the few definite records it would appear that most of the species show a decided preference for flowers with fully-concealed nectar and, moreover, have a tendency to be oligotropic. In a given locality every species gathers pollen and nectar from one or a few species of plants, at least at one particular season.

Time has not allowed me to collect all observations scattered in the literature of Masaridinæ visiting flowers, but the following are believed to be representative for the group. In South Africa, according to H. Brauns, the species of *Celonites*, *Masariella*, *Ceramius*, and *Quartinia* all visit flowers actively, but the species of plants selected are not mentioned. In the Mediterranean Subregion, I have taken *Quartinia major* Kohl at flowers of *Chrysanthemum Myconis* Linnæus (near Algiers) and *Celonites afer* Lepeletier at those of *Echium confusum* de Coincy (near Oran). Dours mentions that he took *Celonites afer* and *Jugurtia oraniensis* (Lepeletier) in Algeria at flowers of *Bupleurum maritimum* Linnæus. *Celonites abbreviatus* (Villers) was observed by H. Loew visiting *Calamintha alpina* (Linnæus) (at Pontresina) and by H. Friese on *Teucrium montanum* Linnæus (in Thuringia). In Paraguay, *Trimeria howardi* Bertoni was seen by de Winkelried Bertoni visiting the flowers of *Talinum patens* (Jacquin). Much more complete are the observations relating to the North American *Pseudomasaris*. Some of these have been given above. In addition, *P. vespoides* (Cresson) has been observed by A. Davidson, in California, visiting *Pentstemon spectabilis* Thurber; by Cockerell, in New Mexico, eating the pollen of a species of *Pentstemon*; and by F. E. Clements and F. L. Long, in the

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[2] The habits of the Gayellinae (*Gayella* and *Paramasaris*) are totally unknown.

region of Pike's Peak, Colorado, at the flowers of *Calochortus Gunnisonii* Watson, *Geranium cæspitosum* James, *Mertensia ciliata* (Torrey) (=*sibirica* Don), *Monarda fistulosa* Linnæus, *Prunus melanocarpa* (A. Nelson) (=*demissa* of authors), *Pentstemon glaber* Pursh, *P. glaucus* Graham, *P. gracilis* Nuttall, *Rubus deliciosus* James, and *R. strigosus* Michaux. Bradley records *P. texanus* subsp. *neomexicanus* Rohwer at flowers of *Astragalus, P. phaceliæ* Rohwer at those of *Phacelia neomexicana* Thurber, and *P. coquilletti* Rohwer at those of *Eriodictyon crassifolium* Bentham.

Since the nesting habits are known for only a few of the genera, it may be useful to review them briefly. Our most important lacuna in this respect concerns the Australian genera *Paragia* and *Metaparagia,* the behavior of which may well be totally different from that of the other Masaridinæ.

Celonites.—The nesting habits of *Celonites abbreviatus* (Villers) were first described by J. Lichtenstein (1869, Ann. Soc. Ent. France, (4) IX, Bull., p. xxix) after observations made by H. Westphal in southern France. The female builds free cells of mud which she places one behind the other on dry stalks of plants and in which she stores a honey paste as food for the larva. (Some additional details are given by J. Giraud, 1871, Ann. Soc. Ent. France, (5) I, p. 379). More complete observations were made with this species by C. Ferton (1901, Ann. Soc. Ent. France, LXX, p. 139; and 1910, *Op cit.,* LXXIX, pp. 174-176), also in southern France. He found the nest fixed to stones. He states that the female lays the egg first, before bringing in any provisions, and that the full-grown larva lines the walls of the cell with a thin layer of silk. His account also seems to indicate that the female uses mass provisioning.

C. afer Lepeletier (= *C. fischeri* of authors, not of Spinola) was likewise studied in southern France by J. Lichtenstein (1875, Ann. Soc. Ent. France, (5) V, Bull., p. ccxi), who found its habits similar to those of *C. abbreviatus.* Nurse, near Aden, southern Arabia, also bred from cylindrical mud cells a species referred by Bingham to *C. fischeri* (C. T. Bingham, 1898, Jl. Bombay Nat Hist. Soc., XII, 1, p. 111).

Ceramius.—Fonscolombe (1835, Ann. Soc. Ent. France, IV, p. 421), in southern France, observed a female of *C. fonscolombei* Latreille entering a gallery burrowed in the soil and provided at the entrance with a chimney of mud.

In South Africa, according to H. Brauns (1911, Zeitschr. Wiss. Insektenbiol., VI, pp. 387 and 445-446), *C. beyeri* Brauns, *C. lichtensteini* (Klug) and its var. *macrocephalus* H. de Saussure, likewise nest in the soil, building an erect or curved, free chimney of mud at the entrance. In *C. lichtensteini,* the female excavates a chamber at the end of the gallery, sometimes at a depth of four to five feet; here she masons oval cells of mud, in which she feeds the larvæ from day to day with flower nectar.

Paraceramius.—J. Giraud (1871, Ann. Soc. Ent. France, (5) I, pp. 375-379) has given a good account of the habits of *P. lusitanicus* (Klug), of which he observed a populous colony in southern France. The nest is similar to that of *C. fonscolombei* and likewise provided with a chimney at the entrance. At the end of the subterranean gallery the female masons a mud cell in which she feeds the larva from day to day with a mixture of pollen and nectar. C. Ferton (1901, Ann. Soc. Ent. France, LXX, pp. 137-139) completed these observations. He noted that the egg was laid in the bottom of the cell before the first load of honeypaste was brought in and that it was not attached to the wall by a thread. It would seem that he too observed progressive provisioning, although he is not explicit about this point.

Ceramioides.—The nesting habits have been observed in South Africa by H. Brauns (1911, *Op. cit.*) for *C. schulthessi* (Brauns), *C. linearis* (Klug) (=*C. fumipennis* Brauns), *C. bicolor* (Thunberg) (=*C. karrooensis* Brauns) and *C. capicola* (Brauns). They do not differ from those of *Ceramius lichtensteini.* The entrance to the nest may be protected either by a free chimney, erect or curved, or by a tunnel built on the ground.

Pseudomasaris.—Ashmead first mentioned breeding *P. vespoides* from a free mudnest (1902, Canad. Entom., XXXIV, p. 219). A. Davidson (1913, Bull. S. California Ac.

Sci., XII, pp. 17-18) also said that this species builds lumps of mud, attached to rocks or twigs and of stony hardness. He claimed, however, that the cells were stored with insect larvæ, but he must have made a confusion with the nests of some other mud dauber, since Hicks' observations, recorded below, show conclusively that *P. vespoides* is a pollen provisioning wasp. T. D. A. Cockerell (1913, Proc. Ent. Soc. Washington, XV, p. 107) stated that this same species was bred by G. Robertson, at Redlands, California, from a nest having the shape of an inverted cone and composed principally of sand, fastened to the stem of some plant. C. H. Hicks' observations on *P. vespoides* (1927, Canad. Entom., LIX, pp. 75-79) are much more complete than those made on any other masarid wasp. He found that, near Boulder, Colorado, the extremely hard mud nests are attached to rocks. The number of cells varies from 2 to 13 in one nest, each cell being about 2 to 3 cm. high; they are all placed vertically side by side, so that the tops, each provided with a cup-shaped depression, are in a straight line. A store of pollen was found in some of the cells, while others of the same nest contained full-grown larvæ from which adult wasps were bred. It would appear that this species uses mass provisioning, since several closed cells were found each containing a large mass of pollen. Before pupating the mature larva spins a light brown, silky lining over the wall of the cell.

At one time is was believed that some at least of the Masaridinæ might be parasitic wasps, but there is no evidence in support of this view. Dours claimed that *Celonites* was parasitic upon *Scolia* and his supposed observations were reproduced by H. de Saussure (1854, Et. Fam. Vesp., III, pp. 35-36). A. de Winkelried Bertoni (1921, Rev. Soc. Cientif. Paraguay, I, p. 11) also stated that his *Ceramiopsis paraguayensis* was parasitic of an anthophorid bee, because he saw this wasp entering a vertical gallery in the soil with a "mouth-piece" similar to that of *Epicharis obscura* Friese. But the inference is almost certainly erroneous, since we know that many masarids that nest in the ground build chimneys at the entrance to their galleries.

DISTRIBUTION OF THE MASARIDINÆ

Not the least remarkable feature of the subfamily Masaridinæ is its present discontinuous distribution, as shown on the map (Fig. 2). This is further emphasized by an examination of the area occupied by the several genera.

Paragia.—20 species in Australia, 1 in Tasmania.[1]

Metaparagia.—3 species in Australia.

Ceramiopsis.—2 species in southern Brazil and Paraguay.

Trimeria.—5 species in subtropical South America.

Microtrimeria.—1 species in Peru.

Ceramius.—4 species in the Mediterranean Subregion and 7 in South Africa. Several of the South African species are known from females only; some of these may be only color variations, while others are perhaps to be placed in *Ceramioides. C. lichtensteini* (Klug) is a true *Ceramius.* On the other hand, *C. beyeri* Brauns combines some of the characters of *Ceramius* (middle tibiæ with two spurs and venter of the male unarmed) and *Ceramioides* (eyes very shallowly emarginate).

Paraceramius.—2 species in the Mediterranean Subregion, and 1 in Korea. The South African species listed by Bradley (1922, *Op. cit.*, p. 396) belongs in *Ceramioides.*

Ceramioides.—7 species in South Africa. Here should be placed *C. bicolor* (Thunberg) (=*C. karrooensis* Brauns), *C. consobrinus* H. de Saussure, and *C. linearis* Klug (of which *C. fumipennis* Brauns is a synonym according to information received by letter from Dr. H. Brauns).

Jugurtia.—4 species in the Mediterranean Subregion (as far as Transcaspia and Persia) and 1 species in Gambia. The British Museum collection contains two specimens from

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[1] Through a curious oversight, Tillyard (1928, 'The Insects of Australia and New Zealand,' p. 296) calls these Australian masarids *Euparagia,* which is the name of a strictly North American genus not belonging to the Masaridinae.

Northern Nigeria which may belong to an undescribed species.

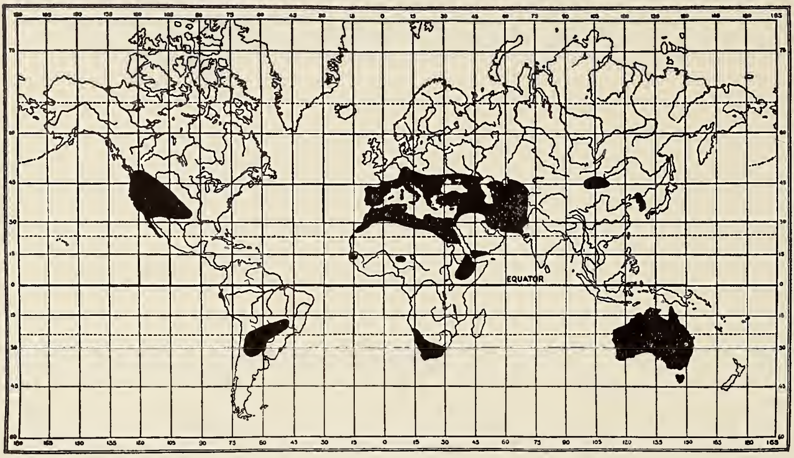

Fig. 2. Map showing the distribution of the subfamily Masaridinæ.

Celonites.—9 species in the Mediterranean Subregion (as fas as Turkestan; one of these species has also been recorded from southern Arabia), 1 in northwestern India, 2 in East Africa (Obock, Abyssinia, and northern Kenya Colony), and 7 in South Africa.

Quartinia.—4 species in the Mediterranean Subregion, 1 in Mongolia, 1 in northwestern India, and 2 in South Africa.

Masariella.—5 species in South Africa.

Masaris.—4 species in the Mediterranean Subregion (as far as Turkestan).

Pseudomasaris.—14 species in the western United States, from the southern part of British Columbia to Lower California and eastward to Colorado and Texas.

In appraising the endemicity of the several genera, one should be aware of the fact that they are of unequal value.

According to their natural affinities they may be grouped as follows:

(1) *Paragia* and *Metaparagia* occupy an isolated position in the subfamily and have rightly been separated by Bradley (1922 *Op. cit.*, p. 388) as a distinct tribe, Paragiini. They are restricted to the Australian Region, where no other masarids are known to occur.

(2) *Ceramiopsis* is strictly Neotropical.

(3) *Trimeria* and *Microtrimeria* are also strictly Neotropical.

(4) *Ceramius, Paraceramius,* and *Ceramioides* are extremely closely allied and should perhaps be regarded as of subgeneric value only. This group is Palæarctic and South African.

(5) *Quartinia* is found in the Palæarctic Region and in South Africa.

(6) *Jugurtia* and *Celonites* are Palæarctic and Ethiopian.

(7) *Masaris, Pseudomasaris,* and *Masariella* are Palæarctic, Nearctic and South African.

A study of the map brings out the interesting fact that the distribution of the Masaridinæ does not fit in the customary scheme of zoögeographical regions based upon the terrestrial faunæ as a whole. On the contrary, these wasps are restricted to a series of disconnected areas, often of relatively small extent and separated by extensive tracts of country where they are entirely lacking. A wide and discontinuous distribution of that type is generally explained on the theory that it is the remnant or result of a more extensive and more or less continuous area occupied by the group or its immediate ancestors during former geological periods. In the case of the Masaridinæ no paleontological evidence can be adduced in support of this view, and we must rely entirely upon analogy of their present-day distribution with that of certain other animals where such evidence is available. Three analogous cases may be briefly mentioned. The present distribution of the Masaridinæ is almost exactly matched by that of the dipterous family Nemestrinidæ, which is known with certainty from the Miocene and may even have existed during the Jurassic[1]. The living Onychophora (*Peripatus* and allies) exhibit a distribution of a somewhat different type, yet distinctly composed of disconnected areas (See the map given by C. T. Brues, 1923, American Naturalist, LVII, p. 211); their extreme antiquity has been demonstrated by the discovery of one species in the middle Cambrian rocks of North America, although the group is no longer found living in that part of the world. The marine genus *Pleurotomaria* is one of the oldest groups of Gasteropoda: over 400 species are known from Palæozoic rocks, from the Cambrian on, and it was also abundant during the Jurassic; it was much rarer during the Tertiary; in the modern seas it is represented by only five or six living species, two in the Antilles, two or three in Japan, and one in the Moluccas.

A closer examination of the distribution of the Masaridinæ brings out some other items of interest. In the Palæarctic Region, these wasps are almost restricted to the Mediterranean Subregion which possesses 27 species of six genera: *Ceramius, Paraceramius* (endemic), *Jugurtia, Quartinia, Celonites,* and *Masaris* (endemic). Only one species, *Celonites abbreviatus* (Villers), extends into Central Europe, being found in Austria, Switzerland, and southern Germany (northernmost locality: Weissenfels near Leipzig, in about 51° N. lat.). *Quartinia* and *Celonites* are each represented by one species in the extreme northwestern corner of India, a region which may be regarded as an extension of the Mediterranean Subregion. Otherwise the subfamily is absent from the Oriental Region. One species of *Quartinia* has been described from Mongolia and one species of *Paraceramius* from Korea, both these areas belonging to the Palæarctic Region.

In the Ethiopian Region, South Africa is unusually rich,

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[1] *Prohirmoneura jurassica* Handlirsch, described from the lithographic chalk (Malm) of Bavaria, is undoubtedly a nemestrinid. Yet, as it was based upon a single specimen, I feel somewhat doubtful of the correctness of the geological horizon to which it was referred.

with 28 species of five genera: *Ceramius, Ceramioides* (endemic), *Quartinia, Celonites,* and *Masariella* (endemic). The vast majority of these forms occur south of the Orange River; a few extend into the Orange Free State (to 29° S. lat.) and South West Africa (to 22° S. lat.). The three remaining Ethiopian species, of the genera *Jugurtia* and *Celonites,* are found in the Sudan (Gambia and Northern Nigeria) and in East Africa (Obock, Abyssinia, and Kenya Colony. The occurrence of one species of *Celonites* in southern Arabia should be mentioned here since that territory belongs zoögeographically to the Ethiopian Region. It is significant that the masarids avoid the West African Subregion and the Malagasy Region.

The 24 species of the Australian Region all belong to the endemic genera *Paragia* and *Metaparagia* and are restricted to the Australian continent and Tasmania.

Only 8 species are known from the Neotropical Region, all belonging to three endemic genera: *Ceramiopsis, Trimeria,* and *Microtrimeria.* They occur in the arid or semiarid parts of South America, avoiding entirely the tropical, moist, densely forested areas.

The Nearctic Region has 14 species, all belonging to one endemic genus, *Pseudomasaris,* the distribution of which has been indicated above. Its northernmost occurrence is at Princeton, British Columbia, in about 49° 30′ N. lat.

The present-day localisation of the Masaridinæ in certain well-defined areas seems to be entirely due to the ecological conditions favored by these wasps. The overwhelming majority of the species occur in arid or semi-arid country only, or at least in regions characterized by a hot and relatively dry summer. These wasps may therefore be called xerophilous. They entirely avoid regions with a heavy and evenly distributed rainfall, whether in temperate or in tropical parts of the world. These ecological requirements, as well as the strictly vegetarian habits, also explain why most masarids are among the rarest of insects. In order to perpetuate the species, the adults must appear at the proper season, when the flora is at its best. This condition is, of course, entirely regulated by the rains, which in desertic and semi-arid regions are always of short duration and often erratic. Thus in the South African Karroo two or more years may pass without rain. As H. Brauns has shown (1911, *Op. cit.*, p. 446), the larvæ of *Ceramius* have the faculty of remaining in their underground cells without pupating throughout these long dry spells. In moister years, however, the adults are ready to hatch in early spring. As there are many arid parts of Central Asia, Arabia, the Sahara, and South America that have never been visited at the proper season by an entomologist, it is safe to prophesy that several species and perhaps even genera of masarids remain to be discovered. It is doubtful, however, whether future finds will materially alter the discontinuous distribution of the group, as known as present.

THE MASARIDINÆ AS AN ARCHAIC GROUP

It has been sometimes assumed that the masarid wasps are an archaic, or primitive, group of Vespidæ, but, so far as I know, no definite arguments have been brought forward in support of this opinion. I believe that this view, although correct in some respects, ought to be qualified, as I shall attempt to show presently.

The detailed discussion of the morphology of these wasps, given above, makes it clear, I think, that in almost every character of phylogenetic importance the Masaridinæ are either not more primitive than most other subfamilies of Vespidæ, or have retained primitive conditions in certain genera while being highly specialized in others. The most striking features of the masarid wing, *viz.*, the presence of only two closed cubital cells in the fore wing and the apparent lack of a discoidal vein in the hind wing, are evident specializations. As for the plaiting of the fore wing, it is indicated in certain species and it is as clearly marked in *Celonites* and *Quartinia* as in *Vespa*. The highly modified mouth-parts likewise preclude the possibility that the present-day Masaridinæ are anything like the ancestral stock of all the Diploptera. As a matter of fact the Gayellinæ and Euparagiinæ are in many features more primitive than the Masaridinæ, since they still have unplaited fore wings with three closed cubital cells, the second and third each receiving a recurrent vein, while the hind wings have a distinct or large posterior lobe and at least a trace of a discoidal vein; in addition their trophi are not modified into a proboscis.

I am therefore unable to regard the Masaridinæ as a primitive or ancestral group. Nevertheless, they undoubtedly constitute an archaic unit, not derived from the immediate ancestors of the other subfamilies of Diploptera nor ancestral to them, but forming a very ancient, autochthonous line of descent. I am inclined to the view that at least five distinct, or independent, lines of descent may be recognized among the living Vespidæ, as follows:

(1) Subfamily Gayellinæ *(Gayella* and *Paramasaris).*

(2) Subfamily Euparagiinæ *(Euparagia).*

(3) Subfamily Masaridinæ.

(4) Subfamily Vespinæ *(Vespa* and *Provespa).*

(5) The remainder of the Vespidæ, comprising the subfamilies Polistinæ, Ropalidiinæ, Polybiinæ, Raphiglossinæ, Zethinæ, Eumeninæ and Stenogastrinæ.

As in many other ancient groups, that have persisted through long geological periods and have thus had time to mature, the Masaridinæ often exhibit extraordinary structural characters. They are the delight of the taxonomist and, in this respect, contrast sharply with the other Diploptera, the morphology of which is only too often of a despairing monotony. Most of the peculiar structures of the masarids are exaggerated secondary sexual characters of the males, the usefulness of which to the species is extremely doubtful or at least not apparent. These characters affect the shape of the antennæ, legs and abdominal segments. Sexual dimorphism is often so pronounced that the specific or even the generic connection between the two sexes is quite a problem.

One of the most convincing arguments in favor of the great antiquity of the Masaridinæ as a distinct subfamily, is their present-day discontinuous distribution, as I have sufficiently indicated above. One remarkable feature still should be mentioned, namely the absence of any close relationship between the masarids of Australia, South Africa, and South America respectively. This group evidently gives no support to the partisans of land connections between these continents during late Mesozoic and Tertiary times.

In view of the highly specialized modification of the trophi into a proboscis correlated with strictly vegetarian habits, one may venture the hypothesis that the Masaridinæ represent an early attempt at evolving an anthophilous group of aculeate Hymenoptera, perhaps anterior to the evolution of the Apoidea (or bees) from a sphecoid stock. It may be supposed that during some former geological periods, these wasps were a predominant group, perhaps holding the same important position in the ecology of the phanerogams as is nowadays reserved to the bees. Their eventual decline, resulting in their present-day scarcity and discontinuous distribution, may have been brought about by the rising competition of the Apoidea, whose branched hairs and highly efficient collecting apparatus gave them considerable advantage as pollen gatherers and feeders over the masarid wasps.

TWO NEOTROPICAL ANTS ESTABLISHED IN THE UNITED STATES.

By William Morton Wheeler.

In a recent number of the Journal of Economic Entomology[1] Mr. M. R. Smith called attention to two Neotropical ants, *Iridomyrmex iniquus* Mayr and *Wasmannia auropunctata* Roger, as occurring in the United States. The former was found inhabiting the greenhouse of the University of Illinois, the latter was taken out of doors at Miami, Florida.

The Iridomyrmex has been a denizen of the greenhouses of the Bussey Institution for at least the past twenty years, as I noticed its occurrence soon after I moved to Boston in 1908. The specimens do not, however, belong to the typical form of the species but to the var. *nigellus* Emery, originally described from Costa Rica. They were probably introduced in soil with tropical plants some years prior to 1908. Although the green-houses have been fumigated on several occasions with calcium cyanide for the purpose of ridding them of plant pests, the ant has always managed to survive and is now as abundant as ever. Our gardener regards it as a nuisance. He has found it visiting the flowers of strawberries used in hybridizing experiments and suspects it of cutting out the anthers. Its principal food, however, is the honey-dew of Coccids, as Mr. Smith has observed. The small nests are made in the thin layer of soil on the benches under the pots and contain glistening white larvæ at all seasons of the year. I have taken the males and winged females in March.

Wasmannia auropunctata, a very common ant throughout Central and northern South America, the West Indies and the warmer portions of Mexico, is cited by Mr. Smith from Miami, Florida. That it is established in tropical Florida is indicated also by the fact that some five years

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[1] Vol. 22, 1929 p. 241-243.

ago Dr. David Fairchild sent me a number of specimens that had been taken by his daughter, Miss Nancy Fairchild, at Cocoanut Grove, Florida, with the comment that their stings were painful. This ant is often abundant in the coffee plantations of Porto Rico where it is known as the "hormiguilla" and proves to be very annoying to the berry-pickers. It is not infrequently transported to northern ports with orchids and other tropical plants. I possess a series of workers and winged females taken by Mr. F. B. Shaw in orchids from Colombia at quarantine in New York City, and Donisthorpe[1] has the following remarks on its occurrence in England: "I first discovered this very small species in Kew Gardens in 1907; it is one of the commonest ants at Kew, being abundant in the propagating pits and some other houses. It nests in and under flower-pots, in the leaf-sheaves of *Piper obliquum* v. *eximium,* etc. and its males and females, which are very large in comparison with the workers, occur in December and January in the nests, and sometimes on the walls of the hot-houses. A small "woodlouse" somewhat like *Platyarthrus hoffmanseggi,* and the little spider *Diblemma donisthorpei* Camb., which is superficially very like the worker ants, are usually found in the nests. In 1922 Halkyard took it in a banana store in Manchester."

While it is probable that both the *Iridomyrmex* and the *Wasmannia* may eventually become established in greenhouses in many parts of the United States, they will be able to survive out of doors only in the very restricted tropical portions of the country.

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[1] British Ants, 2nd ed. 1927 p. 393.

NOTE ON GESOMYRMEX

By William Morton Wheeler

Since the manuscript of my paper on the interesting, Javanese ant, *Gesomyrmex kalshoveni*, was sent to the printer, Dr. Kalshoven has kindly sent me the remainder of the colony which contained the type specimens, together with a note on the precise situation of the nest. He writes: "The new Gesomyrmex was found in a branch of an *Artocarpus elastica* ("bendo") in a stand of various deciduous trees—relics of the old natural mixed forest—amidst the teak-forests of Semarang." This statement confirms my supposition in regard to the habits of Gesomyrmex, which evidently lives much like many twig—or branch—inhabiting Camponoti of the subgenera Myrmentoma, Colobopsis, Pseudocolobopsis, Hypercolobopsis, Myrmocladœcus and Myrmobrachys. That the specimens collected by Dr. Kalshoven were living in a piece of primitive forest is of some interest in connection with the fact that the extant species of Gesomyrmex are sporadic survivors, or relicts of an ancient ant-fauna of much wider distribution during the Oligocene Tertiary.

The second lot of specimens from Dr. Kalshoven comprises in addition to 13 workers (one maxima, five mediæ and seven minimæ), which show the same range of polymorphism as described and figured for the first lot, also one male semipupa and two female pupæ. The male semipupa reveals nothing new, but the two female pupæ are interesting. They are approaching maturity since their eyes and mandibular teeth show the beginnings of pigmentation. Both are naked, i.e. not enclosed in cocoons, and measure about 10 mm. They closely resemble the female of *G. luzonensis* Wheeler from the Philippines, but have distinctly smaller eyes and a much shorter petiole, with less

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[1] See Psyche, vol. 36, p. 1 (1929)

rounded and more anteroposteriorly compressed node. The antennæ are 10-jointed as in *luzonensis,* with the funicular joints 3-8 broader than long. The thorax seems to be stouter and shorter than in the species from the Philippines, but the integument is still so soft, that I can infer nothing in regard to the adult proportions of its various sclerites.

A FLIGHT OF *PIERIS MONUSTE*

I was much interested in the account by Dr. E. D. Ball and W. E. Stone of "A puzzling Butterfly Migration" (Science, vol. 68, p. 110, 1928). It reminds me of a migration which occured while I was living at St. Augustine, Florida. In June, 1881, there was a northward flight of *Pieris monuste* lasting for three days. On the first and second days it was a marvelous sight like a snowstorm with large flakes obscuring the view. On the second day a New York schooner ("Nellie Grant") came in. I knew the captain quite well and asked him when he first saw the flight and he said—"Yesterday afternoon about ten miles off shore." It was the first and only flight I saw during the eight years I lived in Florida, and was noticed at the time as far north as Charleston, S.C. Many asked me the cause of this great flight. I attributed it to a search of the insect for more food plants. There are many cruciferous plants along the sea-coast that are often destroyed by the larvæ. The first brood having devoured all the food plants of the species along the more southern part of the Florida coast, the second brood was compelled to migrate, and in this case it was northward.

This flight was recorded in the American Naturalist, Vol. 15, p. 577, 1881. The report was from Bluffton, near Beaufort, S.C., and occurred June 1 and 2. They were flying "East or northeast." As they were apparently following the coast, this would naturally be the direction they would be flying east of Savannah.

C. W. Johnson.

A SPECIES OF *MEGACHILE* FROM BERMUDA[1].

By Theodore B. Mitchell

A single female *Megachile*, captured during May, 1913, by Mr. Austin Brues in Bermuda, and sent to me by Dr. Bequaert for identification, proves to be either a variety of *M. pruina* Sm. or a very closely related species. Hence I will describe it here as a new variety of that species. If the male becomes available at some future time, it is possible that this will be shown to be specifically distinct from *pruina*.

Megachile pruina bermudensis n.var.

Size: Length 13 mm.; breadth of abdomen 5 mm.; anterior wing 9 mm.

Structure: Head broad; eyes slightly converging below; clypeus entire apically, the margin slightly thickened and shining medially; mandibles 4-dentate; cheeks as broad as eyes; vertex flat, hind margin slightly concave; lateral ocelli slightly nearer edge of vertex than to nearest eye; basal joint of flagellum longer than the second joint; hind metatarsi almost as long and as broad as the tibiæ; abdomen cordate, the apical margins of the segments rather strongly depressed laterally, but not medially; segment six straight in profile, slightly concave at sides in dorsal aspect, with only suberect black hairs visible in profile, the ventral plate bare except for a marginal fringe of black hairs, the apical margin extending as a bare lip beyond the apical fringe.

Puncturation: Close on cheeks and pleura, and on clypeus except in center; on the vertex close on either side of the median line, more sparse laterally; distinctly separ-

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[1] Contribution from the Department of Zoology and Entomology, North Carolina State College, and published with the approval of the Director of the North Carolina Experiment Station as Paper No. 31 of the Journal Series.

ated on mesonotum medially, but close laterally and anteriorly, and quite widely separated on scutellum; fine and close on basal abdominal segment, becoming relatively coarse and sparse on segment five, close and fine on segment six.

Color: Black; the tegulæ and antennæ below more fuscous; the wings quite uniformly infuscated, with fuscous nervures; spurs pale yellow.

Pubescence: White at sides of face, between antennæ, on cheeks, pleura, propodeum, coxæ, femora, tibiæ, and basal abdominal segment; black on vertex, mesonotum, scutellum, and discs of abdominal segments 2-5, with intermixed black hairs between antennæ; more fuscous on clypeus, front tibiæ and tarsi anteriorly, and on outer face of mid tarsi; segments 2-5 with narrow entire white apical fasciæ; segment six whitish tomentose, with erect black hairs laterally, these subappressed medially; scopa white, black on segment six and at extreme sides of segment five.

Type: Female; Bermuda. Coll. Austin Brues. (Museum of Comparative Zoölogy, Cambridge, Mass.).

This differs from typical *pruina,* as occuring in Florida, in the more lightly infuscated wings, and in the fact that the scopa of segment five is largely white. In *M. pruina* s. str. the scopa of segment five is entirely black, and that on segment four is black at the extreme sides. Otherwise, they are nearly identical. *M. pruina* was also described by Cresson as *M. pinguis.* The male was described by Robertson as *M. floridana,* and by myself as *M. shermani.*

THE ANT GENUS RHOPALOMASTIX[1]

By William Morton Wheeler

The genus Rhopalomastix was established by Forel in 1900 for a very aberrant female Myrmicine ant (*Rh. rothneyi*) taken by G. A. J. Rothney at Barrackpore, near Calcutta, India[2]. In 1911 he detected the worker and male of this species and also the female of a second species or subspecies *(Rh. escherichi)* among the ants collected by Prof. K. Escherich in Ceylon[3], and was therefore able to recognize the close relationship of the genus to Melissotarsus Emery, which now comprises four species, confined to the Ethiopian and Malagasy Regions, namely, *M. beccarii* Emery from Erythrea and Natal, *emeryi* Forel from southern Ethiopia, with a var. *pilipes* Santschi in East Africa, *weissi* Santschi from the Congo and *insularis* Santschi from Madagascar. In both genera, which together now constitute the tribe Melissotarsini, the antennæ of the worker are very short, with much enlarged terminal joint, the frontal carinæ are closely approximated and resemble those of certain Ponerinæ (Ponera), the thoracic dorsum is sutureless and the tibiæ of the middle and hind legs are spurless. The wings of the male and female lack the discoidal cell, and have a long cubital and a closed and appendiculate radial cell. The antennæ of the males are 12-jointed in both genera, but the worker of Melissotarsus has the antennæ composed of only 6 joints, whereas there are 10 in Rhopalomastix. Melissotarsus is also peculiar in possessing conspicuously dilated basitarsal joints on all the legs. Emery[4] believed that the worker of *M. beccarii* was distinctly dimorphic, or repre-

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[1] Contributions from the Entomological Laboratory, Bussey Institution, Harvard University, No. 313.

[2] Forel, A. Un nouveau genre et une nouvelle espece de Myrmicide. Ann. Soc. Ent. Belg. 44, 1900, p. 24-26.

[3] Forel, A. Ameisen aus Ceylon. In K. Escherich's "Termitenleben auf Ceylon", 1911 pp. 215-228.

[4] Emery, C. Catalogo delle formiche esistenti nelle collezioni del Museo Civico di Genova. Part I. Anal. Mus. Civ. Genova 9, 1877 p. 378-379, fig.

sented by a soldier phase (Fig 2) with anteriorly broad head and convex blunt-toothed mandibles and a worker phase proper with anteriorly narrower head and acute mandibles, but Arnold[5], who examined a long series of this species, finds a complete gradation between the two forms.

Several years ago Viehmeyer sent me eleven workers and two immature males of a Rhopalmoastix belonging to a series taken by H. Overbeck at Singapore. Viehmeyer[6] had recorded them as belonging to *Rh. rothneyi,* but on comparing them with Forel's description I find that they differ in size and coloration and therefore probably represent a distinct subspecies, which is here described:

Rhopalomastix rothneyi Forel subsp. **johorensis** subsp. nov.

Worker. Length 2 - 2. 6 mm.

Distinctly larger than the typical *rothneyi,* which measures only 1.7 - 1.8 mm. Head scarcely longer than broad (1 1/6 longer than broad in *rothneyi*) and with somewhat smaller eyes (13 to 15 facets, instead of about 20). Head and thorax rich ferruginous red; appendages, abdomen and sides and declivity of epinotum clear brownish yellow.

I have recently received another series of specimens, comprising all three phases of a second subspecies of *rothneyi* from Java, which may be described as:

Rhopalomastix rothneyi subsp. **javana** subsp. nov. (Fig. 1)

Worker. Length 1.3-1.8 mm.

Averaging smaller than the typical form of the species. Head not longer than broad; thorax shorter, only 1 2/3 times as long as broad, with the epinotum distinctly narrower than the promesomotum. Median tooth of the anterior clypeal border very indistinct. Eyes smaller, consisting of only 12 to 14 facets. Sculpture finer than in the subsp. *johorensis;* color similar, but the head and thorax more yellowish ferruginous, the gaster clouded with brown apically.

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[5] Arnold, G. A Monograph of the Formicidæ of South Africa, Ann. South Afr. Mus. 1916 p. 188 nota.

[6] Viehmeyer, H. Ameisen von Singapore. Arch. Naturg. 81, (1919) 1916 p. 108-168, 15 figs.

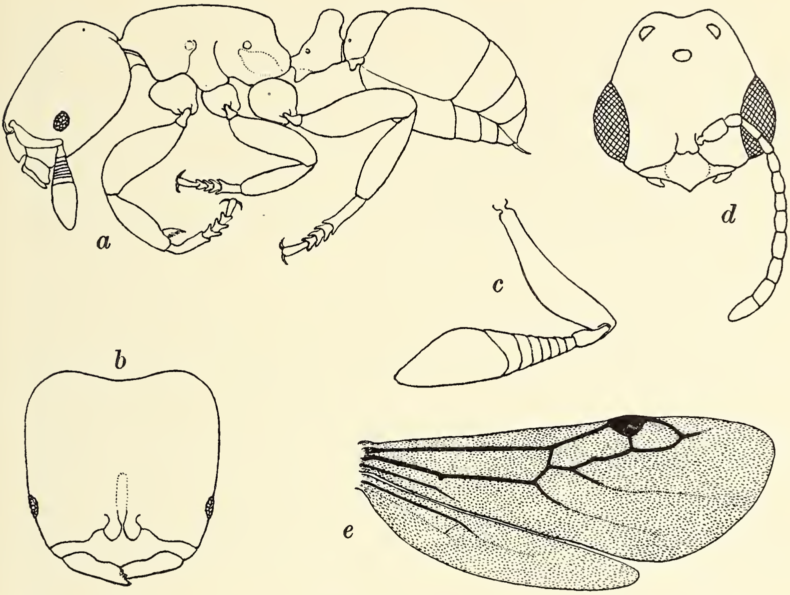

Fig. 1. *Rhopalomastix rothneyi* Forel subsp. *javana* subsp. nov. *a,* worker in profile; *b,* head of same, dorsal view; *c,* antenna of same; *d,* head and antenna of male; *e,* wings of same.

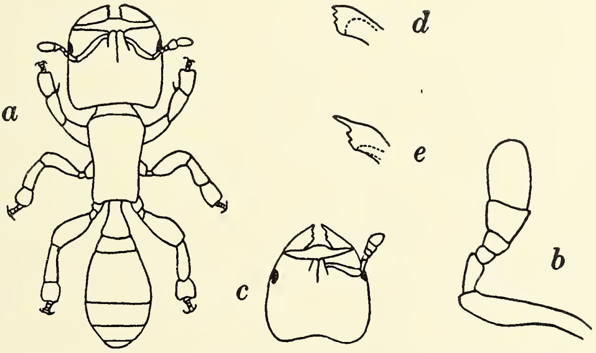

Fig. 2. *Melissotarsus beccarii* Emery. *a,* broad-headed worker, dorsal view; *b,* antenna of same; *c,* head of narrow-headed worker (After C. Emery); *d,* mandible of broad-headed worker; *e,* mandible of narrow-headed worker (After G. Arnold).

Female (deälated). Length 2.5-2.8 mm.

Antennæ 10-jointed as in the worker. Deep castaneous brown; pronotum, thoracic sutures, pedicel and appendages paler, more reddish brown. Sculpture as in the typical *rothneyi*, the anterior third of the head and the thoracic dorsum very finely longitudinally striated, the posterior portion of the head shining, sparsely and rather coarsely punctate, the gaster shining, with finer, piligerous punctures.

Male. Length 2-2.3 mm.

Black, with brown appendages. Wings clear and hyaline, with dark brown veins and pterostigma, the latter small and subelliptical. The costal vein is absent basal to the pterostigma and there is a distinct indication of a former division of the long cubital cell into two cells and pale indications of former prolongations of the cubitus and discoidal veins towards the tip of the wing. The hind wing is narrow and has only one distinct vein, the media.

Described from numerous workers, four females and three males taken at Bondowoso, Besoeki, Eastern Java and received from Dr. L. G. K. Kalshoven.

My female specimens of *javana* do not agree with Forel's description of the typical *rothneyi* in the number of antennal joints. In his generic diagnosis he gives the number as 11, which is also the number given by Emery in the "Genera Insectorum," but in my specimens the number is certainly 10. Probably Forel did not examine balsam mounts, without which it is impossible to determine the precise number of the very short and crowded median joints of the funiculus. That both worker and female of Rhopalomastix have the same number is also indicated by the conditions in Melissotarsus, both the female phases of which have 6-jointed antennæ.

Apart from the complete absence of spurs on the middle and hind tibiæ, the legs of Rhopalomastix also show peculiarities in the structure of the worker and female tarsi, which are by no means of the "common form" as stated by

Forel. To be sure, the basitarsi are not dilated as in Melissotarsus, but the second to fourth joints are unusual in being extremely short, obliquely prolonged on each side and overlapping.

In regard to the palpal joints, I am unable to add anything to Forel's statement that in the worker the "labial palpi are two-jointed, the maxillary palpi not to be found." Perhaps the latter are present but greatly reduced.

The peculiarities of the wing-venation are inadequately described by Forel. As will be seen from Fig. 1e, the fore wing is peculiar in completely lacking the costal vein basal to the pterostigma, in the shape of the pterostigma, and the length of the cubital cell which exhibits traces of a division into two. Forel compares the venation with that of Solenopsis, but it is clearly more like that of Myrmecina, especially in the structure of the radical cell. According to Arnold, the apterostigma is almost obsolete in Melissotarsus.

Both the genera of Melissotarsini have essentially the same nesting habits, as shown by the following notes. Escherich took all phases of the typical *Rh. rothneyi* under bark. Viehmeyer cites Overbeck as having taken the form which I have described as the subsp. *johorensis* from several nests in the dead twigs of mango (Mangifera) and in the bark of durion trees *(Durio zibethinus)*, and Dr. Kalshoven has sent me the following note in regard to the subsp. *javana:* "The Rhopalomastix (g104) was collected from a sample of bark of a dying *Mangifera indica*, which was forwarded to our Institute at Buitenzorg by Dr. Loos, the landbouwconsulent (agricultural expert) at Bondowoso (Res. Besoeki, Eastern Java). Dr. Loos wrote us that the ants were burrowing in the bark of the dying tree. The bark was riddled by the insects over half the circumference of the tree and at least as high as he could reach. Numerous pupæ were seen. The ants, however, were not considered to be the cause of the death of the tree." This note shows that the Rhopalomastix colonies may be very populous. That Melissotarsus has very similar habits may be inferred from Arnold's remark (p. 190) on *M. beccarii*, which was taken at Durban, "nesting under bark in moderately populous colonies."

The affinities of the Melissotarsini to other tribes of Myrmicinæ are very obscure. Forel at first regarded Rhopalomastix as allied to Solenopsis, but on receiving the worker at once recognized its close relationship to Melissotarsus. He believed, however, that "both genera are undoubtedly primitive Myrmicines, allied to the Ponerine group Cerapachyi." In view of the extraordinary specialization of the structural characters in both genera of Melissotarsini, this relationship can hardly be maintained. It was evidently suggested by purely superficial resemblances in general habitus to forms like Cylindromyrmex, Simopone, etc. which also burrow in wood. Emery, who had carefully studied Melissotarsus, when he came to revise the classification of the Myrmicinæ for the "Genera Insectorum" (1921 p. 8) confessed his inability to establish the affinities of the Melissotarsini and a few other aberrant Myrmicine genera. He says: "Myrmicaria, Stereomyrmex, Cardiocondyla and especially the Melissotarsini are very specialized and isolated ants. In the present state of Myrmecology it is absolutely impossible to say anything about their affinities. I am of the opinion that the Melissotarsini are very primitive, but profoundly adapted to particular conditions of existence (thorax without sutures, antennæ, lack of spurs, very small size, etc.). At any rate this group is very aberrant." In the "Genera Insectorum" Emery placed the Melissotarsini next to the Stereomyrmicini, which they somewhat resemble. In my opinion there are also vague affinities between the Melissotarsini and the Myrmecinini, especially in the wing-venation and the structure of the head of the male, though the mesonotum of the male Myrmecina possesses notauli which are absent in the Melissotarsini.

In all probability the Melissotarsini, which now comprise only half a dozen species, are the last survivors of some very ancient Myrmicine stock. Their antiquity is attested by their rare and sporadic occurence in a rather circumscribed geographic area. Evidently the Indomalayan genus Rhopalomastix is more primitive than Melissotarsus, which is known only from the warmer parts of Africa and Madagascar. In both genera, however, the characters of the worker, particularly the diminutive size, compact, subcylindrical shape of the body, the small eyes, reduced palpi, short, stout appendages, the flattened, club-like antennal funiculi, the peculiar shape of the mandibles and the coloration, all reminiscent of similar characters in the Scolytid and Platypodid beetles, represent so many specialized adaptations to a burrowing life in bark and dead wood. The tribe is, therefore, like certain tribes of Ponerine and Formicine ants and certain vertebrates such as the sturgeons among fishes, the ostriches among birds and the monotremes among mammals, a group of ancient but highly specialized and conservative species which have managed to survive in a narrow, constant environment.

A NOTE ON THE ASPARAGUS BEETLE, *CRIOCERIS ASPARAGI* LINN.

In the summer of 1928 I examined some small apple trees planted in an asparagus bed in North East, Erie Co.,Pa. Great numbers of the asparagus beetle, *Crioceris asparagi* Linn., were present on the asparagus, and a large number of both sexes were resting and crawling about on the trunks and branches of the apple trees. Several rows of peach trees were also set in the asparagus bed, but I could find no beetles upon them, although the insects were apparently as numerous on the asparagus between the peach trees as on that between the apple trees. No eggs of the beetle were found on the apple trees, the insects apparently only resting on the trees. Since the beetle is strongly positively phototropic, the fact that the apple trees were open with their branches shaded very little from the sunlight, while the trunks and branches of the peach trees were shaded by foliage, may, perhaps, account for the seeming preference of the asparagus beetle for the apple trees as resting places.

MILTON F. CROWELL.

A CAMPONOTUS MERMITHERGATE FROM ARGENTINA

BY WILLIAM MORTON WHEELER

In a recent paper[1] I called attention to the different effects produced by Mermis parasitism in female ants belonging to different castes and natural subfamilies. When the queens of Lasius species (subfam. Formicinæ) are infected and converted into mermithogynes, the observable effects are a slight diminution in the size of the head and thorax and a pronounced diminution in the size of the wings. In various genera of Ponerinæ (Euponera, Pachycondyla, Odontomachus) the mermithized workers, or mermithergates, have the head narrowed, small ocelli may be developed and some of the other parts of the body may come to resemble those of the queen. In the genus Pheidole (subfam. Myrmicinæ), which has three distinct female castes—queen, soldier and worker—the infected individuals usually present a peculiar blending of the characters of all three phases. The only recorded example of a mermithized worker Formicine ant is a specimen of the large *Camponotus (Tanæmyrmex) pompejus* Emery subsp. *cassius* Wheeler, which I described from the Belgian Congo. This specimen was unmodified and, apart from the swollen gaster containing the coiled Mermis, had all the characters of a normal worker minor.

While studying the large collection of ants made by Prof. J. C. Bradley during 1919-20 in South America, I have found another mermithized worker Formicine, which is more interesting than the Congolese specimen. This is a specimen of *Camponotus* (*Tanæmyrmex*) *punctualatus* Mayr. subsp. *minutior* Forel, a common ant in the Argentine and represented in Professor Bradley's collection by several series of major and minor workers taken at Laguna Paiva, Posadas, La Quiaca, San Juancito and Coquin. The mermithergate was taken in the locality last mentioned, which is in the

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[1] Mermis Parasitism and Intercastes among Ants. Journ. Exper. Zool. 50, 1928 pp. 165-237, 17 figs.

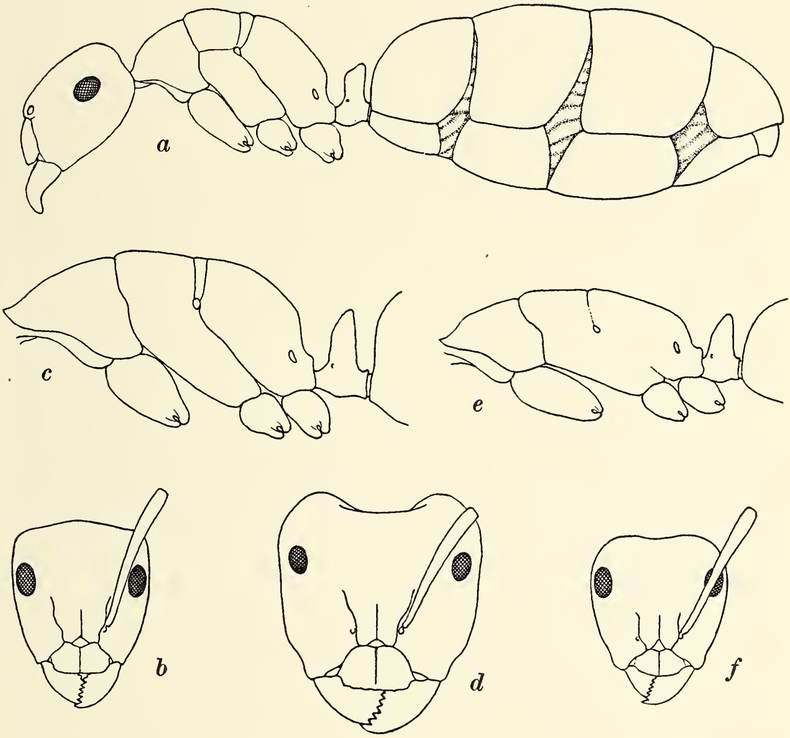

Fig. 1. *Camponotus (Tanæmyrmex) punctulatus* Mayr subsp. *minutior* Forel. *a,* mermithergate, in profile; *b,* head of same, dorsal view; *c,* thorax and petiole of normal worker maxima; *d,* head of same; *e,* thorax and petiole of normal worker minima; *f,* head of same.

Sierra de Cordoba. *C. punctualatus* is a highly variable species of which some 16 subspecies and varieties have been described, ranging over Argentina, Patagonia, Bolivia, Peru and Southern Brazil (Rio Grande do Sul and Sao Paulo). One variety, *pergandei* Emery, is recorded from Mexico.[1]

The normal worker major of *C. punctulatus minutior* (Fig. 1, *c* and *d*) measures 6-7.5 mm., the worker minor (Fig. 1 *e* and *f*) 3.5-5 mm., the fertile female, or queen 11 mm. (according to Mayr.). I have not seen specimens of the queen *minutior,* but there are in my collection specimens of this caste belonging to the typical *punculatus* and its subsp. *andigena* Emery from Argentina, Bolivia and Peru. Both of these differ from the subsp. *minutior* only in size, sculpture and pilosity and in having the head, thorax and petiole black instead of red or reddish brown.

The mermithergate (Fig. 1*a*) measures 7.3 mm. Its head *(b)* is much smaller than that of the worker major *(d)* and shaped more like that of the queen than the worker minor *(f)*. This is especially true of its occipital region. There are no ocelli on the vertex, but these are small and widely separated in the queen. The mandibles are more convex than in the worker minor and therefore more like those of the major and queen. The clypeus, too, in possessing a more pronounced subrectangular anterior lobe is of the queen and worker major type. On the other hand, the antennal scapes of the mermithergate are long and slender and extend well beyond the posterior corners of the head as in the worker minor, whereas the scapes of the major and queen are much shorter in proportion to the dimension of the head. The tho-

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[1] As Santschi has shown (Ann. Soc. Ent. France 88, 1919 p. 386), Mayr's original description of C. *punctulatus* (Annuar. Soc. Nat. Modena 3, 1868 p. 161) was drawn from at least three different forms of the species, namely, the subsp. *minutior* (Forel 1886), with red head and thorax, the subsp. *imberbis* Emery var. *cruenta* Emery (1905), with black head and red thorax, and the form with black head and thorax, which Emery (1887) regarded as the type. Since Mayr mentions the form with *minutior* coloration first in his description of the worker and since the only female he describes belongs to this same form, the black form should have been given a new name and Forel's *minutior* regarded as a synonym of Mayr's *punctulatus.* It may be best, however, to leave this nomenclatorial adjustment to some future monographer of the species and its numerous subspecies and varieties.

rax, though very small, is more strongly convex and arched above than in either of the sterile castes. While it resembles the thorax of the queen, the sclerites, especially the mesonotum, are smaller, but this has distinct lateral sutures as in the queen. These sutures are absent in both major and minor workers, though sometimes indicated by faint lines in the former. There is a distinct metanotal sclerite in the mermithergate, of the same form as in the major (absent in the minor). The petiole is peculiar and apparently somewhat deformed anteriorly, though higher and broader than in the minor and therefore more of the major and queen type. The gaster is enormously distended (nearly 4 mm. long) with one or possibly several Mermis, the compact coils of which are visible through the thin, stretched, intersegmental membranes. The legs are slender, like those of the minor worker, but longer.

In its coarser sculpture, i. e., in the dense punctuation of the head and thorax, the mermithergate resembles the worker major and queen rather than the minor. The same is true of the conspicuous elongate punctures on the occiput, pro- and mesonotum. These are well-developed in the mermithergate as in the major, but obsolete in the minor. In the queen they are less developed than in the mermithergate. The pilosity of the latter is also like that of the major, i. e., more abundant than in the minor and less abundant than in the queen. The head and thorax of the mermithergate are decidedly less reddish and more brownish than in the two worker castes. In coloration it is therefore more like the queen, which Mayr describes as "rufa, capite postice opaco nigro, antice obscure castaneo-fusco, mandibulis castaneis, antennis læte castaneis, thorace supra subnitido castaneo, abdomine nitido nigro." This agrees well with the color of the mermithergate, except that its head is castaneous brown and not black posteriorly.

The *C. minutior* mermithergate above described is of more than usual interest on account of its close resemblance to the mermithized specimens of Pheidole in exhibiting a mixture of worker major, worker minor and queen characters in the structure of the head, thorax, petiole and appendages, instead of being an unmodified worker minor like the *C. cassius* described from the Congo. If the hypothesis which I advanced in my paper of 1928 be accepted, the latter specimen may be supposed to have been infected by Mermis as an adult worker minor larva just before spinning its cocoon, whereas the *minutior* mermithergate was infected as a queen larva which had developed slightly beyond the stage at which, by some difference in feeding, it might have been converted into a normal worker major.

DIPTERA DESTROYING SNAILS

In a series of papers entitled "Natural History Notes from North Carolina" (Journ. Cincinnati Soc. Nat. Hist., vol. 17, p. 72, 1894), A. G. Wetherby under *Zonites elliotti* Redf. says: "This shell is destroyed by a parasitic larva, the imago of which is a small and active species of Diptera. The grown larva occupies the shell as a pupa house after devouring the inmate. I have noticed this habit of the Diptera in the case of but one other species, and that is *Polygyra fastigans* Say. At the only locality where I have collected this latter species, more than half the snails were affected, and the number of dead shells holding the empty pupa cases, were sufficient testimony to the activity of the parasite."

It would be interesting to know what this fly really is. A small Sarcophagid—*Helicobia helicis* Town. was bred from a snail—*Polygyra thyroidus* Say. I have always looked up this record as only accidental, for the fly is common and has been bred from a number of species of insects, and in many cases is considered a true parasite (Aldrich, "Sarcophaga and Allies in North America, pp. 158-161, 1916). Dr. J. Bequaert however, has described a Sarcophagid representing a new genus and species—*Malacophagula neotropica* from a snail—*Bulimulus tenuissimus* at Para, Brazil, which he considers a true parasite of the snail (Journ. Parasitology, vol. XI, pp. 201-212, 1925).

C. W. JOHNSON.

COMMON NAMES AND TAXONOMY[1]

BY J. A. HYSLOP

Bureau of Entomology, Washington, D. C.

Common names and taxonomy. That sounds almost like a paradox. The vulgar thoughts of the rabble and the profound cerebrations of the intellegentsia, but after all a name is a name, and, of course, the first names were vernacular.

Then scientific expendiency led to a system of technical nomenclature so that order might be brought out of chaos. Thus we were to have for each organism a name universally used and recognized, which would indicate phyletic relationship. Undoubtedly Linneaus saw in his work the initiation of a stable system. It is well that we visit this world but once!

Of course, I am in sympathy with the rules of binomial nomenclature and believe that *nomina conservanda,* in taxonomy are diametrically opposed to the laws of priority and the principles of natural classification.

Therefore the vernacular name, despite its myriad colloquial modifications, remains our only hope for immediate stability. But even here we are beset with almost insurmountable difficulty: the roadside grasshopper on the Canadian Plains is *Camnula pellucida* and on the Atlantic seaboard it is *Schistocerca americana.* The cotton boll worm of Texas transforms into a corn ear worm in Iowa and into the tomato fruit worm in eastern Maryland. But we are becoming agreed that the yellow fever mosquito is that self-same insect which transmits yellow fever despite the dipterist's chameleon-like changes in which he one moment decides that it is *Stegomya fasciata,* the next *Stegomya calopus,* then quickly changes to *Aedes calopus, Aedes ægypti,* or *Aedes argenteus.*

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[1] Presented as part of a symposium on Present Trends in Systematic Entomology at the anual meeting of the Entomological Society of America in New York City, Dec. 27, 1928. See Psyche, vol. 36, p. 13 and 21.

Even though the day should come when scientific refinement would make the determination of our commonest insect, in a technical sense, impossible to any but the specialist, house fly will be an excellent name to indicate that troublesome aggregate of dipterous insects that may or may not spread typhoid by walking on the butter.

For a time there was a tendency to foist upon the layman a modification of the technical name, as the Calosoma beetle, brown Anomala, and apple Bucculatrix. An excellent precedent was established for this procedure by the common names applied to many plants, as Geranium, Aster, Verbena, Petunia, Alyssum and many more. But botany is a much older science than entomology and I wonder if in many cases the taxonomic botanist, or herbalist, as he was then called, did not latinize the vernacular names rather than the layman adopt the technical terms. Be that as it may, we have not been nearly so successful with insect names of this type. Then there were the "gay nineties" of geographical names, New York weevil, San Jose scale, Mexican bean beetle, and what not, until a nation's ire was raised because it was being held responsible for so many "wee tim'rous beasties."

Descriptive names are ideal, but lead us into some very ridiculous complications. We have the brown horse louse. Is it a brown louse or a louse on brown horses? And even worse, the biting horse louse. Here exidently the louse infests biting horses. So we must change it around to the horse biting louse. Now we must be careful of the accent, for it we say *horse-biting* louse we can see this louse cavorting over the pasture snapping at the horses. We must pronounce it horse *biting-louse.* And there are the black cabbage beetle, green apple aphid and countless others.

"What should be the structure of a common name?" This was a question that concerned the Association for many years. Committees profoundly considered the academic use of the hyphen, of *ed,* and of *ous,* and delved into Shakespeare and Chaucer until the codification of common names was more involved than the most intricate mental gyrations of the International Commission. But the economic entomologist has a sense of humor and when the balloon got so large that it threatened to blot out the sun, he touched it with a cigarette and Poof! it came to earth.

A common name is a common name and that is all. It is the vernacular name, the name of the people for a thing, in this case an insect.

How simple!

We have only to find out what all the common people everywhere call an insect and after that name write what all the taxonomists agree is the correct Latin name for the same insect, and thereafter all economic entomologists, who are neither common nor taxonomic or are both, as you choose, are constrained, never to depart from this combination; unless the Common Name Committee changes its mind or some taxonomist has the temerity to disagree with his colleagues.

But seriously, it is essential that in applied entomology we have a well established vernacular name for each pest that will be associated with it in the minds of those interested in the pest from some nonacademic viewpoint.

The layman will not even try to swallow *Leptinotarsa decimlineata,* nor can we foist upon him such pseudo-academic names as irrorate leafhopper. He does not know what irrorate means, and I venture to say that there may be some in this august gathering of mental collossi who do not know what that word means.

Even more reasonable common names have failed of popular adoption. Certainly Colorado potato beetle is a nice name. It sounds nice, the insect is a beetle, it feeds on potato and it first attracted attention in Colorado, so we adopted the name. And what then? Go over most of the country and you find that the Colorado potato beetle never even occurred there. No, their pest is the potato bug.

All the Association of Economic Entomologists hopes to accomplish by the activities of its Committee on Nomenclature is a reduction of vernacular names to a reasonable minimum for any given insect and to prevent the same common name from being applied to more than one kind of insect.

To acheive the last-mentioned object is not always possible. For example, what was the apple leafhopper a few years ago is now several species of Jassidæ, but a conscientious effort and serious coöperation on the part of all entomological writers can do much.

We hope to prevent the repetition of such an embarrassing situation as developed in the case of the name Japanese beetle. Long before *Popillia japonica* attracted attention in this country, American entomologists in Hawaii had named *Adoretus umbrosus* the Japanese beetle and had built up a very considerable literature around the name. Now imagine what would be our confusion if *Adoretus umbrosus* should succeed in evading the vigilance of the Port Inspectors, should enter the United States and our Common Name Committee should be confronted with the necessity for deciding on a common name for the new pest. Should it be Hawaiian Japanese beetle? A very silly name! Or should it be the Japanese beetle from Hawaii? Even worse!

Today, if entomologists will use the available facilities, it is possible to ascertain very promptly whether or not a common name has been used previously.

The Committee on Nomenclature of the American Association of Economic Entomologists maintains and attempts to keep up to date a catalogue of all of the English names that have been suggested for insects. This list now includes the common names of 4,400 species of insects, not all American but each referred to in literature under an English common name. In a duplicate reference card index, these names are arranged in one case alphabetically according to the technical names and in the other case according to the common names. Of course some insects have many common names; in fact, our index has now 5,600 common names listed.

Of this vast number the Association has adopted and published preferred names for 625 species of American insects.

One of the present trends in this branch of nomenclature and one which I believe to be fully justified is to let nature take its course in naming insect pests. This is not always possible with newly introduced pests for which names must be promptly adopted for regulatory purposes. But in other cases it is far better to wait until the people have settled upon a name for a pest than to attempt to introduce a new name. We can not introduce a new name in most cases despite our most serious efforts. For over a century a little gray neighbor of man had borne the dignified name of body louse, then the war threw us into the trenches and zowie! We came out with cooties! It is unfortunate that the economic entomologists did not have foresight enough to introduce all of our unnamed pests into "the big parade" so that each would have come out wearing an A. E. F. name as firmly fixed for distinguished service as cootie.

GEOTRUPES HORNI BLANCHARD

This is one of the common species of the genus in this locality occurring, according to my series, from August 8 to September 30. It can be easily distinguished from the other species by its pure black color with no metallic reflections. I have found it frequently under a fungus having an acrid milky juice *(Lactarius*, perhaps *piperatus)* and it often bores from the top down through the stem and into the ground to a depth of five or six inches; I have never noticed this particular mode of attack by *G. balyi Jek.* which at times frequents the same species of fungus. I have found an adult, a pupa and a larva beneath the same fungus though it is not certain they were all *horni.* Generally but one or two specimens are taken under one plant while *balyi* may occur in from two to six specimens. *Horni* occurs in rather dense growths of oak and I took several specimens in a pine grove at South Paris, Me., on September 20, 1928. It was taken at Monmouth, Me., on September 4 and 9, 1917, under fungi. A dead specimen was picked up on the sand area back of the beach at Surfside on Nantucket Island on September 13, 1928. The range of this species is much greater than formerly recorded as I have a specimen taken by Dr. T. H. Frison at Urbana, Illinois, bearing the unusual date of April 16, (1914).

C. A. FROST.

PHENOLOGY OF OLIGOLECTIC BEES AND FAVORITE FLOWERS

By Charles Robertson
Carlinville, Illinois

Authors who have discussed this subject have made no systematic phenological observations on bees or on flowers.

Referring to the supposed short flight of oligoleges, one says: "Some claim this is so because they are small .Robertson explains it by saying that the short flight is the result of the visiting of the few closely allied genera of plants." "Both opinions are probably right." Oligolectic bees are not small and their flight averages only 11.8 days shorter than their related polyleges (4, 422). In 2, 71, it is stated that these bees are no smaller than their relatives and the percentage of small bees is no greater than among the polytropes (polyleges). Of local oligoleges, 38 per cent, while of the polyleges 37 per cent, are large. There is no need to explain something which is not a fact.

Bees with short flight.—Since the female bees do the pollen-collecting, the statements here relate to them. In 1, 30, it is shown that the females of 33 Andrenidæ, both polylectic and oligolectic, average 48 days and complete their flight in 120 days, March 17-July 14. It was argued that it was advantageous for some of these short-flying bees to fall into 11 sets with non-competitive pollen-collecting habits. Polylectic Andrenidæ average only 7.7 days longer than the oligoleges (4, 427). Oligolectic bees resemble their relatives in time even more than they resemble the plants on which they depend (3, 108). The percentages of bees flying simultaneously, May-September, are from 45.9 to 47.2 (5, 522). Short flights make it possible for the bees to be distributed so that not more than 47.2 per cent are flying at the same time (3, 107). This, I think, shows the principal advantages of a short flight.

CORRELATION OF OLIGOLEGES AND FLOWERS

Of 84 oligolectic bees listed in 4, 426-7, fourteen are omitted here because their females have not been observed enough to establish their time of flight, or visits.

In the case of the other 70, the flowers which they visit for pollen average 102 days. The bees average 60 days, 20 days after the flowers begin and 22 days before the flowers end. This is not a close correlation, but the time of the bee should be well within that of the flowers. Three show the average of 42 days, 34 show less and 34 show more. The bee can hardly be expected to collect pollen until several days after it begins to fly, but it is fairly necessary that it should find the flowers in bloom. It is even more necessary that the flowers should bloom later, so that the bee can work up to its last day.

DETAILS

Colletes oligoleges. *Colletes æstivalis,* 55 days, begins 4 days after and ends 3 days before *Heuchera hispida,* 62 days, May 4-July 4. *C. brevicornis,* 32 days, begins 9 days after and ends on the same day as *Specularia perfoliata,* 41 days, April 20- June 29. *C. willistonii,* 101 days, begins 17 days after and ends 29 days before *Physalis,* 147 days, May 11-October 4. *C. latitarsis,* 108 days, begins 36 days after and ends 3 days before *Physalis. C. armatus,* 46 days, begins 25 days after and ends 24 days before the Astereæ which it visits, 95 days, July 29-Oct. 31. *C. americanus,* 73 days, begins 27 days after its Astereæ and Heliantheæ, 100 days, July 24-Oct. 31, and ends on the same day. *C. compactus,* 48 days, begins 47 days after and ends 10 days before its Compositæ, 105 days, July 19-Oct. 31. These *Colletes* range from 32 to 108 days, and are short or long to agree with their flowers. Only two, *C. latitarsis* and *willistonii,* get pollen from the same plants.

ANDRENID OLIGOLEGES

Salix oligoleges. The willows bloom from March 17 to August 11, 148 days. The 6 oligoleges, whose flight-times are pretty well made out, fly from 46 to 88 days, average 86 days shorter than the season of *Salix.* They average 10 days after *Salix* begins and 76 days before it ends. All of them complete their flight 46 days before *Salix* ends. *Andrena salicis*, 47 days, begins with *Salix* and ends 101 days sooner. *Parandrena andrenoides* begins 3 days later and ends 67 days sooner. *Trachandrena mariæ* shows 8 days later and 86 earlier. *Andrena illinœnsis* shows 8 and 81, *salictaria* 14 and 46, *erythrogastra* 26 and 76. Of these equally common species, 3 average 26 days shorter than the other 3, while the Andrenid oligoleges, as stated above, in general average only 7.7 days shorter than the polyleges.

Other vernal species. *Ptilandrena erigeniæ*, 50 days, begins 10 days after and ends 10 days before *Claytonia virginica*, 70 days, March 16-May 24. *P. polemonii*, 37 days, begins 2 days after and ends 4 days before *Polemonium reptans*, 43 days, April 12-May 24. *P. g. maculati*, 24 days, begins 18 days after and ends 11 days before *Geranium maculatum*, 53 days, April 13-June 4. *Pterandrena krigiana*, 35 days, begins 11 days after and ends 4 days before *Krigia amplexicaulis*, 50 days, May 1-June 19. *Trachandrena spiræana*, 13 days, begins 6 days after and ends 9 days before *Aruncus sylvester*, 28 days, May 24-June 20. *Iomelissa violæ*, 51 days, begins 13 days after and ends 20 days before *Viola*, 84 days, March 17-June 8. *Andrena arabis*, 29 days, begins 34 days after and ends 9 days before its Cruciferæ, 72 days, March 20-May 30. The Cruciferæ in general bloom 226 days, March 20-Ocober 31, far beyond the time of this bee. *Opandrena ziziæ*, 47 days, begins 15 days after and ends 30 days before the *zizioid Umbelliferæ*, 92 days, April. 18-July 18. All of these oligoleges and 26 Andrenid polyleges complete their flight in the time of *Salix*.

Late Andrenid oligoleges. *Andrena nubecula*, 79 days, begins 12 days after and ends 1 day before its Astereæ, 92 days, August 1-October 31. *Pterandrena solidaginis*, 71 days, begins 20 days after and ends 8 days before its Astereæ, 99 days, July 24-October 31. *P. asteris*, 37 days, begins 32 days after and ends 10 days before its Astereæ, 79 days, August 14-October 31. *P. aliciæ*, 69 days, begins 35 days after and ends 6 days before its Heliantheæ, 110 days, July 9-October 26. *P. rudbeckiæ*, 67 days begins 11 days after and ends 70 days before its Heliantheæ, 148 days, June 1-October 26. *P. pulchella,* 48 days, begins 33 days after and ends 12 days before its Heliantheæ, 93 days, July 15-October 15. *P. helianthi,* 38 days, begins 41 days after and ends 21 days before its Astereæ and Heliantheæ, 100 days, July 24-October 31. None of the Pterandrenas get pollen from the same Compositæ.

OTHER SHORT-TONGUED OLIGOLEGES

Macropis steironematis, 33 days, begin 12 days after and ends 36 days before *Steironema,* 81 days, June 16-July 18.

Halictoides marginatus, 34 days, begins 39 days after and ends 1 day before *Helianthus,* 74 days, July 23-October 4.

Panurgidæ. *Anthemurgus passifloræ,* 51 days, begins 16 days after and ends 17 days before *Passiflora lutea,* 84 days, July 5-September 26. *Pseudopanurgus compositarum,* 54 days, begins 43 days after and ends 2 days before its Astereæ, 99 days, July 24-October 31. *P. asteris,* 62 days, begins 35 days after and ends 8 days before its Astereæ and Heliantheæ, 105 days, July 19-October 31. *P. solidaginis,* 86 days, begins 8 days *before* and ends 13 days before its Astereæ and Heliantheæ, 91 days, July 11-October 4. But it begins 79 days after and ends 27 days before the general Astereæ and Heliantheæ, 192 days, April 23-October 31. *P. albitarsis,* 100 days, begins 4 days after and ends 21 days before its Heliantheæ, 125 days, May 25-September 26. *P. rudbeckiæ,* 43 days, begins 61 days after and ends 44 days before its Heliantheæ, 148 days, June 1-October 26. *P. rugosus,* 61 days, begins 24 days after and ends 25 days before its Heliantheæ, 110 days, July 9-October 26. *P. labrosus,* 57 days, begins 19 days after and ends 28 days before its Heliantheæ, 104 days, July 15-October 26. *P. labrosiformis,* 42 days, begins 54 days after and ends 31 days before its Heliantheæ, 127 days, June 22-October 26. *Calliopsis coloradensis,* 31 days, begins 3 days *before* and ends 18 days before its Astercæ and Heliantheæ, 46 days, August 23-October 7. *Verbenapis verbenæ,* 75 days, begins 37 days after and ends 25 days before *Verbena,* 137 days, May 22-October 5. The flight is 62 days shorter. *Zaperdita maura,* 59 days, begins 57 after and ends 31 days before *Physalis,* 147 days, May 11-October 4. Its flight is 88 days shorter. In time and frequency it shows little relation to *Physalis. Perdita octomaculata,* 65 days, begins 6 days before and ends 11 days before its Astereæ and Heliantheæ, 70 days, August 17-October 20. None of the Compositæ oligoleges of Panurgidæ get pollen from the same flowers.

LONG-TONGUED OLIGOLEGES.

Gnathosmia georgica, 49 days, begins 19 days after and ends 25 before its Compositæ, 93 days, Apr. 23-July 24.

Ashmeadiella bucconis, 86 days, begins 11 days after and ends 31 days before its Astereæ and Heliantheæ, 128 days, May 25-Sept. 29.

Sayapis. *S. pollicaris,* 16 days, begins 22 days after and ends 14 days before *Coreopsis palmata,* 52 days, June 3-July 24. *S. pugnata,* 58 days, begins 13 days after and ends 48 days before its Compositæ, 119 days, May 25-Sept. 20. *S. sayi,* 92 days, begins one day *before* and ends 26 days before its Compositæ, 117 days, July 7-Oct. 31.

Megachile. *M. generosa,* 87 days, begins 38 days after and ends 21 days before its Papilionaceæ, 148 days, May 27-Oct. 19. *M. sexdentata,* 92 days, begins 15 days after and ends 19 days before its Astereæ and Heliantheæ, 126 days, June 1-Oct. 4.

Oligotropus campanulæ, 72 days, begins 4 days after and ends 22 days before *Campanula americana,* 98 days, July 1-Oct. 6.

Euceridæ. *Melissodes cnici,* 49 days, begins 71 days after and ends 24 days before *Cirsium,* 144 days, May 25-Oct. 15. *M. coreopsis,* 25 days, begins 11 days after and ends 16 days before *Coreopsis palmata,* 52 days, June 3-July 24. *M. vernoniæ,* 38 days, begins 34 days after and ends 21 days before *Vernonia fasciculata,* 93 days, July 1-Oct. 1. *M. vernoniana,* 62 days, begins 24 days after and ends 7 days before. *M. boltoniæ,* 120 days, begins 12 days after and ends 21 days before its Compositæ, 153 days, June 1-Oct. 31. *M. trinodis,* 91 days, begins 19 days after and ends 25 days before its Compositæ, 135 days, June 19-Oct. 31. *M. agilis,* 98 days, begins 13 days *before* and ends 15 days after its Compositæ, 100 days, July 24-Oct. 31. *M. coloradensis,* 62 days, begins 56 days after and ends 15 days before its Compositæ, 133 days, June 10-Oct. 30. *M. simillima,* 66 days, begins 24 days after and ends 10 days before its Compositæ, 100 days, July 24-Oct. 31. *M. autumnalis,* 58 days, begins 33 days after and ends 9 days before its Compositæ, 100 days, July 24-Oct. 31. *Epimelissodes illinoensis,* 29 days, begins 27 days after and ends 34 days before its Heliantheæ, 90 days, June 19-Sept. 16. *Anthedon compta,* 76 days, begins 5 days *before* and ends 18 days before *Oenothera biennis,* 89 days, July 20-Oct. 16. Only two Euceridæ get pollen from the same flowers.

Cucurbita oligoleges. *Cucurbita pepo* blooms 94 days, July 4-Oct. 4. One of its oligoleges, *Peponapis pruinosa,* 77 days, begins 11 days after and ends 6 days before, while the other, *Xenoglossa strenua,* 62 days, begins 25 days after and ends 7 days before.

Ipomœa oligoleges. *Ipomœa* blooms 125 days, June 24-Oct. 26. One of its oligoleges, *Cemolobus ipomϾ,* 80 days, begins 9 days *before* and ends 54 days before. The other, *Melitoma taurea,* 103 days, begins 3 days after and ends 19 days before.

Cassia oligoleges. *Cassia chamæcrista* blooms 100 days, June 28-Oct. 5. One of its oligoleges, *Epimelissodes atripes,* 36 days, begins 37 days after and ends 27 days before. The other, *Amegilla walshii,* 77 days, begins 8 days after and ends 15 days before.

Emphor bombiformis, 44 days, begins 10 days after and ends 5 days before *Hibiscus lasiocarpus,* 59 days, July 20-Sept. 16.

OTHER CASES.

Physalis oligoleges. *Colletes willistonii,* and *C. latitarsis* fly 101 and 108 days, bearing some relation to *Physalis,* which blooms 147 days, but *Zaperdita maura* flies 59 days, 88 days shorter, with little relation to *Physalis,* though it resembles the other Panurgidæ.

Astereæ. The Astereæ bloom 192 days, Apr. 23-Oct. 31. The oligoleges average 57 days, 135 days shorter. The short flight is not on account of the absence of the Astereæ. The flowers which these bees visit for pollen average 93 days, 36 days longer than the bees.

Heliantheæ. These bloom 154 days, May 25-Oct. 26. The 9 oligoleges average 57 days, 97 days shorter. The Heliantheæ which they visit for pollen average 117 days, 60 days longer.

Other Composite oligoleges. The Compositæ bloom 192 days, Apr. 23-Oct. 31. Eighteen oligoleges average 89 days later in beginning, and 32 days earlier in ending, or 121 days shorter. The flowers they visit average 107 days.

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1, Robertson, C. 1899 (7). Oligotropic bees. Fls. XIX. Bot. Gaz., 28:27-37.

2. ———, 1914 (2). Origin of oligotropy of bees. Ent. News, 25:67-73.

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4. ———, 1925 (10). Heterotropic bees. Ecology, 6:412-36.

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THELYTOKY OR ARRHENOTOKY IN *SCLERODERMUS IMMIGRANS*

By John Colburn Bridwell,

Glencarlyn, Virginia.

Parthenogenesis is a common occurence among hymenoptera. Usually it is androgenetic, only males being produced by virgin females. This phenomenon has also been termed arrhenotoky. It is so general among hymenoptera as to lead many students of the group to believe that all the species of the order may breed in this way except for the few which have developed thelytoky, virgin females producing females. Certain Eupelmidæ and Encyrtidæ among the Chalcidoidea, and some Ichneumonidæ have been bred through many generations without males appearing and have to all appearances entirely eliminated sexual reproduction as a part of ontogeny. In other instances however after long periods of gynogenetic parthenogenesis, small numbers of males appear and it is far from certain that any of the species have become perfectly thelytokous. I know of no species, however, which produce large numbers of males and also produce females parthenogenetically. The notes by Dr. Keeler, 1929 (Psyche 36:41-44) on thelytoky in *Scleroderma immigrans* are so much at variance with my experience in breeding *Sclerodermus*[1] that I am convinced an error of observation has mislead him.

The discussion of the biology of *Sclerodermus immigrans* Bridwell and its endemic Hawaiian congeners may be found in the Proceedings of the Hawaiian Entomological Society 4:291-305, 1920. In the course of the work recorded several thousand individuals of this species were reared under very close and long continued observation and among them were many known virgin females whose progeny in every instance were males. In many instances the lots of

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[1] It may not be superfluous to note again that *Sclerodermus* is Latreille's original spelling of this generic name and *Scleroderma* a wholly unnecessary emendation on the part of Westwood.

young produced by old females near the end of their egglaying periods were all males, the sperms from mating having presumably been exhausted or were dead. Nothing in all this work suggested the possibility of thelytoky. The only other species of *Sclerodermus* bred in large numbers is *S. macrogaster* Ashmead which I found at Kingsville, Texas in January, 1920 and bred through several generations at Brownsville and at Washington until opportunity presented itself to put it in the hands of Dr. Wheeler for study. Since its biology differed but little from that of *immigrans* and its Hawaiian congeners, no detailed account of these studies was published. A note upon it was presented to the Entomological Society of Washington as recorded in 1922, (Journ. Washington Acad. Sci. 12:274). In this species also the phenomena of arrhenotoky were observed, probably in more instances than in *immigrans.* In it, as in *immigrans,* about one third of the females were winged while only a small fraction of one per cent of the males were wingless.

If we review the conditions under which the progeny of *Sclerodermus* are produced we may see how a misunderstanding might arise. After the prey is mastered several eggs are laid upon it and the resulting larvæ and their mother feed upon it. When the larvæ are ready for transformation they spin separate coccoons so massed and attached to each other as to make it impossible to separate them without injury. The males emerge before the females and bite their way into the female coccoons and mate there before any of them have made their appearance in the open. The males are short lived and often only one or two appears in a mass of coccoons such as would produce eight females. Dr. Keeler intended keeping eight of the females of his F 3 generation virgin and from these supposedly virgin females only female progeny were produced. Since he does not detail the precautions taken to keep them from mating, I believe that these had mated before they were separated and that the few (normally not more than one fifth) male larvæ died before transforming.

CRITICAL DATA UPON THELYTOKY IN *SCLERODERMA IMMIGRANS.*

BY CLYDE E. KEELER.[1]

On account of the unusual nature of my results in breeding *Scleroderma immigrans,* I thought it well to record the evidence pointing toward thelytoky in my specimens. (Psyche, Vol. XXXVI, No. 1, pp. 41-44)

Mr. Bridwell suggested (Psyche, Vol. 36, p. 120) that my F3 females might not have remained virgin, due to the fact that the early hatching males have been known to chew holes into the neighboring cocoons and fertilize their unhatched sisters. The possibility suggested is quite reasonable and makes necessary a more detailed explanation of the results summarized in Table 1 of my former paper.

In this table I did not report the contents of all the vials individually. The data given under F3 as 1 winged ♂, 1 wingless ♂, and 12 wingless ♀♀, consisted of insects born in five separate vials.

Vial No. 1 hatched Aug. 14, 1928. A wingless ♂, and a wingless ♀ emerged and were removed from the vial. Later in the day two wingless ♀♀ hatched and were kept virgin.

Vial No. 2 hatched Aug. 27. In this vial was found one wingless ♀ which was kept virgin.

Vial No. 3 hatched Aug. 29. This vial contained four wingless ♀♀. They were kept virgin.

Vial No. 4 hatched Sept. 16. In this vial there hatched a single wingless ♀, which was kept virgin.

Vial No. 5 hatched Sept. 16. In this vial were found 1 winged ♂ and 3 winged ♀♀. These were mated together.

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[1] Research Fellow, Harvard Medical School.

No other insects could have hidden in the vials undetected because all coccoons in the vials were dissected with forceps at the time of examination.

The two virgin ♀♀ of vial No. 1 were placed in a separate vial and when the female of vial No. 2 emerged, she was placed with them.

Of the four females in vial No. 3, three were placed in a single vial and the fourth in a separate vial.

The female of vial No. 4 was also given a separate vial.

Mr. Bridwell's objection might be thought to apply to the two virgin females removed from vial No. 1, had I not examined their cocoons for holes when I removed the wingless ♂ and the wingless ♀.

But supposing Mr. Bridwell's assumption to be correct in the case of vial No. 1, and, that sperm could have been transmitted through holes in their cocoons too small to be detected with a hand lens, this would throw out only the data obtained from the virgin females of vials Nos. 1 and 2, the offspring of which (born Oct. 31) consisted of 14 wingless females.

Even then, we would be unable to account for the 19 ♀♀ from the virgin females born in vials Nos. 3 and 4 in which vials no males occurred.

Errata in previous paper: Table 1, column 4, line 2 (read ♂ instead of ♀; line 4 (read 14 instead of 4).

A NEW SPECIES OF BLEPHAROCERA FROM MASSACHUSETTS (DIPTERA)

By O. A. Johannsen,

Ithaca, N.Y.

Blepharocera similans n. sp.

♂. Head dark brown including antennæ, palpi a little paler. Face one-third as wide as head, front one-third wide as face. These measurements are based on a relaxed specimen. The area of enlarged facets about as with *B. tenuipes.* Antenna twice, the palpus as long as the width of the head. Fifteenth antennal segment a fifth longer than the fourteenth; last palpal segment slender, and three times as long as the penultimate. Thorax yellow including scutellum; the mesonotum shining brown with a purplish tinge and only faintly pollinose, the median space in front of scutellum with a pearly lustre; anterior part of pleura, brown. Abdomen brown, somewhat shining, posterior segments and hypopygium darker; venter yellow anteriorly; narrow posterior margins of the first two or three tergites paler. Structure of the hypopygium closely resembles that of *B. tenuipes.* See Kellogg's figure 2, plate 22, in the Proceedings of the California Academy of Sciences, 1903. In this figure the lateral lobes of the dorsal plate have parallel sides, their caudal margins squarely truncate, with the outer posterior angle of the lobe acute, the inner one right angled and the median tooth small. In my specimens of *B. tenuipes* the median tooth on the caudal margin of the lateral lobes of the dorsal plate is more conspicuous than that figured by Kellogg and with the apex directed slightly mesad. The lobe in the new species, *B. similans,* is relatively longer and the inner angle wholly wanting, the inner margin of the lobe gradually curving from the median tooth toward the base of the lobe. The claspers of *B. similans* are slightly more curved than in *B. tenuipes.* Legs brown, slender, middle femur a tenth longer than the fore femur; tibiæ and comsponding tarsal segments of fore and middle legs subequal, the measurements for the middle leg beginning with the femur being 2.8, 2.4, 1.4, 0.6, 0.4, 0.25, 0.25 mm. Hind legs wanting in the type specimen. Wing clear hyaline, iridescent; length from basal articulation, 4.5 mm. Halteres yellow with brown knob. Length of fly 4 mm. Amherst, Massachusetts, June 25, 1927. Dr. C. P. Alexander, Collector.

Aside from the difference in the form of the hypopygium as noted above, this fly differs from *B. tenuipes* in having a distinctly shining thorax, in the proportion of its tibia to basitarsus being 12 to 7 instead of 12 to 6, in the sides of the face being more nearly straight and in the hairs on the base of the claws being less conspicuous.

I am indebted to Mr. F. W. Edwards for submitting this fly to me for description. Several specimens in the British Museum, type in the Cornell University collection.

XENILLUS CLYPEATOR ROBINEAU-DESVOIDY AND ITS IDENTITY

By Arthur Paul Jacot

Shantung Christian University, Tsinan, China.

In 1839 André Jean Baptiste Robineau-Desvoidy described a new genus and species of beetle under the above name, which he secured on the twelfth of July on agarics of an old cherry tree at Saint-Sauveur, Yonne (about 100 miles south of Paris), France. General Dejean, to whom the unique specimen was presented, considered it an acarid and Lucas and Démary were appointed to restudy and report on it. They considered it as related to the Oribatids or Uropodids. It was then submitted through Mr. Audouin to Antoine Louis Dugès who had made a few studies on Acarians, and who referred it to *Oribates castanæ* Hermann 1804 (type locality Strasbourg). Little did Dugès realize, nor did anyone of that time, the fact that any mesophytic locality can boast of 60-80 species. A comparison of Hermann's description of *O. castanæ* with that of *X. clypeator* brings out this point, the former being nearly spherical not ovoid, shining not granular, cephaloprothorax short, not rather long.

A carefull perusal of Robineau-Desvoidy's description reveals two important points (1) he mistakes the anterior pair of legs for antennæ (giving them 5 joints) thus giving his animal three pairs of legs, instead of four, (2) he mistakes the pseudostigmata for eyes.

The description of Lucas and Démary who were, especially Lucas, much more competant students, is far more detailed than that of the finder and is the basis for the present study. They describe the "antennæ" as broken off so short as to leave but a small, cylindric pedicel. Their description includes three outstanding clues to the generic relations of this animal: (1) no plate or wing-like outgrowths to the "carapace" (notogaster) are mentioned in a detailed description and as this is a conspicuous feature, one may consider them as lacking; (2) the armature of the cephaloprothorax is described chiefly on pages 466-467. Most of page 467 is taken up with the description of a structure which Nicolet called a tectum or head-roof. (3) The notogaster (last line of page 468) is described as oval, vaulted (like the carapace of a turtle) with rugose, shagreened surface (Robineau-Desvoidy called it granular).

Fortunately there is but one group of apterogasterine Oribatids to which this description applies, namely, that called Cepheus by Nicolet (not Koch). A more detailed comparison of the description of Lucas and Demary, with the species figured by Nicolet and by Michæl under the names *Cepheus vulgaris, C. tegeocranus* and *C. latus* will make this identity the more certain.

In describing the cephaloprothorax these authors first describe (p. 466) the structure of the portion below the tectum. Of this they say: "Four main pieces form this head, three latero-superior and one inferior. Two of the latero-superior pieces are thin, transversely flattened, and articulate posteriorly with the first piece which forms the thorax or rather the cephalothorax; they are directed forward and approximate each other so as to circumscribe a triangular space which encloses the third medio-superior piece. [These two latero-superior pieces are thus the *genæ* of Michæl]. This latter articulates behind with the median and anterior part of that kind of shield which covers over the body [notogaster] [i. e. it is the rostrum and dorsovertex of Michæl]. Laterally it merges with the projecting blades or ears which we have already indicated [preceding paragraph, i. e. lamellæ]; as it proceeds anteriorly they gradually narrow or turn inward, and terminate at the anterior part of the two lateral plates [genæ], but without merging intimately with them, so that one distinguishes at their ends two little grooves separating three little tubercles called the upper lip. [This condition is clearly indicated in Michæl's 1883 volume, pl. 16, fig. 9: *C. tegeocranus,* where *a* is the medio-lateral piece separated from the triangular lateral piece by a slender tectopedial ridge, also in Nicolet, pl. 7 (31), fig. 8c where the rostral bristle is shown on a tubercular projection of the tectopedium]. They receive in their spread an inferior, horizontal piece which springs from below the first segment of the thorax, bends at its anterior part and houses itself in the midst of the three others. This single piece, larger than each of the preceding, constitutes of itself, the labium."

"Above this head one finds a solid organ which surpasses it at the sides, and gives it [the head] the appearance of being retracted beneath its lower [proximal] part; it is composed of three pieces, two lateral and a median. The median piece is convex, closely fused with the two lateral pieces, near the posterior half of its lateral edges, and ends anteriorly, as already stated between the two pieces of the upper lip [genæ]. The two lateral pieces [lamellæ] are triangular; situated on a higher plane than the median piece, they seem to continue by their exterior edges the curve form by the sides of the carapace [notogaster] [see Michæl 1883, pl. 17, figs. 1 and 12 or Nicolet pl. 7 (31), fig. 9]. Their small end directed forward is pointed, projecting, but does not extend to the extremity of the head; their base articulates with the anterior and lateral part of the dorsal piece [i. e. notogaster]; their inner edges recurve and merge, first [on the inside] with the median piece [of the tectum], then [on the outside] with the lateral pieces of the upper lip [i. e. the proximal part of the genæ or acropleuron of Michæl], forming with them an obtuse more or less rounded angle. These two lateral pieces [lamellæ] include between them and the genæ, a deep groove which encloses, at its posterior part, a small, round black eye, without facets [pseudostigmata], and, a little below this thing, that little cylindrical body which we have noted as probably being the first article of the antennæ described by Robineau-Desvoidy [i. e. coxa of leg I]."

Thus the description corresponds accurately with these so called Cepheus and as he describes the apex of the lamellæ as pointed, it would seem to be *C. vulgaris* Nicolet (=*N. tegecranus* Hermann). The generic identity is further corroborated by the description of the legs which Michæl has figured on plate 17. Lucas and Démary say: "We have been struck by the largeness and length of the coxa [hanche] of the third [i. e. fourth] pair of legs; this last dimension equals at least half that of the femur [cuisse] [fig. 10]. This is so much the more remarkable, as in the other pairs of legs the coxa is barely perceptible and the femur is slender [figs. 8 and 9]. The tibias do not diminish in size at the femoral end, but are more slender at the middle." This is particularly interesting and unusual. The remainder of the paragraph is inaccurate and irrelevant.

Finally, it is significant that without stretching the description to fit the species *X. clypeator* should be the commonest species of this genus occuring in central Europe. Although this species (like the elephant and the tea-pot) is not known to climb trees, is is not certain that the agarics were on standing trees, while it is reported by Michæl to burrow in moss and old wood.

Until, therefore, *Xenillus clypeator* can be proved to ressemble more some other species, point for point, than it does *Cepheus tegeocranus* of early authors, in structure and habits, it will have to be considered monotype of the genus Xenillus and synonym of *N. tegeocranus* Hermann 1804 or: *Xenillus tegeocranus* (Hermann).

DIPTERA OF LABRADOR

By Charles W. Johnson

Boston Society of Natural History

This list was for the most part prepared some time ago, but was laid aside to await the determination of few species. In the meantime, however, other work intervened. The list represents the results of a number of expeditions by zoölogists and collectors including Alpheus S. Packard in 1860 and 1864. Samuel Henshaw in 1881, Lucien M. Turner in 1882 and 1883, J. D. Sornborger in 1892 and 1897, A Stecker and J. D. Sornborger in 1899, Dr. C. W. Townsend and G. M. Allen 1906, Owen Bryant 1908 and O. L. Austin, Jr., 1927. There is also added to the list a number of species more recently described by C. P. Alexander, J. R. Malloch, C. H. Curran, and A. L. Melander, the names of the collectors being given in connection with the species described. The following list contains about 170 species.

Trichoceridæ

Trichocera Meigen

T. sp. Nain, Aug. 18, Kangalasiornik, Sept. 15 (Bryant).

Tipulidæ

Dicranomyia Stephen

D. halterata O.S. Battle Harbor, July 11.

Dactylolabis Osten Sacken

D. rhicnoptiloides Alex.

Limnophila (*Dactylolabis*) *rhicnoptiloides* Alex. Rept. Can. Arctic Exped. 1913-18, Crane-flies, p. 6 c. 1919.

The type was taken at Bernard Harbor, N. W. Territories. It was later recorded from Ellesmereland by Dr. Alexander, collected on the Second "Fram" Expedition.

A specimen of this species was taken at Joksut, an inlet just south of Cape Chidley, Aug. 17, 1927, by O. L. Austin, Jr. Specimen in the Museum of Comparative Zoölogy.

Chionea Dalman

C. waughi Curran. Can. Ent. vol. .57, p. 24, 1925. Cabot Lake, Sept-Oct. and Voisey's Bay, Dec. 5, 1921 (F. W. Waugh).

Limnophila Macquart

L. subunica Alex. Rama, 1899 (Stecker).

Tricyphona Zetterstedt

T. hyperborea O. S. "Labrador." (Osten Sacken).

T. inconstans O. S. Cape Charles, July 28 (Allen).

Dolichopeza Curtis

D. americana Needh. Rigolet, July 16 (Allen). .

Prionocera Loew

P. electa Alex. Can. Ent., vol. 59, p. 188, 1927. Hopedale, July 1, 1923 (W. W. Perrett).

Tipula Linnæus

T. angustipennis Loew. Hopedale and Caribou Isl. (Packard). Rama (Sornborger).

T. aperta Alex. Can. Ent., vol. 40, p. 62, 1918. (*T. imperfecta* Alex. 1915 *non* Brunetti. 1913). "Labrador" (Packard).

T. canadensis Loew, Hopedale, July 31, 1922, June 21, 1924. (W. W. Perrett).

T. entomophthoræ Alex. Can. Ent., vol. 60, p. 99, 1928 Hopedale, June 19-27, 1925 (W. W. Perrett).

T. grenfelli Alex. Can. Ent., vol. 60, p. 96, 1928. Hopedale, July 7, 1923 (W. W. Perrett).

T. labradorica Alex. Insec. Inscit., vol. 3, p. 128, 1915. (*T. tessellata* Loew 1863 *non T. tessellata* de Villers 1789 Battle Harbor July 11, Great Caribou Isl., July 14 (Allen).

T. macrolabis Loew. Rama, Aug. 24, 1882 (Sornborger Hopedale, June 19-Aug. 4, (W. W. Perrett).

T. nebulipennis Alex. Battle Harbor, Aug. 1, 1912 (G. P. Engelhart).

T. packardi Alex. Can. Ent., vol. 60, p. 99, 1928. Hopedale, Aug. 24, 1924 (W. W. Perrett).

T. perretti Alex. Can. Ent., vol. 60, p. 98, 1928. Hopedale, July 17, 1923. (W. W. Perrett).

T. productella Alex. Can. Ent., vol. 60, p. 100, 1928. Hopedale, Sept. 13, 1923 (W.W. Perrett).

T. septentrionalis Loew. "Labrador" (Schneider) Hopedale, June 18-July 5 (W.W. Perrett).

T. serta Loew (*T. albonotata* Doane). Hopedale, June 19 to Aug. 4 (S.S. Perrett).

T. subserta Alex. Can. Ent. vol. 60, p. 97, 1928. Hopedale (Packard). Rama 1894 (Sornborger). Hopedale July 18-25 (W.W. Perrett).

CULICIDÆ

Aedes Meigen

A. punctor (Kirby). *A. provocans* Walk. St. Lewis Inlet, Rigolet and Cape Charles July 12 to 28 (Allen).

CHIRONOMIDÆ

Culicoides Latreille

C. sp. "Labrador" (Packard).

Tanypus Meigen

T. monilis Linn. Great Caribou Isl., July 26 (Allen).

T. sp. Hopedale (Packard).

Chironomus Meigen

C. annularis De G. Hopedale (Packard), Great Caribou Isl., July 27 (Allen).

C. cristatus Fab. Hopedale (Packard), Great Caribou Isl., July 27 (Allen).

C. riparius Meig. Hopedale (Packard).

C. brunneipes Zett.? Hopedale (Packard) Cape Charles, July July 29 (Allen).

CECIDOMYIIDÆ

Rhabdophaga Westwood

R. sp. Hopedale, (Packard).

Packard in his Labrador Coast, p. 390, records *Micromyia leucorum* with the following note: "Prof. C. W. Woodworth writes me that on examining the collection of Diptera which I made in Labrador, and which is now in the Cambridge Museum, he detected the rare European Cecidomyid, *Micromyia leucorum,* belonging to a genus hitherto unrecorded for North America."

I have examined the specimen referred to and thus labeled in the Museum of Comparative Zoölogy, and find that it is a Chironomid.

MYCETOPHILIDÆ

Gnoriste Meigen

G. megarrhina Osten Sacken, Nain, Aug. 18, (Bryant).

Mycomya Rondani

M. maxima Johannsen, Nain Aug. 18 (Bryant). The type locality "Maine," should read Nain.

Allocadia Winnertz

A. sp. Nain Aug. 18 (Bryant).

Neosciara Petty

N. sp. St. Lewis Inlet, July 12 (Allen).

BIBIONIDÆ

Bibio Geoffroy

B. inæqualis Loew ♂ ♀ Hopedale (Packard). Rama 1899, (Stecker and Sornborger). Cape Charles July 29 and 30 (Allen).

Bibio bryanti sp. nov.

♂ Head, antennæ and palpi black, pile of the eyes long and brown. Thorax black, shining with long black pile. Abdomen black, whitish pile. Legs reddish, with yellowish hairs, coxæ and knees black, the inner spur of the front tibiæ about one-half the length of the outer one, the posterior tibiæ and metatarsi enlarged, the latter about as long as the second and third joint combined. Wings hyaline, the costa, stigma and first and second veins brown. Halteres dark brown. Length 8 mm. Nain, Aug. 18 (Bryant). Rama, Aug. 24 (Sornborger). Holotype and paratypes in the Museum of Comparative Zoölogy.

It resembles *B. variabilis* Loew, but the lighter colored femora and enlarged metatarsi readily separates it. From *B. fumipennis* Walk, it is distinguished by its light colored wings and veins and the noticeably thicker tibiæ and metatarsi.

Bibio labradorensis sp. nov.

♂ Head, antennæ and palpi black, the pile on the eyes brown. Thorax black, shining, pile yellowish. Abdomen black pile yellow. Femora black, tibiæ and tarsi yellow, the latter very short, the posterior tibiæ as large as the femora and posterior metatarsi about one-half the diameter of the tibia, the second joint of the tarsus also noticeably enlarged. Wings hyaline, the anterior veins and stigma light yellow. Halteres dark brown. Length 5.5 mm. Two specimens. Nain, Aug. 18, 1908 (Bryant).

This species resembles a small *B. variabilis* Loew, but differs in having thickened metatarsi and obsolete stigma. Holotype and paratype in the Musem of Comparative Zoölogy.

SCATOPIDÆ

Aspistes Meigen

A. analis Kirby. Hopedale (Parkard).

SIMULIIDÆ

Simulium Latreille

S. venustum Say. Cape Charles, July 29 (Allen).

S. (Wilhelmia) vittatum Zett. Fort Chimo (Turner). Hawk's Harbor, July 20, '08. (Peary's North Pole Expd.)

Prosimulium Roubaud

P. hirtipes Fries. Rigolet and Cape Charles, July 18 and 28 (Allen). Nain, Aug. 18 (Bryant). Hawk's Harbor, July 20, '08 (Peary's North Pole Expd.)

STRATIOMYIDÆ

Beris Latreille

B. annulifera var. **brunnipes** Johns. Psyche, vol. 33, P. 109, 1926. Parroquet Isl., July 21, 1881 (Henshaw). Strait of Belle Isle (Packard.)

TABANIDÆ

Chrysops Meigen

C. excitans Walk. St. Lewis Inlet, July 12 (Allen).

C. mitis O.S. St. Lewis Inlet, Great Caribou Isl. and Cape Charles, July 12 to Aug. 29 (Allen).

C. sordida O.S. Great Caribou Isl. July 29 (Allen).

Tabanus Linnæus

T. affinis Kirby, Great Caribou Isl., 27 (Allen).

T. astutus O.S. Great Caribou Isl. and Cape Charles, July 27-30 (Allen).

T. flavipes Wied. St. Lewis Inlet and Cape Charles, July 12 and 21. (Allen) Kangalasiornik Bay, Sept. 5 (Bryant).

T. illotus O.S., St. Lewis Inlet, July 12 (Allen).

T. septentrionalis Loew. Great Caribou Isl. and Cape Charles July 27-30 (Allen). Nain Aug. 18 (Bryant).

T. zonalis Kirby. Lewis Inlet, and Cape Charles, July 12 and 28 (Allen).

T. labradorensis Enderlein. (*Tyloslypia labradorensis* Ender. mitt. Zoöl. Mus. Berlin, xi, 363, 1925). "Labrador." (Enderlein).

T. cristatus Curran. Can. Ent., vol. 59, p. 81, 1927. "Labrador" (Curran).

RHAGIONIDÆ

Symphoromyia Frauenfeld

S. montana Aldr. Ungava Bay (Turner).

ASILIDÆ

Asilus Linnæus

A. nitidifacies Hine. Hopedale, Aug. 19, 1923 (W. W. Perrett).

DOLICHOPODIDÆ

Dolichopus Latreille

D. annulipes Zett. (*D. stenhammeri* Zett). Sloop Harbor, July 19, Hopedale and Caribou Isl. (Packard). Nain, Aug. 18 (Bryant). Dr. Aldrich agrees with Becker that *annulipes* is not preoccupied, c.f. Proc. U.S. Nat. Mus., vol. 61, art. 25, p. 2, 1922.

D. boreus Van D., Cole and Aldr. Ungava Bay, July 22-28 (Turner).

D. brevipennis Meig. Nain Aug. 18 (Bryant).

D. bryanti Van D., Cole and Aldr. Hopedale and Strawberry Harbor (Packard). Ungava Bay, July 29 (Turner) Great Caribou Isl. July 27 and Nain, Aug. 18 (Bryant).

D. dasypodus Coq. Hopedale and Caribou Isl. (Packard). Nain, Aug. 18 (Bryant).

D. delicatus Aldr. Ungava Bay and Fort Chimo (Turner).

D. groenlandica Zett. Ungava Bay, July 29 (Turner). Nain, Aug. 18 (Bryant).

D. packardi Van D., Cole and Aldr. Nain, Aug. 18 (Bryant).

D. latronis Van D., Cole and Aldr. Hopedale (Packard).

Hydrophorus Fallen

H. chrysologus Walk. Strait of Belle Isle (Packard).

Scellus Loew

S. filifer Loew. Nain, Aug. 18 (Bryant).

The nine specimens, all females, are a little smaller than specimens from Farwell Creek, South Saskatchewan (Mrs. Armstrong), and High River, Alberta (Owen Bryant).

Rhaphium Meigen

R. sp. Hopedale (Packard), Caribou Isl. (Packard). "Both specimens are females that I cannot determine." (M. C. Van Duzee).

EMPIDIDÆ

Bicellaria Macquart

B. uvens Mel. (Genera Ins., 74 1927) Fort Chimo, Ungava Bay (Turner).

Iteaphila Zetterstedt

I. curva Curr. Can. Ent., vol. 57, p. 24, 1925. Nain, June 15-22 (F. W. Waugh).

Hilara Meigen

H. unicolor Loew. Caribou Isl. (Packard) Nain, Aug. 18 (Bryant).

Empis Linnæus

E. lævigata Loew. Battle Harbor, July 11; Cape Charles, July 28 (Allen). Caribou Isl., Indian Harbor and Strawberry Harbor (Packard).

E. obesa Loew Nain, Aug. 18 (Bryant).

Rhamphomyia Meigen

R. incompleta Loew. Nain, Aug. 18 (Bryant).

R. setosa Coq. Great Caribou Isl., July 27 (Allen). Nain, Aug. 18 (Bryant). Strawberry Harbor (Packard).

Clinocera Meigen

C. (Hydrodromia) longifurca Mel. (Genera Ins., 231, 1927) Nain, Aug. 18 (Bryant).

C. (Hydrodromia) conjunta Loew. Great Caribou Isl., July 27 (Allen). Nain, Aug. 18 (Bryant).

Chelifera Macquart

C. (Metachela) albipes Walk. Fort Chimo, Aug. 11 (Turner).

Tachypeza Meigen

T. winthemi Zett. Great Caribou Isl., Aug. 11.

Platypalpus Macquart

P. arcticus Mel. (Genera Ins., 344, 1927). Fort Chimo, Ungava Bay (Turner).

P. melanogaster Mel. (Genera Ins., 323, 1927). Ungava Bay (Turner).

P. prorsus Mel. (Genera Ins., 328 1928). Ungava Bay (Turner).

P. satyriacus Mel. (Genera Ins., 327, 1927) Ungava Bay, (Turner).

P. xanthopus Mel. (*P. gilvipes* Coq. not Meig.) Genera Ins., 367, 1927. Great Caribou Isl., July 14 and 27 (Allen).

PHORIDÆ

Megaselida Rondani

M. rufipes Meig. Nain, Aug. 18 (Bryant).

SYRPHIDÆ

Pyrophæna Schiner

P. **granditarsus** Forster "Labrador" (Henshaw).

Platychirus St. Fargeau and Serville.

P. **albimanus** Fabr. Great Caribou Isl., July 21 (Allen). Nain, Aug. 18 (Bryant).

P. **hyperboreus** Stæg. Strawberry Harbor (Packard). Nain, Aug. 18 (Bryant).

P. **peltatus** Meig. dark var. Two females, Nain, Aug. 18 (Bryant).

P. **quadratus** Say. Strait of Belle Isle (Packard).

Melanostoma Schiner

M. **mellinum** Linn. Strawberry Harbor (Packard).

M. **obscurum** Say. Strawberry Harbor (Packard).

Syrphus Fabricius

S. **pallifrons** Curran Kansas Univ. Sci. Bull., vol. 15, p. 172, 1924. Nain, Aug. 18 (Bryant).

S. **perplexus** Osburn. Kangalasiornik Bay, Sept. 5, (Bryant.

Epistrophe Walker

E. **contumax** O. S. Indian Harbor (Packard). Rama (Stecker and Sornborger). Great Caribou Isl., July 14 (Allen).

E. **diversipes** Macq. Indian Harbor, Strawberry Harbor and Caribou Isl. (Packard).

E. **geniculatus** Macq. Nain, Aug. 18 (Bryant).

E. **insoletus** Osburn St. Lewis Inlet, July 12 (Allen).

Sphæropheria St. Fargeau et Serville

S. **strigata** Stæger. Strawberry Harbor (Packard). Great Caribou Isl, July 14 (Allen). Nain Aug. 18 (Bryant).

Volucella Geoffroy

V. bombylans arctica Johnson.

V. facialis form *arctica* Johnson Psyche, vol. 23, p. 163, 1916.

V. bombylans arctica Johnson. Psyche, vol. 32, p. 116, 1925.

Rama, 1899 (Stecker and Sornborger), Nain (Sornborger), Nain, Aug. 18, 1908 (Bryant).

This circumpolar group of Volucella that live in the nests of various species of Bombus, form an interesting but difficult group to classify. Recognizing but one species with numerous subspecies seems to be the most satisfactory method of treating them.

Eristalis Latreille

E. arbustorum Linn. Nain, Aug. 18 (Bryant) Battle Harbor (Englehardt).

E. bastardii Macq. "Labrador" (Williston).

Helophilus Meigen

H. borealis Stæger. Rama (Stecker and Sornborger), Nain, Aug. 18 (Bryant).

H. groenlandicus O. Fab. Indian Harbor (Packard), Nain, Aug. 18 (Bryant).

H. latifrons Loew. Nain, Aug. 18 (Bryant).

OESTRIDÆ

Cephenomyia trompe Linn?

The species that infests the Barren-ground Caribou *(Rangifer articus)* is probably the same that frequents the reindeer and is circumboreal in distribution. The adult fly has not been taken. Dr. Grenfell informs me that in all the heads of the caribou that he has examined he found parasitic larvæ usually just below the ethmoid. See Insects of Labrador, in appendix to "Labrador the Country and the People" by Wilfred T. Grenfell, 1909.

Oedemagena tarandi Linn?

This is also probably the same species that infests the reindeer. The larvæ are subcutaneous, forming large lumps on the back, from which they escape when full grown through holes in the skin. Dr. Grenfell says that he has seen a skin so perforated that it was practically impossible to cut from it a pair of moccasins. The fly has not been taken in Labrador.

TACHINIDÆ

Linnæmyia R.-Desvoidy

L. varia Curran. Hopedale, June 12-July 18 (Rev. Perrett).

Fabriciella Bezzi

F. orientalis Town. (? *Tachina florum* Walk.) Cape Charles, July 3 (Allen).

F. montana Town. Nain (Sornborger).

SARCOPHAGIDÆ

Pachyophthalmus Brauer and Bergenstamm

P. distortus Allen (Proc. U.S. Nat. Mus., vol. 68, art. 9, p. 15, 1926). Hamilton Riv., Muskrat Falls, July 12-19, 1919 (S. E. Arthur).

CALLIPHORIDÆ

Protophormia Townsend

P. terrænovæ R.-Desv. "Labrador" (Sornborger).

Cynomyia R.-Desvoidy

C. mortuorum Linn. Nain, Aug. 18 (Bryant).

C. cadaverina R.-Desv. Square, Isl. (Packard). Rama and Hebron (Sornborger). Kangalasiornik Bay, Aug. 28 (Bryant).

Steringomyia Pokorny

S. flavipalpis Macq. Indian Harbor (Packard).

Boreellus Aldrich and Shannon

B. atriceps (Zetterstedt).

Sarcophaga atriceps Zett. Dipt. Scand., vol. 4, 1311, 31 1843.
Melinda atriceps Hend. Wien. Ent. Zeitz., xx 33, 1901.
Onesia atriceps Zett. Katal. Pal. Dipt., III, 550, 1907
Phormia cærulea Mall., Rept. Can. Arctic Expd., vol. 3, pt. c, p. 61 c, 1919.
Boreellus aristatus Aldr. & Shan., Insec. Inscit., xi, 107, 1923.
Boreellus atriceps Shan., Proc. Ent. Soc. Wash., vol. 28, p. 128, 1926.
Mallochomyia johanseni Town. Insec. Inscit., Vol. 14, p. 25, 1926. Gready Harbor, Aug. 8 (Bryant).

Calliphora R.-Desvoidy

C. vomitoria Linn. Indian Harbor (Packard).

MUSCIDÆ

Musca Linnæus

M. domestica Linn. near Killinek, Sept. 5 (Bryant).

Myospila Rondani

M. meditabunda Fab. Great Caribou Isl., July 27 (Allen).

ANTHOMYIIDÆ

Phaonia R.-Desvoidy

P. errans Meig. Square Isl., July (Packard).

P. monticola Mall. Rama and Indian Harbor (Packard). Nain, Aug. 18 (Bryant).

P. serva Meig. Strait of Belle Isle. (Packard). Rigolet, July 5 (Allen).

Trichopticus Rondani

T. innocuus Zett. Strawberry Harbor (Packard). Great Caribou Isl., July 27 (Allen). Nain, Aug. 18 (Bryant).
T. septentrionalis Stein., Nain. Aug. 18 (Bryant).

T. spiniger Stein. Nain, Aug. 18 (Bryant). Caribou Isl. Packard).

Rhynchotrichops Schnabl

R. subrostrata Zett. .Battle Harbor, July 11 (Packard). Great Caribou Isl., July 14 (Allen).

Pogonomyia Rondani

P. quadrisetosa Mall. Can. Arctic. Expd., vol. 3, pt. c. p. 66c, 1919. Nain.

Helina R.-Desvoidy

H. fulvisquama Zett. (*H. tuberculata* Mall., Can., Ent., Vol. 51, p. 277, 1919, not Mall., Trans. Amer. Ent. Soc., vol. 46, p. 138, 1920). Rigolet, July 18 (Allen).
H. duplicata Meig. Caribou Isl. (Packard).

Spilaria Schnabl.

S. lucorum Fall. Nain, Aug. 18 (Bryant).

S. marmorata Zett. Caribou Isl. and Straits of Belle Isle (Packard).

Hydrotæa R.-Desvoidy

H. cristata Mall. Indian Harbor (Packard).

Fannia R. Desvoidy

F. scalaris Fab. Caribou Isl. (Packard).

Spilogona Schnabl and Dziedzicki

S. alticola (Mall.) Trans. Amer. Ent. Soc., vol. 46, p. 153, 1920. Nain, Aug. 18 (Bryant).
S. sp. Nain, Cape Charles and Caribou Isl.

Lispocephala Pokorny

L. erythrocera Desv. Caribou Isl. and Strawberry Harbor (Packard).

Cœnosia Meigen

C. humilis Meig. Cape Charles, July 29 (Allen). Caribou Isl. (Packard).

Prosalpia Pokorny

P. angustitarsis Mall. Nain, Aug. 18 (Bryant).

P. silvestris Fab. Straits of Belle Isl., Indian Harbor (Packard).

Hylemyia R. Desvoidy

H. brassicæ Bouche. Nain, Aug. 18. Killinek, Sept. 5 (Bryant).

H. cilicrura Rond. Caribou Isl. (Packard).

H. antiqua Meig. Hopedale (Packard).

Egle R.-Desvoidy

E. mystacea Coq. "Labrador (Malloch). Nain, Aug. 18 (Bryant).

E. muscaria Meig. Strawberry Harbor and Hopedale (Packard).

Paregle Schnabl and Dziedzicki

P. radicum Linn. Nain, Aug. 18 (Bryant).

Pegomyia R.-Desvoidy

P. fuscofasciata Mall. Nain, Aug. 18, (Bryant). Caribou Isl. and Strawberry Harbor (Packard).

P. labradorensis Mall. (Trans. Amer. Ent. Soc., vol. 46, p. 176, 1920 Nain, Aug. 18. Kangolasiornik, Sept. (Bryant). Indian Harbor (Packard).

Fucellia R.-Desvoidy

F. maritima Haliday, Great Caribou Isl. July 14 (Allen). Caribou Isl. (Packard).

SCATOPHAGIDÆ

Scatophaga Meigen

S. stercoraria Linn. Indian Harbor and Caribou Isl. (Packard). Ragged Isl. July 23.

S. islandica Becker. Hopedale, Indian Harbor, Caribou Isl. and Strawberry Harbor (Packard). Hebron, Aug. 28. Rama, Aug. 24, 1897 (Sornborger). Great Caribou Isl., July 14, Gready Harbor Aug. 8, Nain, Aug. 18 (Bryant).

S. furcata Say. Ungava Bay (Turner). Nain, Rama, Hopedale and Indian Harbor (Packard). Great Caribou Isl. (Allen). Gready Harbor, Aug. 8 (Bryant).

S. estotilandia Rondani

Scatina estotilandia Rond. Archiv. Canestrini, III, fasc. I, p. 35, 1863. Archiv. Zoöl. Modena, Vol. 3, 35, 1863. Labrador. Osten Sacken, Catl. Dipt. N. Amer., 1878, p. 174, says: "Mr. Rondani in the same place mentions *Scatophaga diadema* Wied. (Montevideo) as having been received from Labrador." Hendel (Wien. Ent. Zeit., vol. 29, p. 116, 1910) in a footnote under *Thyreophorella diadema* (*Scatophaga diadema* Wied.) says:—"The insect that Rondani determined as *Scatina diadema* Wied., is doubtless a *Scopeuma* [*Scatophaga*] but not likely to be the above species." [*S. diadema*].

Trichopalpus Rondani

T. sp. Caribou Isl. (Packard); Nain, Aug. 18 (Bryant).

Pogonota Zetterstedt

P. kincaidii Coq. Nain Aug. 18 (Bryant).

Microprosopa Becker

M. hæmorrhoidalis Meig. Nain, Aug. 18 (Bryant).

Eugenacephala Johnson

E. ruficeps Curran (1925). Natashquan June-July, 1921. (F. W. Waugh).

Acanthocnema Becker

A. albibarba Loew. Nain, Aug. 18, Bryant. The type from the White Mts., N. H., is teneral.

HELOMYZIDÆ

Suillia R.-Desvoidy

S. zetterstedtii Loew. Ungava Bay (Turner).

Allophyla Loew

A. lævis Loew Caribou Isl. (Packard).

Oecothea Haliday

O. fenestralis Fall. Indian Harbor (Packard).

Scoliocentra Loew

S. fraterna Loew. Ungava Bay (Turner).

Neoleria Malloch

N. ruficauda Zett. (*Leria crassipes* Loew) Ungava Bay (Turner). Gready Harbor, Aug. 8. Nain, Aug. 18 (Bryant).

BORBORIDÆ

Borborus Meigen

B. arcticus Mall. Fort Chimo, Ungava Bay (Turner).

SCIOMYZIDÆ

Dictya Meigen

D. umbrarum Linn. Great Caribou Isl., July 29 (Allen).

SAPROMYZIDÆ

Minettia R. Desvoidy

M. lupulina Fab. Strawberry Harbor, Hopedale (Packard).

PALLOPTERIDÆ

Palloptera Fallen

P. jucunda Loew. Parroquet Isl., July 27, 1881 (S. Henshaw).

PIOPHILIDÆ

Piophila Fallen

P. casei Linn. Indian Harbor and Hopedale (Packard).

EPHYDRIDÆ

Scatella R.-Desvoidy

S. stagnalis Fall. Nain, Aug. 18 (Bryant). Hopedale, Strawberry Harbor (Packard).

CHLOROPIDÆ

Chlorops Meigen

C. melanocera Loew, Nain, Aug. 18. Kangalasiornik Bay, Sept. 5, (Bryant).

A BEAUTIFUL CRANE-FLY FROM SIAM

By T. D. A. Cockerell

I have lately received from Dr. and Mrs. James W. McKean along with many other insects, an extremely handsome *Tipula* collected at Chiengmai, Siam, June 28, 1928. The insect was so remarkable that I looked it up in the literature, and decided that it was allied to *T. pedata* Wied., but new.

Tipula (Tipulodina) mckeani n. sp.

♀. Length 28 mm., wing 18 mm.; hind tibia 20.2, hind tarsus 21.5, hind femur 19, ovipositor 1, antennæ about 3, proboscis 1.5 mm.

Antennal scape white at base, more than apical half brown; flagellar joints brown, with somewhat swollen black base, which carries rather long hairs. Facial and frontal regions whitish, with a dusky stripe in middle of front; sides of snout ochreous, posterior part of head dark brown. Thorax dorsally pale brownish grey, a narrow dark brown stripe anteriorly, and the lateral areas broadly pallid, the pleural region whitish; halteres light brown. Wings clear hyaline, marked with dark brown in the manner of *T. pedata* Wied, except that there is no clear costoapical spot, though the color in this region is paler, and the cell R5 is clear except at extreme base; there is a small suffused brown spot on the lower margin of cell M, just about the middle. Abdomen dark brown above, beneath pale and flavescent, segments more or less pallid along apical margins. Femora broad, with blackened apex, the anterior pair broadly dull luteous subapically. Anterior and middle tibiæ black, with a portion 4.5 mm. long and about 3 mm. from apex, creamy white; their tarsi with about the basal 7 mm. black and the rest creamy white; hind tibiæ with an additional white ring, about 3.5 mm. long, near the base, and only about 5 mm. of their tarsi black.

Type in the collection of Dr. C. P. Alexander who confirms the species as new, and cites the following as the closest allied: *T. pedata* Wied., *T. fuscitarsis* Edw., *T. tinctipes* Edw., *T. micrantha* Alex., *T. scimitar* Alex., *T. venusta* Walk. From all of these it differs in the combination of leg pattern and coloration of body and wings.

BOOK NOTICES

A HANDBOOK OF THE DRAGONFLIES OF NORTH AMERICA. By J. G. Needham and H. B. Heywood. vi + 368 pp., with many figures and diagrams. Charles Thomas, Springfield, Illinois. $7.00.

The scattered literature relating to North American Odonata has been gathered together, digested and presented with a large amount of new material in the present book. The introduction of about fifty pages includes a short account of structure and habits and the remainder is a very complete taxonomic treatment, including keys, of the adults and nymphs so far as the latter are known. This is a "handbook" in the full sense of the word, and with its list of literature should serve as a complete guide to the field with which it deals.

C. T. BRUES.

THE PROBLEMS OF APPLIED ENTOMOLOGY. By R. A. Wardle. vii + 587 pp., 31 figures. McGraw-Hill Book Co., New York. $6.00.

After the extensive series of text books on insects that have been published during the past few decades, it would seem that no actually new and unique treatment of any extensive entomological field could be expected. Professor Wardle has shown that such is not the case, and has worked into a consistent treatment a vast amount of general and specific material relating to practically every phase of applied entomology without following any of the usual methods of procedure. The first ten chapters relate to general problems and deal with such diverse topics as "climatic resistance" "tropic behavior" and "stomach poisons". These serve to show the present extent of the fields invaded by the economic entomologist and the methods which he applies in his work. The more specific portion, entitled "Area Problems" deals with the problems that confront the entomologist in particular parts of the world and includes a discussion of the multitude of insects that have forced themselves upon the attention of agriculturists, foresters and medical men in all countries. A discussion of this sort has never before been attempted on so broad a scale. A very extensive and well arranged bibliography completes the book.

Professional entomologists will find this book extremely valuable and for all others interested in the problems with which it deals, it will be a useful compendium.

C. T. BRUES.

NEW FORMS OF *ODONTOPONERA TRANSVERSA*

By Wm. S. Creighton

Odontoponera was first recognized as a distinct genus in 1862 when Mayr raised to generic rank an ant described a year earlier by Frederick Smith as *Ponera denticulata.* This insect was later found to be identical with Smith's *Ponera transversa* described in 1857. The name *denticulata* was, therefore, replaced by *transversa.* Although the single species by which this genus is represented is fairly abundant and distributed throughout many of the islands of the East Indies and the adjacent portions of the continent, little attention has been paid to its variations. Wheeler and Chapman in 1925 described *biconcentrica,* a variety from the Philippines but except for this no other form has been noted. Dr. W. M. Wheeler has kindly permitted me to examine the *Odontoponera* material in his collection and I find that it is possible to recognize two additional variants. One of these is plainly of subspecific rank while the other appears to be a color variety of the typical *transversa. Biconcentrica* must, I believe, be raised from varietal to subspecific status.

The shape and the sculpture of the node of the petiole which appear at first sight to offer striking characters for separation are quite valueless in this regard. In a series of workers from a single nest the petiole may be narrow with a deeply notched summit and heavy rugæ on the basal half or relatively broad with the notch and rugæ reduced or absent. The same is true to a lesser degree of the sculpture of the pronotum. This usually consists of more or less parallel, heavy, transverse rugæ. Occasionally, however, one or two workers in a series have the posterior pronotal rugæ twisted into two whorl-like configurations. As may be recalled this characteristic formed the basis for the recognition

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 315.

of *biconcentrica*. Were this the only distinction the validity of *biconcentrica* would be extremely doubtful but, as I shall show later, there are other very significant differences by which that form may be separated.

Smith, with his customary predilection for minor details, has noted certain characteristics of color in his original description which permit a rather accurate inference as to the nature of the true *transversa*. I have chosen to regard as typical a form which occurs in southern China, Indochina, Burma, the Phillipines, Borneo and Java. This insect shows the piceous body and ferrugineous appendages mentioned by Smith. Furthermore its distribution is considerably more extensive than that of any of the other forms and it seems logical to suppose that it would be the first to be taken. The distribution of the remaining variants is much more restricted. The range of *nitens* (subsp. nov.) extends from Borneo through Java and Sumatra to Singapore. *Infuscata* (var. nov) is known only from Java and one of the Sunda Islands. The distribution of *biconcentrica* appears to be more northern. It occurs in China and the Philippines but the material is so scarce that its range is largely a matter of speculation.

The following key may facilitate the separation of the various forms:

1. Posterior angles of the enipotum each armed with one or two acute short teeth, the subpetiolar lamella feebly pilose, the rugæ strongly shining .... subsp. *nitens*

   Posterior angles of the epinotum each armed with a divergent series of three or four broad, coarse teeth, the subpetiolar lamella strongly pilose, the rugæ opaque or subopaque .... 2.

2. Head one-fifth longer than broad, the sides approximately parallel; color dull yellow, the abdomen brownish .... subsp. *biconcentrica*

   Head as broad as long, the sides feebly convex, color black, the appendages ferrugineous or brownish black .... 3.

3. Mandibles, clypeus and appendages ferrugineous .... *transversa*

Mandibles, clypeus and appendages blackish brown .... var. *infuscata*

Odontoponera transversa (Fred. Smith)

O. transversa, (F. Smith), Jour. Proc. Linn. Soc. Lond. Zool. Vol. 2, p. 68 (1857) worker (*Ponera*).

Ponera transversa, F. Smith, Cat. Hym. Brit. Mus. Vol. 6, p. 86, (1858) worker.

O. transversa, Dalla Torre, Cat. Hym. Vol. 7, p. 30 (1893; Forel, Jour. Bombay Nat. Soc. Vol. 13, p. 314, Hist. (1900) worker; Bingham, Fuana Brit. India, Hym. Vol. 2, p. 73, f. 38, (1903) worker ♀.

Emery, Gen. Insect. Hym. Ponerinæ, p. 60, (1911) worker ♀ ♂.

Ponera denticulata, F. Smith, Cat. Hym. Brit. Mus. Vol. 6, p. 90. f. 13, 14, (1858) ♀; Roger, Berl. Ent. Zeitschr. Vol. 5, p. 11, (1861) worker.

O. denticulata, Mayr, Verh, Zool-bot. Ges. Wien, Vol. 12, p. 717, (1882).

There have been so many descriptions of *O. transversa* that another complete account of this easily recognized insect seems entirely superfluous. I shall give only those characteristics which are of use in distinguishing the typical form from the other variants.

Head and thorax piceous, the abdomen usually brownish black with the posterior borders of the segments narrowly edged with brown, rarely the entire abdomen piceous. Mandibles, clypeus, antennæ and legs ferrugineous; coxæ blackish brown. Long hairs moderately abundant, golden; pubescence whitish yellow, very sparse on the rugose portions but abundant elsewhere, particularly long and thick on the subpetiolar lamella. Rugæ coarse, opaque or subopaque, their surfaces, much roughened by numerous small impressions and ridges, cephalic rugæ rougher than those of the thorax. Antennæ with a few shining oval punctures. Head approximately as broad as long, broadest between the posterior fourth and fifth, the sides feebly convex, the occiput broadly and evently concave. Epinotum with two divergent, serrate carinæ consisting of three or four obtuse teeth at the junction of the basal and declivious faces.

The collection contains numerous specimens from southern China and Burma and a few from Indochina. There is a very large amount of material from the Philippines, two workers and a female from northern Borneo and a number of specimens from Java.

Ondontoponera transversa var. **infuscata** var. nov.

This variety differs from the typical form in the color of the clypeus and the appendages. The mandibles, clypeus, antennæ and legs are blackish brown. The rugæ are in most cases more shining than in the true *transversa.*

Infuscata appears to be confined to Java and some of the closely adjacent Sunda Islands. A large series of workers taken by L. G. E. Kalshoven in the teak forests of Samarang, Java, may be considered as type material. There are a few specimens taken by N. Gist Gee in Buitenzorg, Java, and others from Mao Marroe, East Soemba (Sunda Islands) collected by Dammerman.

Odontoponera transversa subsp. **biconcentrica,**

Wheeler & Chapman.

Odontoponera transversa var. biconcentrica, Wheeler & Chapman, Philippine Jour. of Sci. Vol. 28, No. 1, (1925) worker.

Biconcentrica was originally separated on the circular configuration of the rugæ of the pronotum but, as has been already shown, the value of this character is lessened since it sometimes occurs in the typical *transversa.* There are, however, a number of other differences. The head of *bicon-*

centrica is approximately one fifth longer than broad with the sides parallel or nearly so, the occipital impression is somewhat feebler and a little more angular than in the true *transversa.* The color is a peculiar dull, brownish yellow with the abdomen slightly darker. The punctures on the antennal scapes are circular and deeply pigmented which gives the scapes a speckled appearance. The rugæ are smoother and more shining than the typical form but much less so than in the subspecies *nitens.*

Biconcentrica was described from a single worker taken by Baker on Basilan Island, P. I. There are two others in the collection secured by Sylvestri at Shatin, China. The latter are a trifle smaller and lighter in color than the type but obviously belong to this subspecies.

Odontoponera transversa subsp. **nitens** subsp. nov.

The rugæ of *nitens* are finer and much more shining than those of the other forms. The divergent carinæ at the angle of the basal and declivious faces of the epinotum are reduced to one or two small, rather acute teeth. The subpetiolar lamella is feebly pilose, in some specimens virtually bare. As a general rule the node of the petiole is narrower with a more deeply notchd summit than in the other forms but this character cannot be relied upon since the shape of the petiole is highly variable. The color of *nitens* is quite distinct. The head and thorax vary from ferrugineous to blackish red with the appendages and abdomen brownish red or yellow.

I have designated as types a series of workers collected by E. Mjöberg in North Borneo. I have seen others from Kuching, Borneo, (H. Smith), Depok, Java, (Dammerman), Wai Lima, South Sumatra, (Karny) Dœrian, Riouw Archipelago, (Dammerman), and Singapore, (Baker).

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VOL. XXXVI SEPTEMBER, 1929 No. 3

THE BIOLOGY AND BEHAVIOR OF MINING BEES, *ANTHOPHORA ABRUPTA* AND *ENTECHNIA TAUREA*.

BY PHIL RAU

Kirkwood, Mo.

Introduction

This paper deals with the behavior and biology of two species of mining bees, *Anthophora abrupta* and *Entechnia taurea,* with brief notes on *Anthophora raui.* Large colonies of these three bees carried on their mining operations in a sheltered clay bank at Wicks, Mo. All three species were also important factors in the life of this microcosm (the clay bank community), and their relations, interrelations and reactions to environment have been studied and reported in a paper entitled "The Ecology of a Sheltered Clay Bank: a Study in Insect Sociology."[1] In making an ecological study of that kind, one often faces difficulty in deciding just which data to publish under the title ecology, and which rightfully belongs to biology or behavior. Hence I tried to sift out for that paper the data on ecology, and all the remaining material, which more properly belongs to biology and behavior, is published herewith. Since the reader may not always agree with me in my arbitrary classification of data, and since I have tried not to repeat in this paper the data already published under the title "Ecology," I can only recommend that he read the Academy of Science article in connection with the present one.

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[1] Trans. Acad. Sci. St. Louis, 25:159-276. 1926.

The clay bank (fig. 2) at which these bees (figs. 5, 6 and 7) were nesting, faced the east, where it received the morning sun, and was protected from the weather by the porch above it.

THE TURRET-BUILDING BEE, *Anthophora abrupta.*

Anthophora abrupta makes no secret of its presence. They are neither timid nor aggressive, but they certainly are self-reliant. Their presence is easily and quickly detected by two prominent indicators, the bees themselves, and the conspicuous nests which they build. A glance at the picture (fig. 5) will convey to the reader some idea of how conspicuous they are as they noisily swing their ponderous bodies to and fro on the wing, arrive home and scramble into their burrows or come tumbling out headlong and dash off into the sunny fields, with all the exuberance of boys just out of school. They have none of the shy, stealthy ways of maneuvering, whereby some of the smaller and daintier varieties of bees and wasps hold their own in a competitive world. They go boldly and fearlessly about their work, and soon construct nests which are likewise prominent. While many species of solitary wasps and bees try in some way to conceal the location of their burrows, these construct large mud chimneys over their nests, made from the clay dug out of the burrows (fig. 1). Since they work in colonies, or more correctly remain to build on the site where they were born, the result is a very conspicuous village, sometimes a very crowded and busy town of these masonry turrets as shown in profile in fig. 8. At a busy season when many of these huge bees are bustling about with very audible hum and zip, the entire village with its many wonderful towers and industrious citizens form a spectacle which is in itself quite capable of overawing any but the most unemotional individual.

In 1917 the *Anthophora abrupta* first appeared on June 25th. In 1918, the spring was warmer and they were out and at work much earlier, and the size of the chimneys indicated that they must already have been at work some days before I discovered them on May 28th.

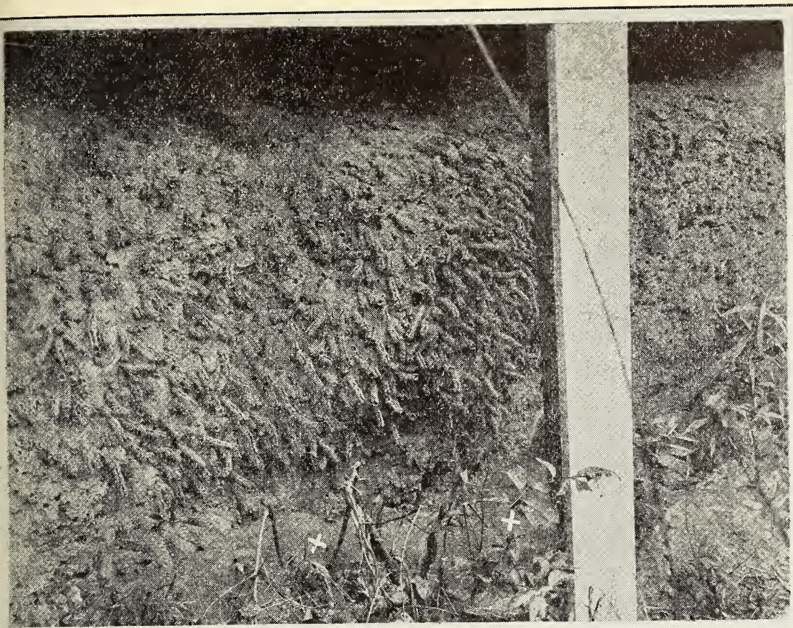

FIG. 1

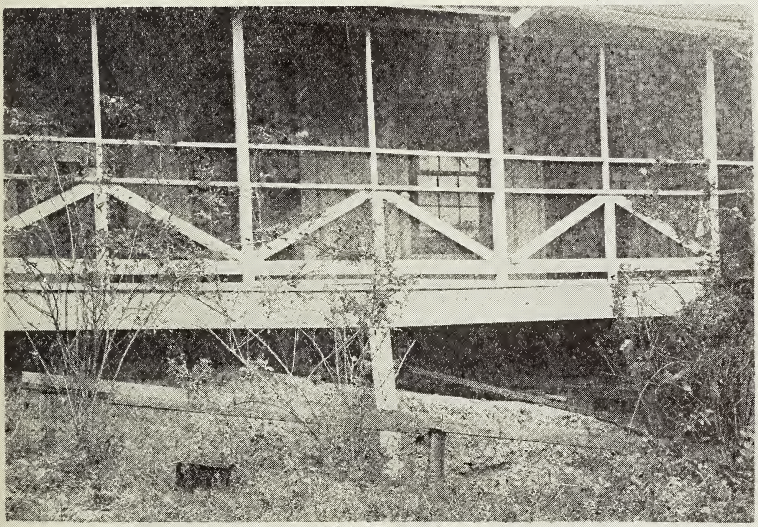

FIG. 2

Fig. 1. The work of *Anthophora abrupta*. Turrets built over their nests.

Fig. 2. The clay bank under the porch where the three species of mining bees nested.

In the spring of 1921 the males were found flying on May 27th, when they were frequently seen on the flower-buds of the rambler roses. Often they seemed to be trying to bite their way into the buds. At evening they were often seen to climb to the top of a grass-blade, grasp the tip firmly in their jaws and go to sleep. Fig. 3 shows a male sipping sugar water from a piece of cotton.

Fig. 3. The male of *Anthophora abrupta*.

I have never seen mating occur at the bank, and I have often wondered if they do not go elsewhere for the purpose of meeting the females. At a point about one hundred yards distant, on a hill side facing the eastern sun, I repeatedly saw a number of males hovering and flitting over a barren spot about three feet square covered with old rusty slag. At first I suspected that this was the place of their courtship-dances, but I failed ever to discover a female there. Instead the males were often found devoting their attention to the rust-covered ashes, to which they clung with their jaws. That reminded me how the females of their species at Manchester, Mo., during the previous summer had shown astonishing persistence in eating the rust from an old iron barrel-hoop and rusty fence-wire. Perhaps these males merely went to this bed of cinders to get their supply of mineral salts while the females were emerging and prospecting for burrows. This habit of licking rusty objects was not merely a casual occurrence but a purposeful and persistent activity; it elsewhere attracted the notice of my companion, who suggested that carnivouous insects can derive their mineral salts from the blood and juices of their food, but these mining-bees are nectar feeders; hence it is possible that they may need to obtain their necessary mineral salts by some such direct methods as this.

On the next day the persimmon blossoms were beginning to open and already the bees had turned their attention thither; within three or four days more they were intensely active at this new task. In this short time, less than a week, the males had disappeared. Thus in a short while, and in keeping with the rapidity with which this species lives and does things, the males had come and gone, and the females remained buzzing at their new work. They hummed and danced in the sunlight in front of the bank; this activity, however, was not a courtship dance such as occurs in other insect species, but merely the industrious search in flight before the face of the bank as each bee tried to distinguish her own burrow. It was not a simple task at so early a time in the season, and it gave rise to more commotion than later when the bees had had more experience. If one singled out an individual in the crowd and continuously followed it with the eye, one would see that it finally plunged into an opening, sometimes to remain and sometimes to come precipitously tumbling out again and try another. It is little wonder that the returning bees must spend some time in distinguishing their own nest among hundreds or even thousands of burrows, but my observations have substantiated my expectation that later in the season, when the turrets were nearly all built, they would consume less and less time in this orienting dance as they learned more readily to distinguish their own nests among the hundreds in the group. I have stated elsewhere that when these bees came home late in the evening, their hovering in front of the nests was much prolonged, owing to their difficulty in finding their way in the fading light. A number of the larger turrets and their occupants were marked; these were watched in comparison with the rest of the population. It was soon apparent that those with large turrets found their homes with much less hesitation than the turretless ones.

Hence I sometimes wonder, since I have never yet learned the utility of these chimneys, whether they might not be built to serve as landmarks for the returning bees. The variation in the size, shape and position of these turrets was much more apparent than that of the mere apertures in the bank. The turrets ran in various directions; some were horizontal, some tilted a little downward, others were at various angles toward north and south. There seemed to be no plan or scheme of direction, except that none were seen with an upward tilt, but the points of the compass were utterly disregarded, (see figs. 1, 4, and 8) and so far I have been unable to discover any factor, light, convenience, efficiency, or anything else, that could determine the direction in which these chimneys curved as they grew. Their diameter, (fig. 11) about ½ inch outside measurement, was fairly uniform for the entire colony, but their length varied from nothing to three inches, the greatest number of finished ones measuring about two and one-half inches in length. None of the tubes were found to be closed either at the base or at the orifice of the chimney; the entire channel leading down to the cells was in every case hollow, with an open groove for its full length along the top. The bees did not tear down the chimney and utilize the material for tunnel-filling as do the *Odynerus geminus* wasps,[1] nor did they even seal the tunnel with a thin wall at the surface of the ground. The tunnels were tortuous and hard to follow, owing to the closeness of the nests and the extreme hardness of the clay. One tunnel was opened which slanted downward, then upward, forming a letter "V" with a total length of five inches. Another, which had a two-inch tube, penetrated the bank to a depth of six and a quarter inches, following a zig-zag course, and terminated in the usual pocket. This mother evidently had lost her nest or had become lost herself before the nest had been completed or used. This was not the only case of this failing; in a number of cells we found this same condition.

But these *abrupta* went further than merely to dig a burrow in the ground and provision it, as do so many species of their kind. Deep down within the tunnels in the

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[1] Wasp Studies Afield, p. 299-312, 1918.

solid clay they built distinct cup-shaped or thimble-shaped cells in which they placed the store of prepared pollen and the egg, and then individually sealed them, in this way obviating the necessity of sealing the outside or main tunnel to exclude intruders. This method gave excellent protection against injury by violence and the weather, for the cells containing the eggs or larvae were heavier than the little pots which the potter-wasps attach to twigs, and they equalled in thickness and warmth the mud walls of *Trypoxylon politum* and they had in addition the protection of the deep burrow. These cells were oval, ¾ inch in length, placed close together and were varnished on the inside with some special waxy substance. Fig. 12 shows a lump of mud with these brood pots.

The bees continued to extend the tunnels by excavation and enlarge the chimneys by addition. They brought water from a mud-puddle in the road fifteen feet distant, carrying the load in the gullet. With a portion of the water they would wet the hard, yellow clay, remove a mouthful of it, back out and apply it to the last ring in the chimney. The bees would carry the mud under the thorax with the front pair of legs, while the two hind pairs furnished locomotion; as the bee backed out of the nest to the opening, the ball of mud was passed to the hind legs, and she now held her footing with the front legs while with hind legs she slapped the mud onto the last layer and with many active thumps with the tip of the abdomen, punched and beat it into shape. "Punched" is really the right word correctly to describe the gesture. *Entechnia taurea* does similar work with much finer precision; in that species the bee divides the ball of earth into two portions, applies the first part to the center of the tube at the bottom, and carefully smooths and works it on the left side almost to the top; then she applies the second portion in the same way at the base and works it up on the right side. The result of this method is that, either through the builder having insufficient material, or from some other cause, there remains a split or open groove down the full length on the upper median side of the tunnel, where the two halves of the load of mud fail by only a narrow margin to meet.

The bee here considered, *Anthophora abrupta* also left an opening along the top of most of the chimneys, (figs. 4 and 11)[1] but here it was not due to the method of building followed by *E. taurea,* for *A. abrupta* applied her load of mud wherever she happened to strike the edge, on the bottom or sides, and the job of spreading it was quickly done. In this species the chimney was somewhat greater in diameter, and it was rougher on the outside, but the interior surface was very smooth and neat. Sometimes in her hurry to apply the mud, the bee dropped it; at other times she might be seen brushing out loose, moist materials by kicking them backwards, probably the crumbs or scraps that had dropped

Fig. 4. A close-up view of the turrets over the nests of *Anthophora abrupta.*

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[1] Fig. 4 and 1 show these openings very distinctly, while Fig. 11 does not show so many, because in the latter figure they were inverted when the photograph was made. In most of the turrets in Fig. 11 we see the bottom side.

from the walls in the process of biting out the hard clay, or the scraps that dropped while she fashioned her thimble-like cups.

Unlike the homes of some species, this gallery was roomy enough that the owner could turn around in it, for while she always backed out when she emerged with her load of mud, she did just the opposite when she came out for water, for then she always came out head first and dashed away. One singular feature occurred in the great majority of individuals observed; when they had used up the water, and had applied the last load of mud to the turret, they did not realize their need and fly directly out and away for more water, but re-entered the hole as usual, sometimes stayed in a few minutes and then came out head-first and flew away to the watering place. This might be due to the fact that the bee did not know that the water was gone and must have as a stimulus the experience of biting out the dry soil to arouse her inclination to go for more water. On the other hand, it might be that she entered the hole only to turn around so as to leave head-first, instead of tumbling out backwards as when she had applied her mud. The bees, when they had arrived at the water, did not alight upon the surface as do certain wasps, by spreading their legs, but landed on the soft mud on the margin, and with the long tongue protruding lapped it up. They were not bound by instinct even to go to the same place regularly for water, for one year after a rain many were seen availing themselves promptly of the temporary convenience and gathering the drops from the vegetation very near to their doors, instead of going to their customary place.

The round trip for water consumed from one-fourth to one-half minute, and the number of pellets of mud that could be carried out with each mouthful of water was interestingly varied. One bee which was watched for one hour, from 2:03 to 3:05 p.m. made twelve trips for water, and removed forty-seven balls of mud. When one considers that the mud was not only excavated, but was built into the chimney, one feels that this is a good hour's work for so small a creature. One gulletfull of water would remove 2 to 5 balls of earth, the greatest frequency being 4; this number occurred six times, five loads occurred three times, three loads twice, while in only one instance did she carry only two loads for one mouthful of water.

Another bee working from 2:03½ to 3:01 p.m. made twelve trips, and carried out 2, 1, 2, 2, 3, 5, 2, 5, 5, 2, 1, 2 loads, or thirty-two balls of earth in 57½ minutes; she was not quite as industrious as the first one. A third one also made twelve trips in the same hour, and carried out 1, 7, 2, 2, 0, 4, 3, 2, 2, 6, 2, and 2, totaling 33 loads. This is sufficient to show that there is no regularity in the number of balls removed.

I was unable to ascertain whether the entire amount of water was ejected at one time and the dirt thereby softened, or whether, as in the wasp *Odynerus geminus,* only a little water at a time was disgorged upon the spot, the mud bitten out, and then another spot moistened.

By the middle of July, I found the *Anthophora abrupta* had entirely disappeared, and some of the chimneys were dropping to the ground beneath. When these bees had completed their work, neither the chimney nor the tunnel was plugged up, and, since the former often dropped through disintegration soon after the work was completed, it seemed that they could serve no utilitarian purpose excepting during nidification. Some of the turrets were built so well that they withstood the winter, remaining intact for a year or more.

Chalcid parasites of the genus *Monodontomerus* were abundant about the bank, loitering about the holes, waiting for the provisioning to take place. They were indolent, and did not even evade when one attempted to take them in the fingers. Many of the empty pupal cases of *Anthophora abrupta* harbored several of these live chalcids. In one cocoon I found twenty living pupae of this parasite on June 28th, and since the adults were plentiful there a month earlier, the finding of the pupae at that date indicated a second generation. On June 24, 1920, several cells of this mining-bee were brought indoors. They were not examined until September 2, when several chalcid parasites emerged. To be exact, there were 109 females and 39 males from four cells, or an average of 35 to each cell. Of the other nine cells collected, three had dead larvae, five contained dried-up balls of food, and one harbored a parasitic cuckoo-bee.

The "open door policy" of this species sometimes brought its trouble too. Not infrequently an animated fight was to be seen between two females, one evidently trying to usurp the burrow that had been made by another, and often dead bees were found at the foot of the bank. Occasionally a dead one was found in the burrow, and in all probability a second mother, in appropriating the nest, cleared the dead body out with the other rubbish. Frequently, however, the fights appeared quite alarming without proving fatal. One pollen-laden mother was seen backing out of her hole with the front leg of an intruder in her mandibles. The visitor showed no fight, but resisted with all her might; at the foot of the hole, every little gain that the rightful owner made was offset by the intruder pulling her back. At last the intruder lost her hold, and as they went tumbling to the ground they engaged in a pugnacious embrace. Needless to say that the rightful owner lost most of her load of pollen, which deluged the face and head of her antagonist. Another pair was locked in deadly embrace for over twenty minutes, and there seemed no probability of their separating soon. They were so intent that they were unaware of the fact that they were being pushed into a test-tube. After five minutes more of violent struggling in this novel place, they lost their grip for a moment and separated, and when they were liberated, they both flew into the air, little disconcerted by the ordeal.

A. abrupta made nests either with or without turrets, and the turret-making activities were directly correlated with water conditions. They required water in abundance, and when it was plentiful, so too were the turrets; in droughty years they struggled on with few and small or no turrets, and their nesting activities were much reduced. If they had to struggle on with a small drop of water, they consumed much more time in mining than when they could be generous with the water and thoroughly and quickly wet the hard clay. It was pathetic to see the mother back out of her hole with a load of slightly moist soil instead of a load of wet mud;

when she attempted to work it into the turret it would crumble and fall to the ground. The size of the population, it seemed to me, was just as much regulated by the amount of water available as by the number of parasites, for in 1922, when hundreds of bees were at work and the fewest turrets were made, the official statement from the local weather bureau at St. Louis showed that the precipitation for the five months, May to September inclusive, was the least recorded in 85 years.

In another colony, in a different locality, the nests were also built without turrets, but in that case the deficiency was due to lack of clay instead of water. Here the mothers were nesting in the disentegrating mortar of an old stone chimney. Despite the fact that so little turret material was available, and no normal chimneys were made, a good many of the tunnels had a very small ring or collar at the opening.

This bee was almost contemporaneous with *A. raui* (fig. 6) ; however, interbreeding of the two species was not possible. Careful observations in 1922, showed that *A. abrupta* emerged from May 30th to June 2nd, and by June 3rd all the males were dead. *A. raui* did not appear until June 10th, a week after the males of *A. abrupta* were gone. This made it impossible for the males of *A. abrupta* to fertilize the females of *A. raui* and since the females of *A. abrupta* had already been fertilized when the *A. raui* emerged, a second fertilization was improbable. In 1929, the *A. abrupta* population waned on about July 2, and the *A. raui* about July 12.

Since *A. raui* Rohwer is a new species, reported so far only from this particular clay bank, it would be fascinating, if justifiable, to surmise that this habitat is the cradle of the species, an offshoot from *A. abrupta*.

We may cite for comparison some observations on other species of this genus in various localities by different investigators.

Sharp[1] says *Anthophora* is one of the most extensive and widely distributed of the genera of bees. He also points out that Friese has made the discovery that *A. personata*[2] at

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[1] Insects. Pt. II, p. 33, 1899.

[2] *A. personata* is now called *A. fulvitarsis* Brulle. (fide T. D. A. Cockerell).

Strasburg takes two years to accomplish the life cycle of one generation. "Some of the species make burrows in cliffs and form large colonies which are continued for many years in the same locality."

Say, in referring to the habits of European *A. parietina,* says that this species digs a hole in a clay bank and that the entrance consists of a cylinder extending downward more than an inch in length and made of small pellets of earth compacted together, rough on the exterior and smooth within.

Hungerford and Williams[1] made note of the nesting habits of *A. occidentalis,* which they call the "larger tube-building cliff bee." The method of nest-building is very similar to that described for *A. abrupta,* for they say: "Their tunnels are 3/8 inch in diameter and extend into the bank about eight inches where they end in several cells. The cells . . are so made that when dug out they come from the gallery as separated urn-shaped nodules of uniform size. The entrance of the tunnel is protected by a curved tube from 3/4 to 2 inches in length. The tubes bend downwards and very often the top or outer curve is split longitudinally." In view of the fact that *Hornia minutifennis* Riley was found to be parasitic on the members of the Wickes colony, it is interesting to learn that these students discovered a new species of beetle, *Hornia gigantea,* parasitic upon *A. occidentalis.*

Frison has discovered a colony of *A. abrupta* near Oakwood, Illinois, and in an interesting paper[2] gives many details of the life history of this species. He finds them nesting in a clay bank, carrying water for mining operations, and on the whole conducting themselves in every way like the bees at our clay bank. His paper includes a valuable review of the American species of *Anthophora.*

Walsh found this species making burrows in the mortar in brick work, and also in the face of a precipitous clay bank. In California, *A. stanfordiana* shows a similar preference for nesting in a steeply inclined surface. They build chimneys over the entrances of their burrows.

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[1] Ent. News. 23:258 1912.
[2] Trans. Amer. Ent. Soc. 48: 137-156. 1922.

Latter[1] mentions that *A. pallipes* is abundant in England, and "make their nests in firm banks of sand or clay, if not too wet; their burrows do not extend very deep and contain one or more cells whose outer wall is made very hard, by a cement of sand or clay applied by the female bee after she has completed the commissariat arrangements." We assume that *A. pallipes* does not build turrets at the opening of their nests, for if they do so, it is quite unlikely that so keen an observer would have failed to mention the fact. The same gregarious condition that has been recorded for other species of Anthophora exists in this species, for the author goes on to say that numbers of Anthophora live in the same bank, and on a warm April morning the scene at such a spot is most lively; females are to be seen entering or leaving the burrows intent on business or possibly engaged in a headlong flirtation with males in front of the bank.

Bouvier[2] calls attention to a most interesting point in the behavior of *Anthophora* wherein a species with solitary habits assumes under certain circumstances an attitude ordinarily displayed by social bees, or we might say a step in the evolution from a solitary to a social state. He says that when it is necessary to struggle for the common defense, the European *Anthophora* of the walls becomes singularly aggressive. "Established in sandy, argillaceous soil which it perforates with tubular galleries, this bee comes out in war-like swarms every time one approaches the colonies. Buttel-Reepen relates the misadventure of an entomologist who was pursued a long time by one of these swarms after a badly executed swing of his net; and Friese reports that he himself was attacked for having tried to collect on the walls of a barn where thousands of Anthophora had their nests."

These European Anthophora have, according to this, progressed in their behavior further toward socialization than the American *A. abrupta* and *A. raui.* Here at various times I sat among their nests for days at a time, and these bees did not at any time show a concerted attack, as described

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[1] Bees and Wasps, p. 74. 1913.

[2] Psychic Life of Insects, p. 317. 1922.

above. One may even swing the net or otherwise disturb them or even handle them with impunity. They possess stings, but they seem not to know how to use them when taken in the fingers.[1] Thus we see that our American *Anthophora*, while gregarious, are very primitive in the scale of socialization.

The White-banded Bee, *Entechnia taurea* Say (J. C. Crawford)[2]

While the mining-bee *Anthophora abrupta*, would build only horizontally in the face of the clay bank in the bright sunlight, the species now considered, her nearest neighbor, whose nesting-habits were in general very similar, built vertical burrows in the top of the bank. Sunlight was not a factor in their choice of a site, for most of their burrows were far back in the shadow of the porch where the amount of light was much reduced.


Fig. 5. *Anthophora abrupta.*

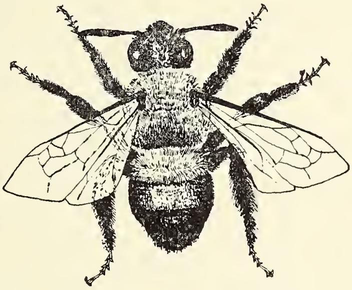
Fig. 6. *Anthophora raui.*

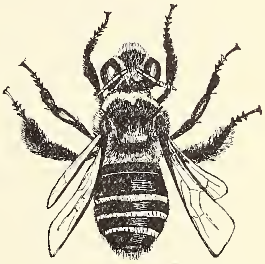
Fig. 7. *Entechnia taurea.*

These white-banded mining bees, *Entechnia taurea* (fig. 7) worked energetically through a much longer season than the *Anthophora* bees. They were out and buzzing about the holes in the clay bank as early as July 12th, 1917, and a few were still to be seen on October 3rd, although many dead

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[1] Many of these bees were taken in the fingers and marked before being taken on homing flights (Journal Comp. Psychology, pp. 35-70. 1929) but they never retaliated with a sting.

[2] This identification was verified by Mr. S. A. Rohwer, who calls it *(Entechnia) Melitoma taurea.*

ones then lay about, which showed that their season was practically over, and the remaining few had not long to live.

The first of the bees were active on the clay bank (fig. 2) on July 12th; by the 16th, about twenty-five were present in a state of agitation but doing nothing definite; most of them were in a group at the extreme south end of the bank. Occasionally some of them would get into the empty holes and quietly remain there, but the great majority spent their time buzzing and fussing about one another, often quarreling. One shallow burrow and its occupant attracted particular attention; the bee was within with its head to the wall and the tip of its abdomen near the orifice. This bee was the object of much conflict; often five or six bees would crowd about the opening and attempt to drag it out by main force; when one would attempt to get the inmate out, and had partially succeeded, then two or three would actually fight furiously in the doorway to get its place in the cell. They would grasp one another by the legs, and often a pair locked in combat would roll down the embankment and struggle in battle on the ground, holding a tight grip of one another's legs with their mandibles. Sometimes the one in possession

Fig. 8. A view in profile of the turrets made by *Anthophora abrupta.*

FIG. 9

FIG. 10

Fig. 9. The turrets of the white-banded bee, *Entechnia taurea* indicated by letter "E." The two arrows point to the upturned turrets of *Anthophora raui*.

Fig. 10. The upturned turrets of *Anthophora raui*. A wad of cotton is placed in the opening of some of the turrets to show their upturned position.

of the burrow would come out and fight with the intruder.[1] On one occasion the occupant grabbed the leg of the intruder in its mandibles and held on so tenaciously that the bee in attempting to pull the leg away, dragged the occupant a great distance from the hole, thus giving opportunity to a bee nearby to enter and take possession of the coveted place. Often throughout the conflict the legs were gripped so fiercely in the mandibles that I thought surely they would be snipped off, but this never happened.

After capturing many of the bees, I ascertained, by the absence of pollen baskets, that they were males, and I promptly wondered if they did not crowd around certain burrows that were about to give forth members of the opposite sex. There was one hole in particular about which they crowded thus in clamorous competition, so I decided to open the burrow with my knife. The contestants, however, were not to be pushed aside; they persisted there, even though the blade nearly severed them, and excitedly buzzed about the tool; it seemed they could scent the female within, and could not be driven from the spot. Again and again I tried to penetrate the mass to remove the few little clods of dirt which hid the secret prize, but it could not be done without dismembering the bees. Another cocoon was unearthed elsewhere in the bank, however, and with a knife it was carefully opened; within was a bee, fully developed but all wet and soggy and with wings uninflated. It was in my forceps but a few seconds before a half a dozen males were clinging to it, displaying every evidence of a great eagerness to mate. The excitement continued for some minutes, when one male and this immature one succeeded in making their escape.

Since at the beginning of the season only one female was seen at work burrowing, and some twenty-five males were about, it appears that in this species, as in many other cases of the insect world, the males enjoy a priority of emergence, and await the coming of the females.

[1] I do not know whether or not they used their stings on one another; when females were taken in the fingers, they did not hesitate to use the sting freely. The pain, however, was not severe, lasting only a few minutes. In this they differed from *Anthophora abrupta*.

Following these first busy days, the population of *Entechnia taurea* seemed to disperse, for on several occasions during the remainder of July, only a few at a time were seen about the place. They, of course, were females, busily coming and going about the burrows they were rapidly digging and the clay chimneys which they were building over them. A few males were there too. The bees were divided into two groups, one at either end of the bank, while the center which bore an abundance of old burrows of *Anthophora*, had no bees. Enormous numbers of parasites lurked about this portion, which would indicate that only those at the extreme ends had escaped their ravages. At the north end, some half dozen males were playfully buzzing about, keeping strictly to the confines of their own

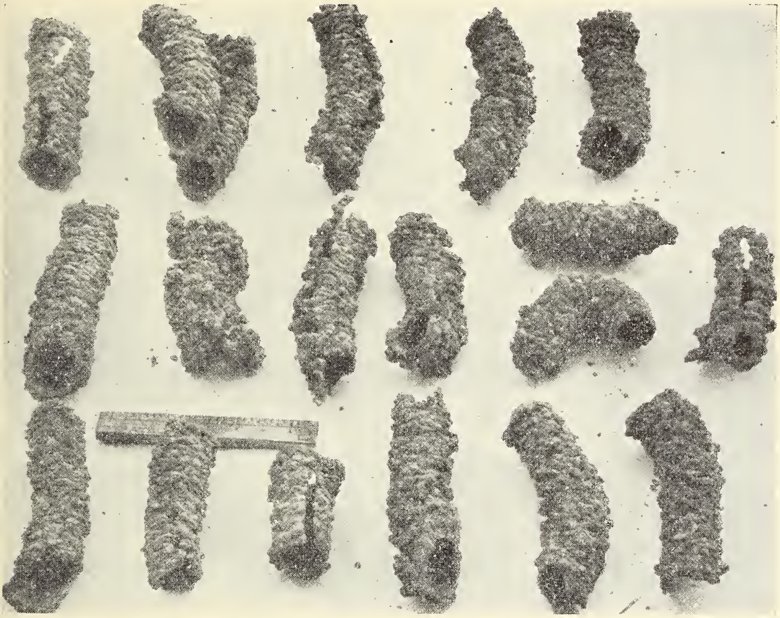

Fig. 11. A collection of turrets of *Anthophora abrupta* to show details of construction.

neighborhood. Moreover there were then in this immediate area no females, nor were any nests in construction. This was conspicuously different from the south end, where activities were occurring, in small numbers to be sure, but further advanced, since there the males had departed and the females were nesting. This playfulness of the males at the north end seemed to be merely a repetition of the male frolics at the south end some ten days before.

A visit to the bank on August 14th showed that the females and their burrows were becoming more numerous. At the south end, the males were again in abundance, buzzing, flying, dancing about and repeating the performance of leg-pulling and leg-biting. The females were still burrowing in the top surface of the bank; none had as yet gone into its vertical face. Few of the females would work after the sun had left the bank at about noon, and the males too were most active in the sunlight.

The method of digging and building was in most of its details similar to that of *Anthophora abrupta,* previously described. The *Entechnia taurea* female carried water with which to moisten the clay before she bit off a mouthful. One mother was observed to begin her burrow at 11 a.m. She stood on her head in a vertical position, with the abdomen waving in the air, and worked the soil, often leaving the work to go for water. At 2:30 p.m. the hole went down to a considerable depth, and over its top was a little turret about three-fourths inch in length. There was much loose, wet soil about and under this turret, showing that not all of the mud carried out had gone into the tube. The bee was at work within, and every few seconds she appeared walking backwards and pushing up a pile of moist, fine-cut soil. Many turrets had beneath them a similar accumulation of clay which had been dumped out of the burrow, (fig. 9E) so that one may say that only the portions first removed go into making the chimney, and the remainder of the clay that comes out of the burrow is loosely pushed out.

One mother had been busily occupied at nest building for three hours, when suddenly a male appeared upon the scene, hovering over her. Quick as a flash she quit her work, and her precipitous haste in attempting to clean herself and primp (this female rubbed the powdery dust off) was really uproarously funny; but little details of appearance seemed to make no difference to him, and he urged his attentions without delay. Immediately after their separation a half minute later, she went into the hole and the male followed. Soon both came out; then they went in again as though prospecting, she leading and he following her all the time. After a few minutes, both came out, danced and fluttered about each other before her doorway for two minutes, then she went back to her work and he continued the dance for many minutes before the burrow, during all the time going no more than two feet away.

At the rear of the house on its west side was another clay embankment, of similar soil, but not protected by a porch, and neither did it receive the morning sun. No bees were burrowing there, but the area bore many plants of bindweed, with the large white morning-glory-like flowers. Here the females sought pollen, and on one autumn day, when only six blossoms were open, each flower was occupied by an idle male, while dozens of others were trying to find places. They would most persistently sit within the cup for hours at a time, and would bob up and fight away any bee that attempted to enter. All that I examined were males. The only explanation that I can think of to justify such conduct is that they were lying in wait here for the females. Yet I cannot have full confidence in even this supposition, for on a few occasions I saw these dogs-in-the-manger fight away even the females who came in earnest quest of pollen. The same leg-pulling behavior that was seen on the clay bank was practiced within the blossoms whenever a second male attempted to usurp the place of the first. When the males entered the flowers they did so head first and then turned themselves around and faced the outside, so they could watch what was going on out in the world. It will be noted that while the length of life of adult males of the two species of Anthophora bees is only a few days, in *E. taurea* the males live all summer.

When the females came in from the fields pollen-laden, it appeared at first that they carried the pollen under the abdomen, with great masses bulging out at the sides and back. In reality, however, the pollen-baskets were overflowing, and masses of pollen adhered to the underside of the body, while the legs were held close to the body, probably holding the abdominal masses in place, with the result that the little bee had the appearance of being very fully laden indeed.

Up to August 20th, most of the white-banded bees were still making their burrows and chimneys on the surface plane, and only about ten per cent of them were beginning to dig into the vertical face of the bank. In the case of this species, probably as soon as one nest was completed another was begun.

Most of the turrets made by this species (figs. 9E and 13) had a longitudinal split extending almost the full length of the upper side along its center. The purpose of this, as well as the purpose of the whole chimney, has often puzzled me. I have wondered whether the cause of this was mechanical or psychological, but after having observed the method of making the chimney, I have concluded that the opening along the middle of the chimney may be accounted for as mechanical. The bee backs out with a large ball of mud under her throat; with the forelegs she divides this load in half and passes one portion backward under the body until it reaches the tip of the abdomen. This is applied to the edge of the turret, commencing at the bottom and working toward the top. This amount of wet clay is usually about enough to make half a ring. Then likewise the second half is passed beneath the body to the rear legs, the bee begins at the bottom again, joins this wet mass to the end of the first half of the ring and works upward in the opposite direction, perhaps with the intention of completing the ring, but rarely doing so. Since the second portion does not quite reach the first, there is a discrepancy, and the result is that layer after layer of this leaves an open groove on the top of the turret. It is possible that this is done purposely, and that the insect could just as easily carry out a little more mud or stretch what she has so as to complete the circle if she wished to do so. It may be that it is of advantage to build the nest so that it will admit the light, and this peculiarity of construction has become a habit. It is very pretty

Fig. 12. (Above) A clump of earth containing cells of *Anthophora abrupta* (¾ natural size).

Fig. 13. (Below) The turrets of the white-banded bee *Entechnia taurea* (slightly enlarged).

to see the bee's abdomen extending just beyond the last ring of the turret, and then applying the two portions of mud deftly to the last layer. She cannot see what she is doing, since during this work her head is always inside the chimney.

Fig. 14. An uprooted tree, both sides of which contained nests of *Entechnia taurea*.

Since I wished not to demolish the bank, I opened only a few burrows. The first consisted of a gallery one inch in length, terminating in a pocket in which were two neat, thimble-shaped cells.[1] One of these was sealed; when opened, it was found to be crammed full of white pollen (or perhaps bee-bread, since part of it was moist and might have been mixed with nectar or water), and on a dry portion of the mass and securely attached to it was the elongated egg. The lower cell contained the same. The lower part of the mass of bee-bread was very moist and soggy, while the

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[1] These cells were not made by merely partitioning the tunnel, but each was a solid mud cup built inside the burrow and snugly fitted into it. When these nests were opened the surrounding earth could merely be picked off leaving a complete cup as illustrated in Fig. 15.

upper part was dry, powdery pollen. There were also many drops of moisture condensed on the walls of this cell. Whether the pollen had been put in dry, and the moisture that we found in the cell was due to nectar or water which the mother may have added, or whether the pollen was moist and the moisture which I found upon opening the cell was that which had come out of the pollen and condensed on the walls, is matter for conjecture.

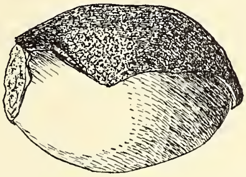

Fig. 15. The brood cup of *E. taurea,* with the mud wall cut away to show the intact papery lining.

Another nest was opened which had a three-and-one-half inch gallery leading down to the cell. This cell was half filled with pollen, and the bee itself was within, with her pollen baskets full to overflowing. The nest was obviously far from complete. These bees do not seal the mouth of the turret; neither do they seal the burrow at the surface of the ground, but leave it open its full length. The cells at the bottom are sealed securely enough to afford sufficient protection when they are hidden within the tunnels chiseled out of the hard clay. Sometimes one does find one of these turrets sealed, but this work is done by a *Trypoxylon* wasp which takes possession of the place for her own nest.

These white-banded bees varnished the interior of their brood-cups with some waterproof substance, as did the two species of *Anthophora;* but these supplied an added protection to the young bees, in the form of a thin, papery wall which completely lined the cells. While it is brittle, it is strong enough that one may pick away the mud from the outside and leave this lining intact, as shown in fig. 15. At first I thought that this lining had been placed there by the mother, but since those cells in which the eggs had failed to hatch did not have this lining, it seemed reasonable to attribute it to the work of the larvae. An examination of this material under the microscope does not show a structure of spun silk; hence it is probably made of the contents of the alimentary tract, which are completely emptied at the time of pupation. It is a known fact that in certain aculeate Hymenoptera, the excrementary material of the larva is retained until pupation time when it is emptied and fashioned into a cocoon. Here in the white-banded bee is a similar condition, with the slight change of using the material for caulking purposes instead of cocooning.

That *Entechnia taurea* attains gregariousness is due just as much to the fact that the clay bank is protected as to their community instincts. In 1917 I noticed a sickly colony in a clay bluff about one-quarter mile south of the bank. These burrows went horizontally into the bank at a road, and had no protection from the weather. Only three turrets and their builders were seen. This colony did not become established, and in 1918 no progeny were there. In 1918, two turrets were found at the side of a foot-path on a hilltop in the shade of an old oak. In the same season, the dirt about the base of an uprooted tree at a point about fifteen miles distant from the bank had twelve turrets of this species. The knotty roots served as protection from the weather, so the colony there was able to grow. The fact that the bees of the Wickes clay bank became colonized under the protection of the porch is no mere accident, but the following notes made at various distant localities, show that the habit of seeking protected places is general for this species, or, to put the explanation in other words, those bees which nest in sheltered areas grow into colonies and those which do not, either they or their progeny fall victim to the elements, landslides, etc.

At Keys Summit, Mo., a clay embankment by the roadside and facing the western sun, had forty or fifty of these turret-topped nests, penetrating the slope horizontally, scattered along the slope for about a hundred and fifty yards. This bank was about ten feet high, and some vegetation and a few trees were growing there whose roots held the earth firm and made protecting niches in the bank. All of these nests were found in the protected spots, and none in the exposed portions. One can readily see how landslides or rain would demolish the work of these little builders, and do damage to their tunnels as well. Three small colonies were seen, also, in roadside banks in situations similar to the above except that the soil was crumbly and exposed. Much of their work has been lost; they did not become established in these exposed sites. Others were seen at Wesco, one hundred twenty miles southwest of St. Louis. Some were in banks, others in level ground, and in three different places they had chosen for their home-site the soil in the roots of some trees which had been torn up by a tornado three years previously. Here again they enjoyed the protection of the roots, and throve. One of them (fig. 14) had twenty-five nests on one side of the base of the upturned tree, and thirty on the opposite side.

The colony of bees during the five years, had decreased in size. In 1922 about forty members were building and two-thirds of them were far back on top of the clay bank where the darkness was indeed conspicuous; the turrets were pointing in every direction. During this same period its neighbor *Anthophora abrupta* had reached great proportions. The causes for the rise of one species and the decline of the other, are fully discussed in the St. Louis Academy of Science paper already referred to.

A DISCUSSION OF HUMAN AND INSECT SOCIETIES

By Milton F. Crowell

In considering insect and human societies together we face several problems. 1. What is a society? 2. By what methods do insects and men solve the problems of a social life? 3. Is there any reason to believe that, if human and insect societies differ, they may, eventually, evolve into the same type?

To define a society in terms that will permit the inclusion of both insects and men, and exclude animals not usually regarded as social, is well-nigh impossible, but the following definition is suggested: A society is a group of organisms of the same species in which specific survival is dependent upon association in a group; the characteristics of the group as a unit differ from those arising as a mere sum of its individual parts; the functions of the group necessary for its existence, therefore necessary for the survival of the species, are carried out by a division of labor among the individuals of the group; the successful carrying out of these functions is dependent upon the ability of the group to exploit a given area, or trophoporic field. As a corollary to this definition, implied, but not specifically stated in it, a society must be self-perpetuating.

The problems of social life are contained in definition of society, and they over-lap.

1. The creation of the group.

2. The maintenance of the group.
   a. The re-creation of the group.
   b. Provision of food and shelter.
      (1). Exploitation of the trophoporic field.
   c. Defence of the group.

3. The perpetration of the group.
    a. Dependent upon the effectiveness with which the group is maintained.

In neither man nor insects can we speak of the creation of the group in the strict sense. The groups, or societies, are being constantly re-created, or perpetuated. In the insect society perhaps, we come nearer to society creation, for, regarding each colony as a separate society, it is begun, in the termites, when a male and female start a new nest; in the ants, when, by various methods, a fertilized female succeeds in founding a colony, and in the bees, when a swarm occurs. But in most instances, even here, there is a mixing of colonies, since in the nuptial flights of social insects a certain amount of cross-breeding takes place, i.e., between males and females of different colonies, so we can, to a certain extent, regard insect society as being much broader than the single colony.

The problems of maintenance and perpetuation are, to a great degree, the same. In order to provide food and shelter there must be a sufficient number of individuals to carry out the work of provision. In order to have a sufficient number of individuals to provide for the group, food and shelter must be efficiently supplied. Since both the production of offspring and the provision of food are necessary to maintain a society it is fruitless to discuss which is the more important.

In reproduction we find that there are two general methods found in the various types of societies. Both are effective, and each is apparently the best for the society in which it is found. There may be developed a special machinery for reproduction, i.e., a reproductive caste, whose contribution to the community is solely offspring. Or we may have no special reproductive caste, but the production of a few offspring by each, (or as is actually the case, by most), of the group units. (Group units, in speaking of reproduction in higher animals, are obviously not individuals, but are composed of two individuals of the opposite sex.)

The first type produces numerous large families which, to a great extent, form separate homogeneous societies. The second type produces a looser heterogeneous society of which separate families are but the basic units. The insect society depends upon large numbers of offspring produced by individual females; the human society depends upon a large number of females producing few offsprings. This distinction is primarily biological, hence fundamental.

There are two ways in which large numbers of offspring can be produced by a single female. One is by the over-development of the ovaries, and the laying of a great number of eggs. (Queen of *Termes bellicosus;* "she has laid an egg every three minutes for the past four years," Wheeler, 1928, a total of almost a million)[1]; the queen honey-bee, *Apis mellifica,* lays about 3500 eggs a day for several weeks at the height of the breeding season, Langstroth, 1909. The second is by polyembryony, or the development of several offspring from the same egg. This is found in a number of the higher hymenoptera. *(Aphelopus theliae,* whose single egg produces 40-60 offspring, according to Kornhauser, 1919; *Copsidosoma gelechiae, Paracopidosomopis floridanus, Platygaster sp.,* the first with over 300, the second averaging over 1000, and the last 5-36 offspring, which Patterson, 1919, believes may develop from single eggs.)

The method of foetal development in the placental mammals makes impossible the production of offspring in great numbers by a single female. Both the limits of space, (the size of the uterus,) and the limits of time, (length of life compared with time necessary for foetal development), place decided limits to the possible number of offspring. So it seems clear that, basically, human and insect societies can never be physically homologous.

In solving the problems of maintenance by the provision of food and shelter both human and insect societies exploit a trophoporic field. This field is the actual territorial area

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[1] E. Hegh, 1922, in "Les Termites," says of *T. bellicosus,* "qui, d'apres Smeathman et Escherich, serait d'au moins trente mille par jour, soit dix millions par an et cent millions pour la duree probable de la vie de la reine." I do not understand this disagreement of authorities, but an egg every three minutes is 20 an hour, and thus only 480 a day. In either case, a large number of eggs is laid.

which supplies the raw materials of food and shelter building. While there is a fundamental difference between the methods used by men and insects to re-create the group, the methods used by each to exploit the trophoporic field do not differ fundamentally. There are two methods used: the actual collection from the field of the materials needed (in the insects by foraging for what can be found), by development, as the growth of fungi and the "domestication" of aphids by ants; in man, foraging, (not common), and development, (farming, mining, etc.), and the taking by force of the materials collected by other groups. The second method is dependent upon the first, and is essentially non-social when it means the exploitation of parts of a society by other parts. Of course, one society may legitimately become a part of the trophoporic field of another, as the keeping of bees by man, or the eating of a library by termites. (There is no reason, from a termite point of view, for respecting the possessions of man). And in each society, human and insect, the exploitation of the trophoporic field is possible only by labor on the part of the individuals of the society.

Since the many activities necessary for efficient production can be carried out best by a specialization for particular tasks among the members of a society we find that there is a division of labor developed by both insects and men. The first most fundamental division of labor is, of course, the development of sex. This is found in both groups. But, as pointed out before, the insects have developed a special caste that does nothing but reproduce, while man has not. In the exploitation of the trophoric field, too, the insects have developed a caste, which has, to a great degree, lost its ability to reproduce, the worker caste. This sterile caste does all of the labor necessary for producing food, building the nest (except in the case of some insects where the primal sexual pair, or a single fertilized female, initiates the work of nest building), caring for the reproductive caste (whose children they are), and caring for the new brood (their brothers and sisters). This division of labor has brought about an actual structural difference between the reproductive and worker castes, and in many instances, specialization to tasks performed has caused the development of structural differences among the workers themselves. This is termed polymorphism.

The differentiation of sexes is a form of polymorphism, and it would be admissible to speak of a male and a female caste, but that is as far as caste and polymorphism in any way homologous to that of insects has been carried in man. Since in a society which is based upon a grouping of small families[1] the production of offspring falls upon all, it follows that in order to maintain and perpetuate the society there cannot be present in it a large percentage of sterile individuals. Also, in that type of society, there cannot be any great degree of polymorphism, for the forming of numerous families implies the necessity for a wide range of possibility to mate. There is also the implication that any member of this society shall be able to carry on any function of the group. This may not seem evident at first glance, but human society is a conglomeration of numerous small societies, i. e., families, and because of the type of foetal development in the placental animals, and the period after birth during which the young are dependent, the maintenance of the family falls upon the adult members, and they cannot become so specialized that they cannot perform any one of the functions necessary for maintenance. Hence, if they must remain generalized with regard to the family, they must remain generalized with regard to society, which is but a group of families. (This refers only to morphological specialization). Therefore it follows that the division of labor in the exploitation of the trophoporic field is, in man, brought about in a manner fundamentally different from that of the insects. It is not a specialization, in the biological sense, but is a development of one or more generalized abilities possessed in varying degrees by all members of the group. Therefore the laboring class, the

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[1] The human family, no matter how large it may be, is, of course, a small one. This is evident when we consider that, at the utmost, one woman could bear only about 30 children, while a family of social insects may number well over a million individuals all produced by one female.

capitalistic class, and the castes of India, are not homologous to the castes of insects.

There are at least two classes of human beings that might be considered as being somewhat analogues to the workers of the termites, or higher ants: the priests of many religions, and the eunuchs of Eastern countries. The priest, in so far as he represents a sterile class, sterile through voluntary celibacy, is an example of a non-reproducing individual laboring for the good of the organization to which he belongs. (Not necessarily for the good of society). The eunuch is functionally sterile, and thus approaches nearer an analogy to the insect worker. And if the interpretation of polymorphism of the social insects which holds that the differentiation of the castes is caused by giving different food to the larvae that are destined to develop into different forms be correct, the difference between the ennuch of the harem and the worker insect becomes still less. Both are then products of a deliberate castration, whether it be a reasoning and purposive act, or a blind instinctive reaction governed by the needs of the insect colony.

But the likness of the priest and eunuch to the worker insect is more apparent than real. Although the priest may be socially sterile he is not functionally so, and he is not morphologically set apart for the performance of certain duties. And while the eunuch is, of course, sterile, his sterility is not the result of the necessity of society to have a group of workers who will have their labors uninterrupted by the functions of reproduction, but is to prevent his having sexual connection with the women of his master's household.

While the exploitation of the trophoporic field by a society requires many laborers, and the problem has been solved in man and in insects by two methods of reproduction (a great number of offspring produced by one female, and a great number of females each producing a few offspring) man has added a second method of producing workers, that is by the invention and development of machinery. The machine either greatly increases the efficiency of the individual worker, or greatly multiplies him by doing what many men would be required to do. In being sterile, (physiologically), and in being able to accomplish only a special task, the machine is nearer to the insect worker than is any class of men. Genetically, of course, it is not even analogous to the insect. The introduction of the machine, on the one hand, and the development of the highly specialized worker on the other, has forced both men and insects to face the problem of what to do with individuals that the machine, or the accomplishment of a special function, has deprived of work. The insects have solved it. When the work of the specialists is done they are slaughtered. When the introduction of a new machine deprives a number of men of work . . . the problem has not been solved.

Besides maintenance by the exploitation of the trophoporic field the society must be maintained against destruction by the elements, broadly, climate, and destruction by other societies, sub-groups of itself, (nations, different colonies), and against the attacks of other organisms, (beasts of prey, disease germs, etc.).

The primary method of defense is flight; next comes the building of shelters. The ants and termites construct caverns, the wasps build houses, i. e., paper nests, etc. Man's shelters differ little fundamentally from those of insects. Advantage is taken of natural shelters, caves, comparable to the use of hollow trees by bees, or houses are built, comparable to wasps' nests. Shelters are employed as a means of defense against all types of attack.

A more active method found in both insect and men is the development of special classes for defensive purposes, "soldiers" in the ants, termites; soldiers, policemen, etc., in human society. There is the same distinction between the human soldier and the insect soldier that is found between the human worker and the insect worker. One is a specialized organism, the other is a generalized organism in which certain abilities are specialized. An insect soldier can be only a soldier, really a specialized worker, but a human soldier may be a soldier temporarily, and is not forced by his morphology to be one whether or no.

The last problem of a society, and perhaps the first, perpetuation has already been discussed. Its successful accomplishment depends entirely upon the success with which the group is maintained.

The possibility of the insect and human types of society becoming identical was the third question asked at the beginning. The two societies face the same problems, and in some instances their methods of solution are the same. But in the development of the means by which these methods are carried out the two societies are different. In the discussion of the methods by which the two societies are re-created, and the workers developed, the points of difference were stated. And there it was brought out that the two types of society are not homologous. The fundamental difference, and one which is insurmountable, is the difference between the Hexapods and the Placentalia.

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A JURASSIC NEUROPTERAN FROM THE LITHOGRAPHIC LIMESTONE OF BAVARIA.[1]

By F. M. Carpenter

In the Hagen collection of fossil insects at the Museum of Comparative Zoölogy there are a number of Neuropteroides from the lithographic limestone of Solenhofen, Bavaria. Most of these insects were adequately described by Hagen in his several papers on the neuropteroid fauna of this formation, but some of them were dismissed with only a few words or were not described at all, so that their exact affinities have been uncertain. Among these incompletely described fossils there is one which is especially striking, because of its excellent preservation and its affinities with certain recent genera. Since Mesozoic Neuroptera are very rare, it seems advisable to describe this fossil with the completeness it deserves.

The insect is a true Neuropteran (Planipennia) and is the specimen to which Hagen applied the name *Nymphes fossilis* in his *Neuropteren aus dem lithographischen Schiefer in Bayern* (1862). Except for the mere statement that the fossil was an excellent one, no description or figure was given, so that Hagen's name for the insect has no standing. Handlirsch did not examine this specimen during the preparation of his comprehensive account of fossil insects, and was obliged to ignore it. The other Neuroptera of the lithographic limestone have been treated by several authors in general accounts of the Solenhofen insects. Eighteen recognizable species have been described, although it is probable that some of these are synonymous. Handlirsch's division of the species into families is largely artificial and unsatisfactory, but a dependable classification can be made

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 322.

only after a study of the type specimens. It is quite obvious, however, that insects related to the recent *Hemerobiidae* and *Myrmeliontidae* are present, as well as others more remote from these families. One of the genera, *Nymphites* Hasse (1890,) seems to be closely related to the recent Australian genus *Nymphes*, as observed by Hasse. The Jurassic genus differs from *Nymphes* by the possession of a branched media in the fore wing and a much smaller number of cross-veins. A second genus, *Sialium* Westwood (1854), was based upon a species apparently somewhat similar to *Nymphites*, but the type specimen is so poorly preserved that its exact affinities cannot be determined.[1] Hagen's "Nymphes fossilis", although undoubtedly belonging to a new genus, is so closely related to *Nymphites* that I can see no reason to exclude it from the family *Nymphitidae*.

Family *Nymphitidae*.

Mesonymphes, new genus.

Allied to *Nymphes* and *Nymphites*. Wings slender, pointed, with a number of cross-veins in the costal space and in the subcostal area, between R1 and Sc. Sc close to R1; R1 bent downward distally; Rs with 13 branches in the fore wing, and 11 in the hind wing; media joined to the stem of the radius a little basad of the origin of Rs; M branched in the fore wing, the branches diverging close to the base of the wing; M unbranched in the hind wing; Cu1 without a basal branch; Cu2 a well-developed vein, sending a large series of short terminal branches to the hind margin of the wing; 3 anal veins in the fore wing. The hind wing has a narrower costal space, a smaller anal area, and is somewhat shorter than the fore wing. Cross-veins much less numerous than in *Nymphes*.

Genotype: *Mesonymphes hageni*, n. sp.

(Figure 1.)

Length of fore wing (estimated), 4.0 cm.; hind wing, 3.6 cm. Width of fore wing, 1.0 cm.; hind wing, 9 cm. Anterior

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[1] Scudder even placed it within the Blattidae (Mem. Bost. Soc. N. H. 3:472, 1886).

margin of wing straight or nearly so, posterior margin regularly convex, the wing being broadest at about the middle; the costal space is much broader distally, so that the termination of R1 is very remote from the apex of the wing; area between Sc and R1 with 4 or 5 cross-veins; R1 distinctly curved backward at its distal end; Rs and M diverging from R close together; space between R1 and Rs with less than 10 cross-veins; between the basal branches of Rs there are numerous cross-veins, but there are apparently none at all between the distal branches; Cu1 long and straight, with seven irregular distal branches; Cu2 is much more strongly developed, with eleven branches; 1A forked in both wings; cross-veins present between Cu1 and Cu2. The specimen has the left fore and hind wings well apart; the right wings are folded together, so that the veins are indistinguishable. The body is slender, being 30 mm. long, and 3 mm. wide; no details of the head are preserved.

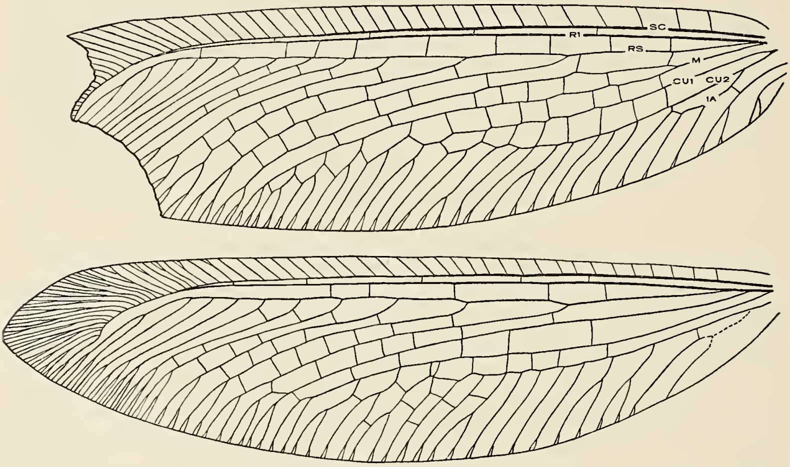

Fig. 1 Venation of fore end hind wings of *Mesonymphes hageni*, n. sp. Sc, subcosta; Rl, radius proper; Rs, radial sector; M, media; Cul and Cu2, branches of cubitus; 1A, first anal.

Holotype: no. 1999 Museum of Comparative Zoölogy. On the back of this specimen, in German script and in Hagen's characteristic writing: "Nymphes verwandt, herrlich!", and also printed on a label, which has been pasted to the rock: "Nymphes fossilis Hagen. Paleont. X. P. 108 No. 36. Type. Solenhofen, Dr. Krantz."

The generic affinities of *Mesonymphes* are quite obvious. From *Nymphites* it differs by the possession of an unbranched media in the fore wing, by a more pronounced development of the costal space towards the apex of the wing, by the more specialized termination of R1, and especially in the degree of development of Cu2. In the structure of the first three of these features the venation approaches that of *Nymphes* itself, but the cubitus is decidedly different. Cu1 of *Mesonymphes* sends off only seven branches while Cu2 gives rise to eleven; in *Nymphes* there are 8 branches leading from Cu1, and only 5 from Cu2. There is a close resemblance of *Mesonymphes* to the Myiodactylid genus *Osmylops*, which inhabits parts of Australia.[1] The costal area is much broader in the recent genus and the terminations of Sc and R1 are somewhat different, but the structure of the cubitus in the fore wing is quite the same in both genera. Martynov has described a related Neuropteran from the Jurassic beds of Turkestan (1927), but this fossil has closer affinities with the *Hemerobiidae* than with the *Nymphitidae.*

The modern aspect of *Mesonymphes* is of unusual interest. If a Neuropteran with the venational characteristics of *Mesonymphes* were found in the tropics at the present time, it would probably not arouse much comment. The only feature of this insect which is more primitive than that of *Nymphes* is the small number of cross-veins. For although Martynov in his description of the Turkestan form claims that the original ancestral condition of the Myrmeleontid types was characterized by a larger number of cross-veins, which have decreased from the Jurassic to the present, this conception is contrary to all the evidence that has been accumulated on the evolution of the order.

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[1] I do not accept Tillyard's interpretation of the venation of this genus, as explained in his "Insects of Australia and New Zealand" (p. 321, and fig. U16). The vein which he has labeled M3+4, being strongly *convex*, is Cu1, and his Cu1, being strongly *concave*, is Cu2.

Tillyard, in his Panorpoid Complex, concluded from a study of recent and fossil Neuroptera that the ancestral and primitive forms of the order possessed only a few, widely-spaced cross-veins, and nothing has subsequently been found to refute his view. This small number of cross-veins is the only characteristic of *Nesonymphes* which is not found in *Nymphes* or closely related genera now existing in the tropics.

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ECOLOGICAL OBSERVATIONS UPON THE MYRMECOCOLES OF *FORMICA ULKEI* EMERY, ESPECIALLY *LEPTINUS TESTACEUS* MUELLER[1]

By Orlando Park,

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

The Ecological Status of *Leptinus testaceus*.

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

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

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

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

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

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

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

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

Leptinus testaceus and other Coleoptera in nests of *Formica ulkei.*

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

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

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

TABLE I. Myrmecocoles of *Formica ulkei* Emery.

HOMOPTERA

Cicadellidae

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

NEUROPTERA

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

DIPTERA

Syrphidae

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

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

COLEOPTERA

Carabidae

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

5. Two small carabid larvae were taken from the lower dome galleries, one at Palos (August 16, 1929) and one at Palatine (August 6, 1929).

Staphylinidae

6. *Megastilicus formicarius* Casey. Palos: August 4, 1929. It is interesting to note a further parallel in the myrmecocoles of *ulkei* and *exsectoides,* this staphylinid being reported from nests of the latter by Schwarz (1889).

7. *Atheta polita* Melsh. This species of the Myrmedoniini was abundant on October 6, 1928, in the dome galleries and entrances of a weak colony at Palos. This species has also been recorded from the galleries of *Reticulitermes flavipes* by Park (1929 c), and Ulke (1890) mentioned finding staphylinids allied to *Myrmedonia* in numbers in the nest of a species of *Formica.*

Leptinidæ

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

Pselaphndæ

9. *Batrisodes globosus* (Lec.) October 6 and 13, 1928, at Palos. In numbers on the former date.

10. *B. denticollis* Casey. Abundant at Palos on October 6, 1928; April 4 and 12, and August 4, 1929.

11. *B.* species. Palos on October 6, 1928.

Cucujidæ

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

Elateridæ

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

Scarabæidæ

14. *Phyllophaga* species. Larvae, pupae and imagos taken from the Palos nests on October 6, 1928. Rather abundant.

15. *P. horni* Smith. One male. In lower dome galleries as above.

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

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

ENEMIES

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

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

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

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

Food

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

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

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

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

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

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

Incurva apparently shows some periodicity in its appearance with *Formica ulkei*, thus some days (August 9, 1929) it was present in great numbers, several to a square foot of nest surface, running about over the surface of the mound, in the grass on the moist soil around the nest, and coming in and out of the gallery openings with the *ulkei* workers, especially the openings near the base of the dome of the nest. On this date it was also present in numbers within the nest itself, at the ground level and the intervening galleries to the most superficial ones. On other days (August 16, 1929) it was almost absent, several being taken from three nests. Again, the species would appear to frequent some nests rather than others in common with *Batrisodes* and other myrmecocoles. Thus one nest would yield a number of the carabids while adjacent nests would be almost devoid of myrmecocoles. I have found *incurva* to be the most abundant beetle myrmecocole of *ulkei* at Palos, as well as at Palatine on August 6, the only trip made to the latter locality.

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

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

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

In the first place, these carabids are essentially cannibalistic, and given a dead or disabled *incurva,* it is seized by others if they are within a sufficiently short distance to be stimulated by the food. Apparently the beetles must be within several milimeters before the presence of food stimulates them, and if the latter is removed a short distance away they have difficulty in again locating it. If one of the beetles finds the food it seizes it in its mandibles and quickly hides with the morsel where it can devour it unmolested. If two or more of the beetles find the food at the same time, or discover one feeding, they immediately attempt to take the morsel away, and tug and pull the food about until each obtains a portion, or one manages to run away with the whole, of their dead comrade. Such behavior is only shown in the presence of food apparently, as the species can be kept in confined quarters in great numbers and the individuals will not fight or molest one another as long as they are in good condition.

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

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

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

The queens of the guest ant, *Solenopsis molesta,* living with *Formica ulkei,* are attacked by the latter when possible (Park T. Loc. cit.) and *Tachyura* feeds on *molesta* also. Here the *molesta* queen is devoured in the same way that the *ulkei* workers are, the mouth-parts being most stimulating to the beetles.

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

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

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

RESPONSE TO MOISTURE

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

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

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

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

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

This behavior was repeated at will in two of the three experimental petri dishes, with the same results. In the third the paper was allowed to dry over night by placing it on a table and covering it with the glass top, the glass bottom of the petri dish being removed. The next morning the leptinids were found dead, and strangely enough, in the area "A", as if these unfortunates had run about until exhausted in the dry atmosphere, and had returned to die in the originally moistened area.

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

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

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

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

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

RESPONSE TO LIGHT

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

Under these conditions, the following results may be mentioned:

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

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

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

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

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

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

ACTIVITY

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

On the other hand, *Tachyura* is much more active, and rights itself more easily. *Leptinus testaceus,* in consequence of its great width in proportion to its depth of body, loses its balance only rarely and then rights itself with ease. Being so flat it may creep into narrow crevices between particles of soil and hide, as was frequently observed, the general body plan reminding one of the flattened Cucujidae, Nitidulidae, the histerids *Hololepta* and *Platysoma,* the flat bark bugs, Aradidae, the exotic forms, as the carabid, *Mormolyce,* and others which live normally beneath bark. The movement of *testaceus* is peculiar. The individuals observed are given to frequent, short pauses in their running, and exhibited an unusually quick change of pace and direction. In consequence of this behavior, their normal gait is a darting movement.

The speed of these three species, and of the host, *Formica ulkei,* may be mentioned as interesting. Individuals were placed on a wide expanse of concrete floor, their path traced in with chalk and the distance covered in a unit of time taken with a stop watch.

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

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

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

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

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

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

SUMMARY

In this paper the term "myrmecocoles" is suggested to cover the organisms found in the nests of ants, irrespective of degree of association with the host ant, viz. accidental occurrence to the symphiles and parasites, and a supplementary list of the myrmecocoles of *Formica ulkei* is given. Certain ecological interrelationships have been observed among the beetles inhabiting the nests of the mound-building ant, *Formica ulkei* Emery and experiments have been made to determine their general behavior with respect to the biotic factors of enemies and food and the physical factors of light and moisture as well as the differential activity of these species under laboratory conditions. It is suggested that the rate and character of locomotion of certain myrmecocoles may be a partial criterion in determining the degree of association between the species and its host ant.

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

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

C. A. Frost, Framingham, Mass.

NOTES ON THE STRUCTURE AND SIGNIFICANCE OF PALAEOGYRINUS[1]

By P. J. Darlington Jr.

The beetle family Palaeogyrinidæ was erected by D. H. R. von Schlechtendal in 1894 to contain the single genus Palæogyrinus, described from the obverse and reverse of a single fossil specimen from the Upper Oligocene deposites of Rott in Siebengebirge, Prussia. Concerning the later vicissitudes of the genus it should be sufficient to say that Handlirsch, in "*Die Fossilen Insekten*," placed it directly in the Gyrinidae, leaving it there, without a query, in Schroder's "*Handbuch*" and that Hatch[2] has recently removed it and placed it as a separate subfamily of the Dytiscidae.

The characters given for the genus by von Schlechtendal were simple and striking. The most important was the compression of the tarsi of the *middle* legs for swimming, and, if the figure which accompanies the original description is accurate, the tarsi were very highly specialized indeed. The undivided eyes and the presence of a mesosternum larger than that of the Dytiscidae were considered of secondary importance. Von Schlechtendal's figure, which is repeated by Hatch, shows the external structure of the beetle in some detail, but, when considered in conjunction with the text, is obviously in part a reconstruction. Except for the tarsi, the insect is almost wholly dytiscoid.

Much might be written of Palæogyrinus as originally described, indeed remarks on its significance as a link between the Dytiscidae and the Gyrinidae have already been

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 320.

[2] Bulletin Brooklyn Entomological Society, 1927, Vol. 22, No. 2, p. 89: On page 94 will be found a bibliography of reference to *Palaeogyrinus* which need not be repeated here.

published, but under the circumstances I shall refrain from a discussion and shall be content with pointing out certain facts which seem thus far to have escaped notice, and which at once reduce the matter to its simplest elements.

To return to the most important character, the structure of the middle legs, a glance at von Schlechtendal's figure will show that, in spite of the huge tarsi, comparable in their development with the swimming feet of such powerful divers as Laccophilus and Cybister, the femora are slender, and the coxae drawn so small that the whole leg is grotesquely disproportioned. Furthermore, the posterior legs have powerful femora hinged to broad coxal plates, but have no recognizable tarsi, though we should expect to find heavy ones attached to such bases. Now if tibiae should be drawn between the hind femora and the so-called middle tarsi, a pair of well-proportioned swimming legs would be formed in a position in which they are found in a good percentage of recently killed dytiscids today, and we should have to assume the loss of the imprints of only the typically slender mesotarsi, which might actually be covered by those of the heavy hind legs. Thus by a small change, and reference to the original figure will show how slight it would need to be, we should replace an anomalous and unconvincing insect by a nearly typical dytiscid, such as might well have occurred in the geological period in question. Any doubt that this suggested reconstruction is the correct one in spite of the original figure is, I think, removed by von Schlechtendal's own statement that the different parts of the posterior legs cannot be surely recognized, since they have left only slight impressions.

Among the characters of secondary importance, the entire eyes indicate at once the dytiscid affinities of the insect, as do the rest of the discernible structures except, perhaps, the mesosternum. As the latter is figured it is larger than in the Dytiscidae, but if, as we may suspect, the suture between it and the metasternum is imagined or due to a crack in the rock, we should avoid even this difficulty, for an anterior projection of the metasternum would meet the intercoxal process of the prosternum, the typical dytiscid condition. The so-called mesosternum should certainly be re-examined with this possibility in view.

To restate the case, Palaeogyrinus is a fossil which looks like a dytiscid, with a coxal structure demanding that the posterior and no other legs be highly developed, and which is said in the original text to be poorly preserved in the very place where the reconstruction is most remarkable. The conclusion must be that the insect was a dytiscid, but that it may have had an unusually large mesosternum. It is rather surprising that these facts have not been brought out before.

I do not believe it is possible to place Palæogyrinus accurately with relation to living genera, and see no reason to attempt it, since the placing would be a matter of guess work and might lead to confusion. The genus is interesting, therefore, chiefly because it is an example of a more or less typical dytiscid from the Upper Oligocene. It has also a temporary interest in that it provides an excuse for a few remarks on the place of fossils in the study of Coleoptera.

Among orders where there are good characters in the wing venation fossils are often reliable, as they are in other groups when good series of good specimens are available, as, for instance, in the case of the Florissant ants which have recently been studied by my friend Dr. F. M. Carpenter. Unfortunately, however, the parts of beetles which are usually preserved have few diagnostic characters, nor are good series of fossil specimens usually obtained. The placing of a species by examination of a single elytron from any but the most recent deposites must depend upon the unwarranted assumption that the beetle fauna of a given period was practically the same as that now existing. It is difficult to see the value of generic and specific descriptions of such nearly unidentifiable remains, when the greatest care and some faith are required to classify even a fairly complete specimen. This does not mean that fossil beetles have no value, but rather that their value is limited, the limit depending in each case on the number of characters actually observable in the fossil itself. There is a good deal of random guessing and specious reasoning to be eliminated before "Palaeocoleopterology" can be taken without a grain of salt.

I am not a palaeontologist until forced by circumstances and can make no general statement on my own responsibility, but I have discussed the matter with experienced friends who agree that, although a fossil insect may be rather loosely said to be in two dimensions, it can rarely be "adequately recorded in the form of figures" as stated by Mr. Hatch, and most emphatically should not be studied in that form alone. Indeed, the history of Palæogyrinus suggests that it may be more important to see the type of a fossil than of a living species.

EUROPEAN COLEOPTERA AT PROVIDENCE, R. I., IN 1928.

Several specimens of *Agrilus coeruleus Rossi* were taken on June 16, 1926; they were determined by Mr. C. A. Frost of Framingham, Mass.

On October 12, 1919, a fine specimen of *Geotrupes* was taken and not being like any of the described North American species it was submitted to Mr. H. C. Fall of Tyngsboro, Mass., who stated that it resembled the European *G. sylvaticus* Panz. in his collection. I find that the specimen answers very well to the description of this species in Thompson's Scandinavian Insects.

J. V. Nylen, Providence, R. I.

A PRELIMINARY STUDY OF THE TRACHEAL SYSTEM OF THE MATURE LARVA OF *BLEPHARIPA SCUTELLATA* R-DESVOIDY.[1]

By Milton F. Crowell.

Blepharipa scutellata R-Desvoidy is one of the imported parasites of the gypsy moth, *Porthetria dispar* (L). The individuals studied emerged from pupae of the moth collected in July 1929, in southern New Hampshire. I had but four larvae and one puparium to examine, hence the study of this insect is by no means complete, and note can be made of only the more obvious features.

The larva of this insect has the amphipneustic type of respiratory system (Palmen 1877, DeGuyse 1926) characterized by one pair of functional spiracles on the prothorax and from one to three pairs of functional spiracles at the end of the body. This is considered to be a secondary, physiological type, (DeGuyse 1926), but the larvæ of muscoid flies possess a higher type in a rudimentary, or nascent state.

The Spiracles.

The anterior pair of spiracles was not observed in detail. Their general position was noted in a study made of the tracheae visible through the integument at the cephalic end of the body. The main tracheal trunk appeared to bend upward and join the body wall near the posterior margin of the prothorax. Since Snodgrass (1924) found the prothoracic larval spiracles of *Rhagoletis pomonella* Walsh (the apple maggot) to be located in a position similar to these

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 321.

observed tracheal endings, the conclusion that these endings indicate the position of the spiracles seems warranted. (Fig. 1).

At the posterior end of the body are two fairly heavy chitinous rings marking the edges of the spiracles. In each of these, covering the spiracle openings, are chitinous plates which vary in their thickness. I was unable to see any openings through these plates. Greene, describing puparia of muscoid flies, (1921), states that "each plate has two or more openings for respiration, and these openings are called "*slits*;" Snodgrass (1924) describes the openings in the stigmatic plates of *Rhagoletis*.

Just beneath the stigmatic plate is the stigmatic chamber. The walls of this chamber are slightly thicker than the tracheal walls to which they are joined, and they are somewhat pigmented. Upon drying a reddish, rusty-looking deposit appeared on the walls and upon the interior surface of the stigmatic plate.

No lateral spiracles are observable on the larva.

Parkard (1874) in a short table of spiracular positions says that the larvae of Cecidomyiidae have nine pairs; one prothoracic, and eight abdominal, and that Muscidae have two pairs, one prothoracic, and one on the ninth abdominal segment. Further (1898), he says that the number of pairs varies in larval Diptera in adaptation to their varied modes of life.

Pratt (1897) figures an embryo of *Melophagus ovinus* (Linn) with a row of ten small circles inside of each of which is a smaller circle, which he designates as "Tracheal invaginations." Williams (1910) states that the larva of *Cecidomyia resinicoloides* Williams (Cecidomyiidae) has nine pairs of spiracles, "one on the first thoracic segment and one each on segments 4-11."

Snodgrass (1924) says that eight pairs of spiracles appear on the puparium of *Rhagoletis*, and he cites various authors to the effect that the lateral spiracles in larvae of the higher Diptera are present as imaginal discs.

It would appear, therefore, that in the higher Diptera the lateral spiracles are not absent, but remain in an undeveloped state until they take part in the formation of the peripneustic system of the adult. Palmen (1877) describes the removal of the larval tracheal lining through the rudimentary spiracles of Ephemerida and Trichoptera. The rudimentary second thoracic spiracle of *Pyrausta nubilalis* Hubn. (European corn borer: Lepidoptera) functions in the removal of the tracheal linings from the body at pupation. Snodgrass (1924) says that the lateral spiracles of the puparium of *Rhagoletis* are opened in the pupal stage by the shedding of the tracheal linings.

The Longitudinal Trunks.

On each side of the body is a large tracheal trunk. These are very large at their attachment to the walls of the stigmal chambers, and they taper to the anterior end of the body, where they divide into several smaller branches. Besides a gradual taper, these trunks taper abruptly at several places, and have somewhat the aspect of a telescope.

These trunks represent the dorsal longitudinal trunks (Dt fig. 2.), which, in the Trichoptera larvae are very much smaller than the ventral trunks, and which are apparently present only in the thorax of larval Lepidoptera.

The ventral longitudinal trunks (Vt fig. 2) which, according to Snodgrass (1924), send branches to the rudimentary spirales in *Rhagoletis,* and which are connected with the open spiracles in *Cecidomyia* (Williams 1910), appear in *Blepharipa* as anastomosing branches from the large dorsal trunks.

The dorsal trunks lie within the body cavity and are not crossed by muscles, as are the longitudinal trunks of the lepidopterous larvae. The ventral trunk is crossed by a muscle in the first abdominal segment (m1 fig. 2.), and further investigation may show this condition present in the other body segments.

Transverse Tracheæ.

Snodgrass (1924) states that in *Rhagoletis* the dorsal trunks are connected by a dorsal commissure in all segments but the first; the first and the last being larger than the others, and going straight across. Williams (1910) figures and describes dorsal transverse tracheae in segments four to nine in *Cecidomyia.*

In *Blepharipa* I found, in the anterior part of the body, three transverse tracheae. The first springs from a branch of the dorsal trunk near the point of its division into several branches mentioned above. The origin of this branch lies beneath the protractor muscles of the pharynx, and the trachea bends around these muscles and crosses them, and the posterior part of the pharynx. No branches arise from it.

Rising from the opposite side of the dorsal trunk, apparantly at about the same place as the branch from which the transverse branch described above arises, is a branch which divides into three parts. The termination of the anterior branch I do not know. The middle branch runs diagonally backward above the duct of the salivary gland (sg fig. 2) and above the ganglia and meets a branch from the opposite side arising from a similar position, and having a similar path. This transverse commissure may send two branches backward to the ganglia. In one specimen examined it apparently did so, and in another it apparently did not. The third branch also runs diagonally backward, and apparantly supplies the ganglia (br fig. 2).

Arising from a point slightly behind one opposite the middle of the ganglia is another trachea which meets a corresponding branch from the opposite side, making the third of the transverse tracheae mentioned above. This seems a short branch forward from its junction point.

Other transverse tracheae are probably present.

Tracheæ to the Nervous System.

At about the line between the third thoracic and first abdominal segments, probably lying in the metathorax, a branch springs from the dorsal trunk and runs forward (1 fig. 2). Just anterior to its junction with the dorsal trunk a branch springs from it and runs beneath it toward the middle of the body. This branch shortly divides into six branches. The anterior one goes to the salivary gland. The next three run to the ganglia, and the posterior two supply fat bodies (fb fig. 2). The three tracheal branches here mentioned, together with the branches described in the former section on transverse tracheae, appear to be all of the branches to the "brain."

The ventral ganglionic mass (g figs. 2, 3), a large appendage of the brain lying ventral to the alimentary tract, receives its tracheae from branches from the ventral tracheal trunks (Vt fig. 3).

As far as I can determine from my notes the first ventral trachea to the abdominal central nervous system arises in

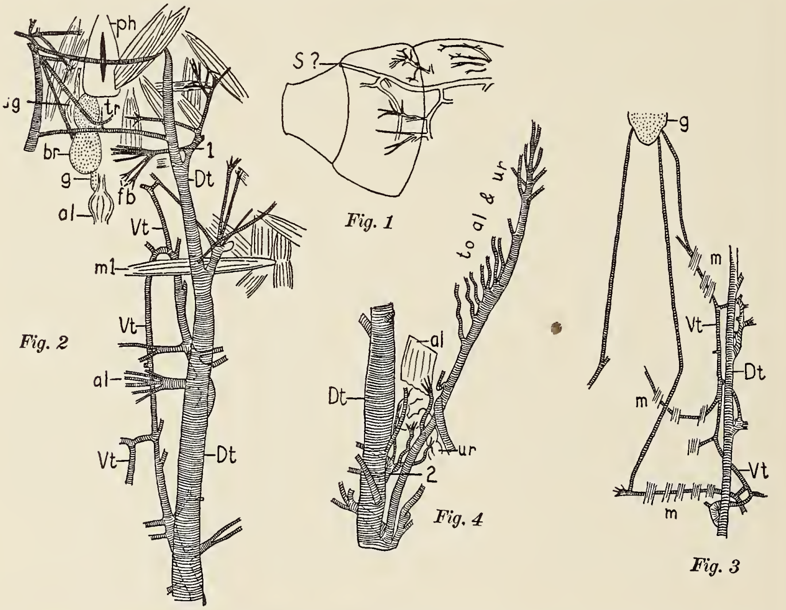

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 1. Sketch of tracheæ as seen through the body wall in the anterior end of a larva. Fig. 2. Tracheæ and organs in anterior part of body. Fig. 3. Tracheae to the ventral ganglionic mass. Fig. 4. Study of tracheæ in posterior end of body. al, alimentary tract, and tracheæ to alimentary tract; br, "brain"; Dt, dorsal tracheal trunk; fb, tracheæ to fat bodies; g, ventral ganglionic mass; m, muscle layer; ml, muscle crossing ventral tracheal tract; ph, pharynx; S?, position of anterior spiracle?; sg, salivary gland; tr, transverse trachea; ur, urinary tubule; Vt, ventral longitudinal trunk; 1; trachea branching to gland, ganglia and fat bodies; 2, trachea sending branches to urinary tubules.

the third abdominal segment. It runs diagonally forward and inward, crossing the second abdominal segment on the outside of the muscle layer (m,m,m, fig. 3) and sends a branch toward the middle of the body at about the middle of this segment; then it continues across the first abdominal segment, in the body cavity, no longer attached to the body by muscles, and joins the side of the ganglionic mass.

In the specimen examined, the fourth abdominal segment contained on the right side the trachea running outside of the muscle layer, but none that ran forward to the ganglia. However, the corresponding trachea on the left side sent a long branch forward across the third, second and first abdominal segments, to the ganglia.

In the fifth segment a branch from the right ventral longitudinal trunk ran almost directly inward between the muscles and the body wall to nearly the mid ventral line of the body, where a long branch arose running forward, crossing the fourth, third, second and first abdominal segments, in the body cavity, to the ganglion. None was present on the left side. This alternating right and left supply of tracheae to the central nervous system merits further investigation.

The tracheae, which ran between the muscles and the body wall apparently are homologous with the ventral transverse branches found in the lepidopterous and trichopterous larvae. In the larva of *Pyrausta nubilalis* Hubn. these tracheae form a transverse connection between the spiracles, except in the first abdominal segment. In the larvae of the Hydropsychidae studied by me these tracheae form transverse connections in the thorax but not in the abdomen, and in *Blepharipa,* they apparently do not form transverse connections. Snodgrass (1924) does not mention ventral commissures in *Rhagoletis;* and Williams (1910) does not mention them in *Cecidomyia,* but his figure (5 Pl. 6) apparently shows one in the metathorax.

Tracheæ to the Alimentary Tract and Urinary Tubules.

The alimentary tract (al figs. 2, 4) is supplied, in the anterior part of the body by branches springing from the commissures between the dorsal and ventral longitudinal trunks near to the dorsal trunks (al fig. 2); the urinary tubules (ur fig. 4) are supplied in the same manner.

Arising from the stigmatic chamber, beside of the large dorsal trunk are several other tracheae. One of these runs forward and breaks up into many smaller branches which supply the alimentary tract and urinary vessels (to al and ur fig. 4). A branch arising from the dorsal trunk near to its junction with the stigmatic chamber also sends three good sized branches to the urinary tubules (2 fig. 4).

The Salivary Glands.

The salivary glands (sg fig. 2) are supplied with tracheae arising in a manner similar to those going to the alimentary tract.

The Muscles.

A study of figure 2 will make clear the supply of tracheae to the muscles much better than would a worded description.

Discussion

The present study is necessarily incomplete, because of lack of material, and too superficial to allow of any but the most general conclusions to be drawn.

It does seem safe, however, to say that apparently the trichopterous, lepidopterous, and dipterous tracheal systems are variations of the same general scheme. This statement could not be made, however, were it not for the excellent works freely cited in the text.

The Trichoptera, as shown by Palmen (1877), possess rudimentary spiracles from which are developed the spiracles of the imago. In a study which I have made, but which has not been prepared for publication, I found that other than lacking functional spiracles, and possessing tracheal gills, the trichopterous larval tracheal system is very similar to that of the lepidopterous larva. The dipterous larval tracheal systems vary, as noted by Packard (1898), but here we have, in the Cecidomyiidae (Williams, 1910) open spiracles with a small ventral system, corresponding to the main longitudinal tracheae of the

Lepidoptera and Trichoptera, with a large dorsal system corresponding to the small dorsal system of the Trichoptera. Should a study of the tracheal systems of the more generalized Diptera show them to possess a system yet more similar to that found in the Trichoptera, it might be possible to make a real homology of the various tracheal branches in the three orders. *Blepharipa,* and other muscoids, apparently have but carried the specialization shown in *Cecidomyia* a few steps farther, and not really departed from the general type.

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DOWN WITH THE TYPE-CULT.

By Professor Embrik Strand

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F.E.S., F.Z.S., F.L.S.

The "Type", *i. e.*, the object on which the definition or description of a zoological novity is founded, is an idea that did not become of great importance in zoology until modern times. Among the earlier workers on systematics "types" practically did not exist. Later on we find in the literature the designation "type" here and there, but still no one thought of determining the priority of species on the "types". To-day we are so "advanced" that numerous authors, especially those who choose to call themselves "specialists", found their species almost exclusively on the "types", while the description and eventually the figure are considered as a matter of quite secondary importance, or as merely a matter of form, in spite of the fact that the modern rules of nomenclature, as well as those which Linné, Fabricius, etc. used *exclusively* acknowledge a definition or a description as the basis which alone can be the foundation of priority. Thence it follows, that the establishment of species on the basis of "types" is opposed to the rules of nomenclature, and even if one asserts that the types have been used only in order to verify and better the descriptions, that is likewise an abuse, if it leads to conclusions that are quite contradictory to the description. In using "types" there are so many particulars which may turn out to be quite misleading or may lead one astray and give rise to *abuse*, that it is difficult to understand why people, who are not wholly lacking in a knowledge of men and matters, do not discover and notice such particulars themselves. A partial explanation may lie in the fact that the type-cult, as a matter of *fashion*, is not readily eliminated. A fashion may be quite ridiculous, nevertheless the masses adore it. The most reasonable explanation may be, however, that the "specialists", who are to-day dominating systematic natural history can most easily maintain their hegemony through the type-cult and thus are personally interested in it. Now and then, however, voices are heard which protest against the worst sides of the type-cult. We find *e. g.*, in the Stettiner Entomologische Zeitung, 1928, p. 63, seq., a paper by R. Kleine on the types of the Brenthidae, in which he points out in his introduction that the description is and has to be a primary and the type a secondary consideration. The types in most cases are not accessible to the worker, and shortly it will be quite impossible to write a monograph if an examination of the types is to be considered a necessary prerequisite for such work. Only he who is in favor with the keeper of the types can get access to them; moreover, Kleine asks: "who guarantees that the animal designated as 'type' really is the type?", for he adds: "the strangest things have at times taken place" (he is doubtless quite right). He also asks how the types in many cases are preserved, further where are they preserved, and finally he concludes, that the description represents everything and that we must proceed so far as to release monographers from the necessity of examining the types. What Kleine thus emphasizes so far is quite right; however, as we shall see it represents only half the truth and when he (*l. c.* p. 63) quotes the assertion of an American entomologist that hardly one-quarter of the 20,000 American insects which have so far been described can be determined from the description alone, I am astonished that he is so credulous.

More extensively and more clearly, but not sharply enough, Edmund Reitter expresses his opinion on the same topic in the Wiener Entomologische Zeitung, vol. 31, p. 21-26 (1912). He emphasizes how unjust and absurb it is to declare species null and void, when so called "types" are not in accordance with the description. Types may be easily misleading as a result of misplaced labels, damage, etc., and to this is to be added that such misplacements can be made *intentionally* and that in the case of a printed description this is quite out of the question. Here we must do what Reitter did not do, expressly emphasize that the description is quite an absolutely constant, invariable thing which is accessible to the whole world. Accordingly, misapprehensions may at any time be corrected by anyone and from different viewpoints while the examiner of "types" is often in the position so he can decree his "discoveries" to the credulous entomological public without any disputation from others. Another point which Reitter does not mention but which in my opinion is of *very great importance*, is the following: the entomological public is obviously always apt to place more confidence in the new "examiner" of the "type" than in the original describer. That is quite wrong for logical as well as for psychological reasons; the reverse is right. It is most certainly the author of the species who has every reason, including his personal interest, to examine the "types" precisely and conscientiously. The new "examiner", however, is liable to present himself, either unconsciously or not, to the public as a discoverer, wiser person, and improver, and this liability can easily cause him to "discover" differences in the "type" which in reality exist only in his own imagination. If the eye of the "reviser" has been influenced by *personal animosity*, envy or hatred, then it is no wonder that the results of the "examination" are often peculiar. Moreover, we should bear in mind that what is to be seen on an entomological type, depends greatly upon the examiner himself; one may see distinct differences which another who has the best intentions and makes the greatest efforts does not see. Who guarantees that the new examiner of the type is abler than the original describer in this respect? I think that it has often happened that the "reviser" has degraded a number of species into synonyms because he did not see the distinctive marks which the original describer stated, and which in reality are present. Reitter speaks *(l. c.)* of the pronounced endeavor of many authors to change the usual synonymy on account of more or less problematic "types" and to degrade the species of other authors into synonyms and he asks what the end will be when the "type-madness" proceeds so far as to consider the type as all and the description as a mere matter of form. Another point in the "examinations" of "types" which likewise has not been taken into consideration by Reitter and which is often of decisive importance, is the fact that if a "specialist" personally cannot have some "types" for the sake of examination, he writes some correspondent, who lives in the town where the types are preserved and asks him to examine the types. In order to show his superiority in this domain the specialist does not forget in the same letter to suggest that type A may be cospecific to species X and type B to species Y etc., and then asks the correspondent to settle this question. The correspondent compares type A with species X but has no specific knowledge of the group in question and consequently he does not know which items in this question are of most importance and he is not trained to find the distinctive marks which will decide the matter. Under these circumstances it is no wonder that he is not willing to spend much time in order to study the matter. For logical and psychological reasons one can be sure that the answer of the correspondent at all events will be affirmative in such cases, for he will not be able to voice a final opinion contrary to the opinion which "Mr. Specialist" had already expressed or at least indicated. Consequently the correspondent finishes the matter with "it may be so" and the specialist proclaims triumphantly that comparison of types has proved that his supposition was quite right. I could mention concrete examples of such *swindles*. The whole "comparison of types" proves in such cases to be a comedy which the "specialist" utilizes in order to make the entomological public believe that which is agreeable to the "specialist".

For this reason I have always considerer types as of no great importance and the descriptions have always been the main point to me, and for this point of view I now stand more than ever. Consequently: Down With the Type-Cult!

NOTES ON REPRODUCTION IN *ASPIDIOTUS HEDERÆ* (COCCIDÆ).

By Franz Schrader

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Our present knowledge of the reproductive processes in the Diaspinæ is a very limited one. The following observations represent a rather cursory attack on this aspect of the biology of the oleander scale (*Aspidiotus hederæ*) and in view of the lack of similar studies on this group of Coccidæ no attempt is made to arrive at any final and concluding generalizations.

The study had its inception in the very interesting paper of E. Gabritschevsky ('25) and so far as its more particular purpose is concerned, hinges especially on Gabritschevsky's statement regarding *Aspidiotus hederæ* that "bisexual cultures live on the plant *Aucuba japonica;* parthenogenetic or unisexually-female cultures grow best on a variety of palms." It will be seen that Gabritschevsky does not commit himself on a possible relationship between host plant and mode of reproduction and it is only fair to state that he was not primarily concerned with that aspect. Nevertheless, the possibility that there might be some corelation between the type of host plant and the presence or absence of males induced me to investigate the species with this point in view.

Parthenogenesis has been reported for various Diaspinæ on several occasions. However so far as I know, no controlled experiments have been made to sustain these contentions and certainly the observed scarcity or absence of males in several instances is insufficient to establish the point.

In the present case, the work took the following form: The stock cultures were derived from oleander plants. Larvae that had just escaped from the egg were isolated on plants which had been cleaned with great care, and the plants were then covered with lamp chimneys whose tops were covered with fine meshed gauze.

Many of the insects were injured in the transfer and died within a short time. Some others apparently attached themselves successfully but died during more or less advanced instars. Out of 34 larvae that attached themselves after isolation only 9 reached the reproductive stage, the deaths being distributed approximately evenly over the various instars. The host plants used were *Aucuba japonica, Hedera helix,* and an unidentified palm. The offspring of the isolated insects were not counted until they themselves had reached the adult stage. This was done because of the great difficulty of counting the migrating larvae that have just hatched and means of course that the number of individuals in each brood as here given is not as great as the number of eggs or first instars produced by each isolated insect.

	Date of Isolation	Host	Young first appeared	Number reaching adult stage.	Sex
1.	Oct. 7	Hedera	Feb. 1	12	Female
2.	Oct. 7	Hedera	Feb. 3	28	Female
3.	Oct. 22	Hedera	Feb. 10	10	Female
4.	Oct. 7	Aucuba	Jan. 2	50	Female
5.	Oct. 7	Aucuba	Jan. 4	10	Female
6.	Oct. 7	Aucuba	Jan. 8	24	Female
7.	Oct. 22	Aucuba	Jan. 28	45	Female
8.[1]	Jan. 10	Aucuba	April 1	52	Female
9.	Oct.	Palm	Jan. 15	9	Female

The breeding experiments demonstrate the following points: *a.* The nine isolated individuals as well as all of their offspring were females. No males arose on either palm or Hedera plants. *b.* Reproduction occurs without mating, regardless of the type of host plant. *c.* The life cycle is com-

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[1] This individual was obtained from Experiment No. 4 and thus represents a second generation raised under control.

The temperature of the greenhouse used was very variable, ranging from 55° to 90° F.

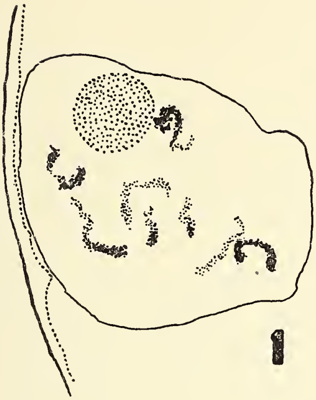
pleted more quickly on Aucuba than on Hedera and palm.

In any other group of insects, this evidence might be deemed sufficient to demonstrate that parthenogenesis occurs in the species. But it must not be forgotten that it is in the Coccidae that a case of functional hermaphroditism is encountered *(Icerya purchasi,* one of the Monophlebinæ as reported by Hughes-Schrader, '25).

In such an instance no breeding experiments of the type I have described will in themselves settle the question. Only a cytological examination would finally decide the point and such an examination was made in Aspidiotus. This shows that not only is there no internal evidence of the presence of any male tissue in the females, but also that the maturation and development of the eggs follow a series of steps which is typical of so-called diploid parthenogenesis.

The somatic cells of immature as well as mature females carry 8 chromosomes. In the course of maturation of the egg, 8 chromosome threads are formed and these show no trace of bivalence or tetrad structure (Fig. 1.). 8 chromosomes also appear in the stages of final condensation (Fig. 2.) so that evidently there is no pairing of the chromosomes. Only a single meiotic division takes place and this is equational in nature, 8 chromosomes going to each pole. Apparently the polar body is not actually extruded but remains at the periphery while the egg nucleus migrates toward the center of the egg (Fig. 3.). Further divisions of this egg nucleus occur in a quite normal manner and the cleavage nuclei all carry 8 chromosomes. (Fig. 4.).

It is plain that taken together, the experimental and cytological evidence demonstrate that in this particular stock of *Aspidiotus hederæ* reproduction is parthenogenetic and normally results in nothing but females. But it would be rash to generalize on this basis. Males have certainly been described for the species and as mentioned above Gabritschevsky reports that males were produced on some of the plants under his observation. Indeed it may well be that some stocks of the species are more susceptible to environmental influence than others and that in such cases the host plant may drastically affect the process of re-



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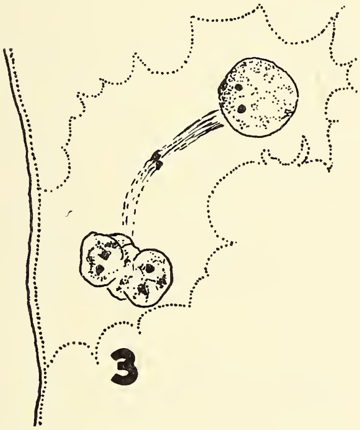

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Fig. 1. Prophase stage showing 8 chromosome threads.

Fig. 2. Metaphase of maturation division.

Fig. 3. Telophase of maturation division, with polar body near periphery of the egg.

Fig. 4. Cleavage nucleus showing 8 chromosomes.

Drawn with 15X ocular and 2mm. oil immersion, using camera lucida.

production. Gabritschevsky's observations were made in Russia so that geographically at least the two stocks of insects used are widely separated. However for the present, I am inclined to adopt the explanation that is presented in the investigations of Thomsen ('27) on *Lecanium hemisphæricum* and *Lecanium hesperidum.* In both of these species there are two distinct races. In one race reproduction is always parthenogenetic and no males are found. The other race however is facultatively parthenogenetic and its eggs are capable of fertilization or, lacking that, of parthenogenetic development. The cytology of the two races is radically different. I suggest that in *Aspidiotus hederæ* also, there may be two races of this kind. The race that I have worked on reproduces solely through parthenogenesis and indeed, its cytology is in principle identical with the corresponding race of Lecanium. That the other race exists also is supported by the recorded occurrence of males as well as by Gabritschevsky's findings, who may well have had a mixed population composed of both the races in question.

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A NOTE ON *CHILOSIA HIAWATHA* SHANNON

By Charles W. Johnson

Boston Society of Natural History.

This species was described in 1922[1] from a single male collected by Dr. Jos. Bequaert at Forest Hills, Mass. On June 4, 1922, Mr. W. S. Brooks took a female at Topsfield, Mass., that I though might be *Chilosia haiwatha,* but the bare eyes and several minor differences seemed to make the determination doubtful. On June 10, 1926, Mr. F. H. Walker collected a male at Danvers, Mass., but from the description I was still doubtful. In June, 1928, Dr. J. P. Bill took a female at Wayland, Mass. On June 16, 1928, I collected a female at East Gloucester, Mass. On June 14 and 17, 1929, I again visited the same place, near Braces Cove, East Gloucester, and captured twenty-one specimens, including three males. Most of the specimens were taken on the flowers of the tall buttercup *(Ranunculus acris)*. On June 16, 1929, Mr. Nathan Banks took a female at Holliston, Mass.

I now felt sure that these were the males and females of *Chilosia hiawatha,* notwithstanding the sexual differences and discrepancies in the original description. To make sure, however, I submitted a male to Mr. Charles T. Greene of the U. S. National Museum, pointing out some of the characters not clearly defined in the description, and received the following note based on the type.

"The 'central, longitudinal groove' is in the frontal triangle (not the ocellar triangle) ; the halter is pale luteous with a brownish infuscation at the base of the stem

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[1] A Revision of the Chilosini. By Raymond C. Shannon Insec. Inecit., vol. 10, pp. 47-145.

and a brownish spot on the knob. Abdominal pile long and yellow, under side of all tarsi with yellowish pubescence; joints 2, 3, and 4 of front tarsi are slightly more brownish in the type than in your specimen. Your specimen is slightly smaller than the type, but otherwise it is identical."

The female has the eyes bare; the third joint of the antennae is often more brownish than in the male; the front, about one-fifth the total width of the head, is black, shining, with three slight grooves; lower parts of the orbits whitish pubescence. The 2nd, 3rd, and 4th joints of the front tarsi are often darker than in the male the latter being often decidedly yellow. The pile on the abdomen short and oppressed. Wings more yellowish at the base and the knobs of the halters entirely yellow. The species vary from 9 to 10 mm.

Becker restricted the genus Chilosia to those species having hairy eyes and antennal pits. Those with bare eyes and with the antennal pits confluent were placed in the genus Cartosyrphus Bigot. Shannon says: "Unfortunately the type species of Chilosia, *flavipes*, has the eyes sometimes bare in the female, but the writer believes that this species will be found to have the anntennal pits separated which would put the genus Chilosia on a better basis."

If the narrow oblique impressed lines extending from the base of the antennae to the orbits, can be called antennal pits, then this species could be referred to Chilosia, otherwise it would be difficult to separate the female from species of Cartosyrphus which have similar oblique impressed lines. The genus Cartosyrphus seems to stand on very weak characters.

A NEW THYNNID WASP FROM NEW CALEDONIA.

By T. D. A. Cockerell.

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On the occasion of our recent (1928) visit to New Caledonia, my wife and I collected many interesting insects, but perhaps none more interesting than a wasp of the family Thynnidæ now described.

Eirone superstes n. sp.

♂. Length about 12 mm.; slender, variegated with black, red and yellow, the surface shining; head rather thick, circular seen from in front, the orbits slightly diverging below; clypeus, rather broad bands along inner orbits, and mandibles except apex, yellow flushed with red, the mandibles ferruginous subapically, very stout, with a long oblique cutting edge, and a small but well defined inner tooth; clypeus obtusely angulate in middle, both it and the mandibles furnished with long glistening yellowish hairs; maxillary palpi brown, slender, the three last joints subequal, and decidedly elongated; front shining with few scattered punctures; ocelli in a high triangle; cheeks with a yellow band behind the eyes, ending about two-thirds of the way up, but behind this a broad pale red area, which sends a pointed projection far up on the occiput; antennae slender, long enough to reach metathorax, the scape reddish yellow in front, the flagellum black; a pair of large tubercles just above and between antennae bright yellow; thorax black marked as follows: a yellow marginal band on prothorax briefly broken sublaterally; crescentic yellow mark just in front of tegulæ; large rather footshaped yellow area, suffused with red, on mesopleura; two reddish-yellow stripes on hind part of disc of mesothorax; large yellow spots on axillæ; scutellum and postscutellum pale yellowish red; the bulging impunctate metathorax pale ferruginous; parapsidal furrows deep; tegulæ testaceous with a large yellow spot; wings strongly reddened, blackish at apex; stigma and nervures dull ferruginous; second cubital cell with sloping sides, but still very broad above, receiving recurrent nervure at middle; third cubital receiving second recurrent far from base, but distinctly before middle; anterior coxæ red in front, the coxæ otherwise black; femora, tibiae and tarsi entirely bright ferruginous; abdomen narrow, subcylindrical, the margins of the segments with stiff black hairs, but apex with thin pale hair; first, fifth and sixth and base of seventh segment black above and below; second, third, fourth, and apical segment except base bright orange-ferruginous above and below; apex truncate, unarmed.

New Caledonia: Bourail, May 22 (W. P. Cockerell). Type for the present in my collection. Allied to *E. obtusidens* Turner, 1919, from Noumea, New Caledonia. Dr. James Waterston kindly examined the type of *E. obtusidens,* in order to confirm certain points of distinction. He reports as follows:

(1) Clypeal hairs. The longest and strongest blackish brown, the finer ones, especially those near edge, much paler.

(2) Clypeus with nearly straight edge, but in the middle one fourth or one-fifth produced into a blunt triangular tooth.

(3) Anterior coxæ shining black.

(4) Abdomen with only tergites 2 to 4 reddish; sternites are black or blackish.

(5) Apex of abdomen; tergite black, with reddish bristles, sternites narrowly reddish edged at apex.

(6) Abdominal tergites 2 to 5 fringed with short stiff black bristles, on 2 to 4 these bristles extend beyond the

hind edge about one-third of their length, on 5 to nearly half, i. e., relatively longer.

(7) Apical joints of maxillary palpi are in my opinion elongate, the last obviously a little more slender than the penultimate.

Dr. Waterston thinks Turner's species is probably correctly placed in *Eirone*, but the abdomen is a little unusual. The characters of the mandibles, clypeus and palpi may perhaps be considered to indicate at least a distined subgenus. My species is allied to Turner's, but evidently distinct.

In 1922 Montet described a *Spilothynnus thalluse*, said to occur in New Caledonia. Miss Sandhouse has kindly copied the description for me, and I find that the species was based on two females, 8.5 mm. long, one said to be from Australia, the other from New Caledonia. There is apparently no history with either, and Montet remarks that there may be an error in the indication of localities. The Australian specimen, of which details are figured, is herewith designated as the type. *Spilothynnus* is a South American genus with spotted abdomen.

If we disregard Montet's species as too uncertain, it still remains true that New Caledonia has two species of Thynnidæ which are endemic, and abundantly distinct from anything known in Australia. There is also a Mutillid *(Mutilla caledonica* André), found at Noumea in New Caledonia.

These Hymenoptera, having wingless females, are doubtless relics of ancient continental connections, probably north-westward. There are Thynnidæ in New Britain, the Solomon Is. *(Thynnus barbarus* Turner), New Guinea, the Aru Is., Ceram, Celebes, and north to the Philippine Is. *(Thynnus luzonicus* Turner; *T. bakeri* Rohwer). There is a species *(Rhagigaster novaræ* Sauss.) said to come from New Zealand, but Tillyard in his recent work credits none to that country. *Eirone* has 33 known species, in addition to the two from New Caledonia. With the exception of the latter, it is strictly an Australian genus.

The Thynnidæ, also well represented in South America, illustrate the discontinuous distribution of ancient groups; and the fact that the New Caledonia species can be placed (if not quite comfortably) in an Australian genus indicates the great antiquity of the general type. The family is probably as old as the mesozoic. New Caledonia has doubtless, during its long history, experienced many changes of level, and there are reasons for thinking that it has at times been reduced to a much smaller area, and at other times connected with the Loyalty Islands, which have a very similar fauna. West and South of New Caledonia is a great submarine bank, extending to New Zealand, and including near its western edge Lord Howe Island. In Lord Howe Island we have a very remarkable assemblage of land snails, including the genus *Placostylus* and (as Mr. T. Iredale pointed out to me) *Platyrhytida;* characteristic New Caledonia genera. North of Lord Howe Island are reefs dangerous to shipping, representing former islands. As we passed one of them, on which the wreck of a large vessel could be seen, it was impossible to avoid a feeling of disappointment at the loss of the interesting fauna and flora which must have flourished there in early times. Even in Lord Howe Island, where so many interesting relics survived, the fauna is rapidly disappearing as the result of the accidental introduction of rats.

I have recently described a bee (*Paracolletes philonesus* Ckll.) collected by A. R. McCulloch on Lord Howe Island, and now in the Australian Museum. It belongs to an Australian genus, which also occurs in New Zealand, but not in New Caledonia. The female is about 9.5 mm. long, and runs in my table near *P. metallescens* Ckll. but has the abdomen dull, not metallic, hardly punctured. The wings are brownish; second cubital cell broad at base, greatly contracted above. It may be that *Paracolletes* will yet be found in the mountains of New Caledonia; in Australia it is richly developed in the temperate portion, but there is a small species (*P. tropicalis* Ckll.) on Melville Island, off the north coast.

THE NESTING HABITS OF THE BURROWING BEE, *EPINOMIA TRIANGULIFERA* VACHAL[1]

By Phil Rau,

Kirkwood, Mo.

Epinomia triangulifera is a large bee, recorded heretofore, according to W. Dwight Pierce[2], from New Mexico, Kansas and Nebraska. In St. Louis it was found in large colonies on two clay hillocks in a vacant lot comprising a few acres in the heart of the city. These bees seem to have a strange liking for elevated areas, for in this sunny region, which was a favorite haunt of so many Hymenoptera, only these two colonies on the hillocks were found. For want of a temporary name, I called them the "knoll-bees," and was much interested to find that Mr. Pierce had been impressed with the same characteristic, for he also records having found them in colonies and on elevations "a foot or so above the surrounding ground."

On the gentle slope of a knoll, a few nests of this species were seen during the warmer months of three years. On September 1 of the fourth year, 1918, when this spot was examined, they were found in enormous numbers. The conditions which obtained in that place or year must have been exceptionally favorable to this species, in order to produce so many. The most densely populated portion was the area sloping gently toward the southwest, although the level portions of the hill-top were also abundantly occupied. This region was covered with grass of a wiry nature, growing sparsely on the clay soil, with occasional patches entirely barren. Both amidst the grass and on the uncovered areas their domes of excavated earth were to be seen; in

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[1] Identified by J. C. Crawford.
[2] Univ. Nebr. Stud. 4: 29. 1904.

Fig. 1. Nesting Site of the Knoll-bee, *Epinomia triangulifera*.
Fig. 2. Nests of Knoll-bee.

the grassy areas the vegetation helped to anchor the loose soil and hold the little hills intact over their burrows. Figure 1 shows their domes among the sparse grass.

In another area, perhaps a hundred yards away, on a plateau left by the artificial cutting down of a high embankment, they also occurred in great abundance in that year. This plateau, about six feet above the surrounding surface, had a slight southward slope, the same as the first locality. The population of bees inhabiting this small elevation was of especial interest. Four years previously, in the early spring, this embankment had been graded down and the yellow clay hauled away for use elsewhere. Every season thereafter, I frequently scanned the newly exposed soil of this plateau in search of data upon the succession of insect life that would take possesssion of it. The first and second summers gave no vegetation, (this suggests how heavy and impenetrable was the soil, if even seeds and grasses could not take hold upon it), and besides a few turret spiders, grasshoppers and cicindela beetles, nothing was seen to nest upon it. In the third year, the parent stock of the present population migrated thither from the other knoll one hundred yards to the north. Considering the enormous increase and the flourishing condition of this immigrant population, we are justified in concluding that the conditions which characterized this spot must have been precisely to their pleasure and advantage, and therefore we may justly accept this as their characteristic habitat, although we have seen them in only few localities. Especially on the northern portion of this plateau, in an area about twenty-five feet square, the nests were so abundant that one could not step anywhere without trampling upon them. In fact, it often happened that three to five nests were so close together as to have one large, spreading mound to cover them all, and in one area only one yard square, I actually counted two hundred and sixty nests of these bees. Figure 2 shows seven nests and a coin (American ten-cent piece) to show the relative size. The task of digging must have been great in this heavy clay, for the amount of soil was enormous. When one looks upon the work of a colony of these bees, one cannot help thinking that they, like the earth-worms, are active agents in working over the soil.

The openings into the burrows are not exposed, but each is completely covered by its mound of loose soil. Sunflowers abounded in this region, and the returning bees were heavily laden with golden pollen, not only on the legs, but on the under side of the abdomens as well. Close examination of specimens later revealed that there were rows of hairs on the abdomen and legs, the purpose of which is readily apparent.

A returning bee has little difficulty in finding her burrow, and alights upon it without hesitation or orientation. She does not kick away the soil to make an opening as do certain wasps; in fact, I doubt if her heavily laden condition would permit her to do so, but she immediately pokes her head into the loose soil of the mound, and with a few mysterious pushes, wriggles through somehow, without for an instant uncovering the burrow.

On September 1, the date when I discovered the large population in 1918, the mounds were inspected at noon, but, although they were watched for an hour, no life was seen about them. At three o'clock when I returned, many of the bees were on the wing bringing in pollen. A few were not so laden, but out of about one hundred counted in one area, only three were seen returning to the nest empty-handed; however these might have been still occupied with burrowing. One nest was opened after one of these unladen mothers had entered; the digging was indeed a task, for the yellow clay was gummy and unyielding. The burrow was $\frac{3}{8}$ inch in diameter, and went down straight into the ground for 17 inches. In the bottom was the mother bee, but no cell was there: the burrow was not yet quite ready for pollen. I was not at hand when the excavating was going on, but, as mentioned before, they work close together in a small circumscribed area, and they may possibly use for nidification the burrows from which they emerge.

It rained all of September 2, and when I examined the nests the next day, I found that all the little hills of loose soil had been washed smooth and packed down over the nests, and the openings had not yet been uncovered. One bee with her heavy load of pollen was trying to effect an entrance to one of the holes. Whether she had been away from home during the storm and was just now returning, I do not know. The following night it rained again, and my next examination three days later, showed that they were making but slow progress in resuming activities; scarcely more than one-tenth of them had then been able to escape from their temporary imprisonment. From this it is at once apparent that rains are really a serious impediment to the work of this species, even more than we see in the cases of some of the burrowing wasps, as *Bembix mubilipennis* and others, which scramble out uninjured almost as soon as the storm-clouds have blown away. May there be some correlation between this greater liability to injury in heavy rains and their habitual choice of high knolls for nesting sites? In three or four places on the ground were little masses of pollen which the females had lost in their extreme efforts to gain entrance to burrows closed by the rain.

The next day the sun shone and there was a slight increase in activity, but in some portions of the field it appeared that there had been heavy mortality. On this occasion I made one more attempt at digging up nests. In following one, it was necessary to dig out a space about a foot across, and in so doing I broke into five other nests. I could follow only one of these channels, however; it went straight down for 24 inches, and the worker was at the bottom. Three inches above the terminus was a lateral cell filled with golden pollen and containing a very young larva.

In the area of the colony where the hill-top had recently been cut away, the nests occured in abundance on the top and some were very close to the edge of the sharp declivity, but there were none at all on the steeply sloping side. Since all of the burrows went straight down, some of the nests near the edge, although they were placed at a proper depth below the top, had very little protection of soil on the side.

By September 12, the nests had almost regained their normal proportions, and one could hardly see that the rains had played havoc. The great majority of the bees had been able to dig out of their temporary prisons. When I visited

Bee-city the next morning at nine o'clock, I was surprised to find almost all nests wide open and heavily laden mothers entering them. These bees made no effort to keep the holes closed either in their absence or presence as they had so constantly done before, probably because the soil had been washed away. Only a few nests were still covered; perhaps these contained lazy or sleepy bees. This was my first visit to the colony so early in the morning. The afternoons had always found the nests covered, and likewise on this day, at five o'clock the holes were all covered as usual, with the exception of perhaps a half-dozen which had probably lost their proprietors through disaster. The problem remains whether they close them to exclude the mid-day heat, or open them for a morning airing, or for some other reason. One frequent reason for closing or guarding the entrance to wasp or bee burrows is the annoyance of parasites. The only enemies observed lurking about here were a few *Philanthus puctatus* females, but they were not actually seen to enter the holes. These wasps seek bees for prey, but I am very doubtful that they would venture to attack healthy bees three times as large as themselves.

Thus they flourished in bliss unalloyed for a few days until the next rainy spell came in the latter part of September. Meanwhile their progress in provisioning their cells must have been great, for the surrounding region was full of sunflowers and autumnal composites, which brought their supplies of food near to hand. Great quantities of white snakeroot also grew near by, but I did not at any time see the bees carrying white pollen, although in two or three cases they were seen feeding upon the flowers.

The autumn rains again flattened the mounds of the knoll-bees and covered the burrows with sticky clay as before, and caused a permanent stoppage of activities. Days passed, and I waited for them to reappear, but they did not. Either they were so old that they could not again dig themselves out, or this late date practically marked their three-score and ten. A very, very few stragglers were seen later, but in the few nests which were excavated each was the tomb of its maker.

STYLOPIZED VESPIDÆ[1]

By George Salt[2] and Joseph Bequaert[3]

It is becoming increasingly difficult to prepare a complete account of the various insects infested with Strepsiptera. Many of the early writers on these parasites gave lists of hosts without stating definitely whether they had themselves seen stylopized specimens or whether their records were copied from earlier workers. Taxonomists have mentioned infested specimens in monographs of various host groups, so that many records have become scattered in articles not at all concerned with the parasites, where they are likely to be found only by a student of the hosts. Mistakes in the identification of host species have caused much confusion; and the change of names, which seems inevitable in taxonomic revision, has greatly complicated the existing lists.

As one of us (J.B.) has been for a number of years interested in the Vespidæ, while the other (G.S.), in the course of studies on stylopization, has found it necessary to keep lists of stylopized wasps, we have thought that it would be useful to publish jointly an annotated list of the Vespidæ known to be infested with Strepsiptera. From the data contained in our list we have been able to draw several conclusions which are of some interest and importance to the general subject of the inter-relation of parasite and host.

We have examined stylopized material mainly from the Academy of Natural Sciences of Philadelphia, the American Museum of Natural History, the Boston Society of Natural

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 305.

[2] Department of Tropical Medicine, Harvard University Medical School.

[3] National Research Fellow in Zoology, 1927-1928.

History, the Canadian National Collection, Cornell University, the Museum of Comparative Zoölogy, and the United States National Museum; and from the personal collections of Mr. Charles Robertson of Carlinville, Illinois, Dr. C. H. Kennedy of Ohio State University, and Dr. W. M. Wheeler of the Bussey Institution, Harvard University; as well as that which we had in our own possession. We have been particularly fortunate in being able to study the stylopized specimens accumulated at the United States National Museum by Dr. W. D. Pierce and thus to connect our own identifications and records with his extensive lists. To the authorities of these institutions and to the workers who have so kindly lent or given us material, we are very grateful.

In the following list valid records are given in heavy face type, synonyms or records based on misidentifications in italics. References cited only once are given in full in the text, those used in several instances are placed in the bibliography. The words "male" or "female" invariably refer to the host, the signs ♂ or ♀ to the parasite. ♂ e represents the exuvium of a male Strepsipteron, ♂ p the puparium of the same. We record the position of the parasite by giving the number of the abdominal tergite under which it is found and the letter "R" or "L" for the right or left side respectively. In the few cases in which the parasite was situated under a sternite rather than a tergite, the letters "st" follow the number of the segment. The other abbreviations are self-explanatory. Needless to say, our re-assignment of host records, in particular those of Pierce, is based upon an examination of the specimens in question.

LIST OF THE KNOWN VESPID HOSTS OF STREPSIPTERA

Masaridinæ

Paragia decipiens Shuckard. Smith, 1867, Proc. Ent. Soc. Lond. (3) 5, lxxxviii: Gawler River, Adelaide, South Australia; ♂ e. Kriechbaumer, 1874, Stettin Ent. Zeit. 35, 254: South Australia; six males and three females. Oglobin, 1923, Sbornik Ent. Odd. Narod. Mus. Prague

1, 46: Gawler, South Australia; Odewahn; ♂ and ♀ of *Paragioxenos brachypterus* described. Hofeneder, 1928, Societas Entom. 43, 46: Gawlertown, Australia; male, ♀-4R. ♀ *Paragioxenos brachypterus* Ogl. Hofeneder, ibid. p. 48: Flasun, Australia; 1872; male, ♂ e.

New record: New South Wales; female, ♂ e-3L, ♂ e-3L, ♂ e-3R, ♂ e-4R (A.M.N.H.).

Paragia tricolor Smith. Saunders, 1872, 42: Australia; ♀. This may have been either the true *P. tricolor* Smith or *P. smithii* Sauss.

Raphiglossinæ

Psiliglossa odyneroides Saunders. Saunders, 1872, 42: Epirus; ♂ p.

Zethinæ

Zethus pubescens Smith. Salt, 1927, 183: Mfongosi, Zululand; Dec. 1911; W. E. Jones; female, ♂ p-4L.

Zethus romandinus Sauss. New record: Iquitos, Peru; 27 July to 7 Aug. 1920; Cornell Univ. Exped.; female, ♀-3L, ♂ e-4R.

Zethus spinipes Say var. **variegatus** Sauss. Salt, 1927, 183: Dallas, Texas; Jacob Boll; female, ♀-4R; and female, ♀-4R (both M.C.Z.).

New record: Gainesville, Alachua Co., Florida; 23 April 1923; Alexander and Walker; male, ♂ e-4R (U.S. N.M.).

Eumeninæ

Eumenes arcuatus (Fabr.) var. **praslinius** (Guérin). Pierce, 1918, 489 (as *E. flavopicta* Blanchard): Larat; F. Muir; ♀, ♂ p, ♂ e, and triungulinids.

New record (probably one of above specimens): Larat; male, ♂ e-4R (U.S.N.M.).

Eumenes campaniformis (Fabr.) var. **higletti** Meade-Waldo. Salt, 1927, 183 (as *E. campaniformis* var. *marshalli* Bequaert): Salisbury, S. Rhodesia; Dr. Melle Arcturus; male.

Eumenes campaniformis (Fabr.) var. *marshalli* Bequaert. Salt, 1927, 183:=*E. campaniformis* var. *higletti* Meade-Waldo.

Eumenes campaniformis (Fabr.) var. **rendalli** Bingham. New record: Boma, Congo; 16 June 1915; Lang and Chapin; female, ♂ p-4R (A.M.N.H.).

Eumenes fenestralis Sauss. See *E. maxillosus* var. *fenestralis* Sauss.

Eumenes flavopicta Blanchard. Pierce, 1918, 489: in error for *E. arcuatus* var. *praslinius* Guérin.

Eumenes fraternus Say. Salt, 1927, 183: Forest Hills, Mass.; 19 Aug. 1926; George Salt; male, ♀-3R.

Eumenes harmandi Pérez. New record: Chas Yang, Chili, China; 11 July 1921; A. P. Jacot; male, ♀-3R (U.S.N.M.).

Eumenes maxillosus (Degeer). Heyden, 1867, 398 (as *E. tinctor* Christ): Abyssinia; ♀.

New records: Matadi, Congo; 9 June 1915; Lang and Chapin; female, ♀-3L (A.M.N.H.). Boma, Congo; 17 June 1915; Lang and Chapin; male ♂ p-4R (A.M.N.H.).

Eumenes maxillosus (Degeer) var. *circinalis* (Fabr.). Salt, 1927, 183=*E. pyriformis* var. *circinalis* (Fabr.).

Eumenes maxillosus (Degeer) var. **conicus** (Fabr.). New record: Bangkok, Siam; 18 April 1926; H. M. Smith; female, ♀-3R, ♀-3L (U.S.N.M.).

Eumenes maxillosus (Degeer) var. **fenestralis** (Sauss.). Heyden, 1867, 398: Abyssinia; ♀.

New record: Boma, Congo; 29 June 1915; Lang and Chapin; male, ♂ e-3L (A.M.N.H.).

Eumenes maxillosus (Degeer) var. **reginus** (Sauss.). Salt, 1927, 183: Diego Suarez, Madagascar; female.

Eumenes melanosoma Sauss. var. **æthiopicus** (Sauss.). New record: Kakatown, Liberia; Aug. 1926; J. Bequaert; male, ♀-3L.

Eumenes petiolata (Fabr.). Smith, 1859, 130:= *E. pyriformis* Fabr.

Eumenes pomiformis (Rossi). Saunders, 1872, 42: Nicæa; ♂ p.

Eumenes pyriformis Fabr. Smith 1859, 130 (as *E. petiolata* Fabr.) : India; female, ♀-3, ♂ e-4.

Eumenes pyriformis Fabr. var. **circinalis** Fabr. Salt, 1927, 183 (as *E. maxillosus* var. *circinalis* Fabr.) : Amboina, Moluccas; Rouyer; female.

New record: Trong, Lower Siam; W. L. Abbott; female, ♀-3R, ♀-3L; and female, ♀-3L (both U.S.N.M.).

Eumenes tinctor Christ. Heyden, 1867, 398:=*E. maxillosus* (Degeer).

Odynerus (See also Pachodynerus and Ancistrocerus).

Odynerus sp. Smith, 1859, 130: Brazil; female, ♂ p-3. Pierce, 1918, 489: Tucson, Arizona; 24 Aug. 1913; W. D. Pierce; ♀-3, ♀-4.

Odynerus annulatus Say. Pierce, 1909, 180: Dallas, Texas; 31 July; W. A. Hooker; ♀. Salt, 1927, 183: Austin, Texas. New Braunfels, Texas. Custer County, Dakota; S. W. Garman.

New records: Montana; female, ♂ p-5R (A.N.S.P.). New Mexico; female, ♀-4L (A.M.N.H.).

Odynerus anormis (Say). Robertson, 1910, 325: Carlinville, Illinois; 31 May, 29 Oct., Chas. Robertson. Salt, 1927, 183: Carlinville, Illinois; Chas. Robertson.

New record: Colorado; C. F. Baker; male, ♀-3R (U.S.N.M.).

Odynerus arvensis Sauss. Robertson, 1910, 325: Carlinville, Illinois; 2 Aug.; Chas. Robertson. Pierce, 1911, 499: from above specimen describes ♀ of *Pseudoxenos arvensidis*. Pierce, 1918, 489 (as *O. firmus* Cresson) : Cedar Point, Ohio; 19 June 1913; J. B. Parker; ♀. Salt, 1927, 183: Carlinville, Illinois; Chas. Robertson; male, ♂ p-4R (M.C.Z.).

New records: Put-in-Bay, Bass Island, Ohio; 1-10 July; C. H. Kennedy; female, ♀-4L. Texas; female, ♀-3L, ♀-4R (A.N.S.P.).

Odynerus ater (Sauss.). Schultze, 1925, Phil. Journ. Sci. 27, 235: Manila, Philippine Islands; Oct. 1924; W. Schultze; male, ♀-3R, ♀-3L, ♂p-4R, ♂p-4L; male, ♂p-4L; wasp, ♂p-4; and wasp, ♀-3. ♂ and ♀ of *Macroxenos piercei* described (as *Rynchium atrum* Sauss).

Odynerus bellulus Cresson. Salt, 1927, 183: Lee County, Texas; G. Birkman; male.

Odynerus bermudensis Beq. New record: Bermuda; Sept. 1925; L. Ogilvie; female (holotype), ♀-4R (Brit. Mus.).

Odynerus bifurcus Rob. Robertson, 1910, 325: Inverness, Florida; 3 March; Chas. Robertson.

New record (may be same specimen as above): Inverness, Florida; 3 March; Chas. Robertson: Male, ♂p-4L (U.S.N.M.).

Odynerus blandus Sauss. Salt, 1927, 183: Stanford University, California.

Odynerus chloroticus Spinola. Heyden, 1867, 398: Abyssinia; ♀.

Odynerus colon Cresson. Pierce, 1909, 180: in error for *Ancistrocerus fulvipes* (Sauss.).

Odynerus crenatus Lepel. Monod, 1925, Bull. Soc. Zool. France 50, 230: Sierra Morena, Spain; A. Seyrig; female, ♂p-3-L, ♂p-4L, ♂p-5R; and female, ♀-3R, ♂e-5R. ♂ and ♀ of *Pseudoxenos seyrigi* described.

Odynerus dantici (Rossi). New record: Dalmatia; male, ♀-3R (A.N.S.P.).

Odynerus deflendus (Saunders). Saunders, 1853, 141: Epirus and Corcyra; male; June to Aug.; ♂ and ♀ of *Pseudoxenos heydenii* described.

Odynerus figulus Sauss. New record: Sanchez, Rep. Dominicana; 11-16 May 1915; male, ♀-3R (A.M.N.H.).

Odynerus firmus Cresson. Pierce, 1918, 489: in error for *O. arvensis* Sauss.

Odynerus flavomarginatus (Smith). Smith, 1852, Trans. Ent. Soc. London (2) 2, pt. 1, 35 (as *Rhynchium flavomarginatum* Sm.): Northern China; male; 2 ♀-3. S. Saunders, 1872, 42. Pierce, 1909, 180.

Odynerus flavopictus Sauss. New record: Put-in-Bay, Bass Island, Ohio; 1-10 July; C. H. Kennedy; male, ♂ e-3L, ♂ e-4R; female, ♂ e-4R; and male, ♀-4R. Falls Church, Virginia; 2 June; N. Banks; male ♂ e-5R (M.C.Z.).

Odynerus foraminatus Sauss. Pierce, 1909, 180: Cincinnati, Ohio; 10 Aug.; ♀. Robertson, 1910, 325: Carlinville, Illinois; 13 Aug.; Chas. Robertson. Pierce, 1911. 506: Trenton, New Jersey; 5 July 1907; ♀ of *Pseudoxenos foraminati* described p. 499. Salt, 1927, 183: Woods Hole, Massachusetts; male, ♀-4L; female, ♀-4L, ♀-4L, ♀-4R; and male, ♂ p-4L. Carlinville, Illinois; Chas. Robertson; female, ♀-4L (M.C.Z.). Chicago, Illinois; female, ♀ p-5R; male, ♂ e-4L; and male, ♀-4L. Philadelphia, Pennsylvania; 23 Aug. 1900; female, ♀-4L. Dallas, Texas; J. Boll; female, ♀-3R, ♀-3L, ♀-4R (M.C.Z.). Fedor, Texas; 11 May; G. Birkman; male, ♀-3R (M. C.Z.). West Jefferson, Ohio; 26 Aug. 1923; J. Bequaert; female, ♂ p-5R. Vienna, Virginia; 18 Aug.; male, ♀-4R. Dyke, Virginia; 14 May; N. Banks; male, ♂ p-4L (M. C.Z.). Falls Church, Virginia; N. Banks.

New records: Nyack, New York; 2 July 1884; female, ♀-4L (A.M.N.H.). Pennsylvania; male, ♂ p-4R (U.S.N.M.). Put-in-Bay, Bass Island, Ohio; July; C. H. Kennedy; female, ♂-3R, ♀-3L; female, ♀-3L, ♀-4R; female, ♀-4L; female, ♀-4L; and female, ♀-4L. Lawrence County, Ohio; 23 Aug. 1926; C. H. Kennedy; male, ♀-4R. Texas; male, ♀4R (A.N.S.P.). Texas; 5 May 1900; male, ♀-4R.

Odynerus fundatiformis Robt. Robertson, 1910, 325: Orlando, Florida; 17 Febr.; Chas. Robertson.

Odynerus fundatus Cresson. Robertson, 1910, 325: Carlinville, Illinois; 25 June, 19 July; Chas. Robertson.

Pierce, 1911, 506: Carlinville, Illinois; 25 June; Chas. Robertson; ♀ of *Pseudoxenos fundati* described p. 500. Salt, 1927, 183: Austin, Texas. Carlinville, Illinois; Chas. Robertson.

Odynerus fusus Cresson. New record: Texas; female, ♀13R, ♀-3L; female, ♀-3R; and male, ♀-3R (all A.N.S.P.).

Odynerus hæmorrhoidalis (Fabr.). New record: Buitenzorg, Java; March 1909; Bryant and Palmer; female, ♀-3L (U.S.N.M.).

Odynerus hidalgi Sauss. Pierce, 1909, 181 (as *O. verus* Cresson): Dallas, Texas; 21 July; W. A. Hooker; male, ♀ of *Pseudoxenos hookeri* described p. 139 (U.S.N.M.).

Odynerus japonicus (Dalla Torre). New record: Kyoto, Japan; female, ♀-3L (A.N.S.P.).

Odynerus lævipes Shuckard. Saunders, 1853, 142 (as *O. rubicola* Dufour): Epirus; ♂ of *Pseudoxenos klugii* described.

Odynerus leprieurii Spinola. Spinola, 1841, 128:= *Montezumia leprieurii* (Spinola).

Odynerus leucomelas Sauss. New record: Queen's Park, Aylmer, Quebec; 15 Aug. 1924; C. B. Hutchings; female, ♀-4L (Can. Nat. Coll.).

Odynerus manifestus Cresson. Salt, 1927, 184:= *O. primus* Dalla Tore.

Odynerus megæra Lepel. New record: Florida; female, ♂e-4R, ♂e-4L (Can. Nat. Coll.).

Odynerus molestus Sauss. Dury, 1902, 180: Cincinnati, Ohio.

Odynerus pedestris Sauss. Robertson, 1910, 325: Carlinville, Illinois; 6 July; Chas. Robertson. Pierce, 1911, 500: from above specimen describes ♀ of *Pseudoxenos pedestridis.*

Odynerus perennis Sauss. Salt, 1927, 184: Great Falls, Virginia; 9 Sept.; N. Banks; male, ♀-3L (M.C.Z.). Dyke, Virginia; 14 May; N. Banks; male, ♂p-4L (M.C.Z.).

Falls Church, Virginia; 27 June; N. Banks; female, ♀-3L (M.C.Z.).

Odynerus pratensis Sauss. Salt, 1927, 184: El Paso, Texas; female.

Odynerus primus Dalla Torre. Salt, 1927, 184 (as *O. manifestus* Cress.): Fedor, Texas; female.

Odynerus rubicola Dufour. Saunders, 1853, 142:= *O. lævipes* Shuckard.

Odynerus spinipes (Linn.). Saunders, 1872, 46: Corcyra; 22 May; ♂ of *Pseudoxenos corcyricus* described.

Odynerus sulphureus Sauss. New record: Baron, California; female, ♀-3R, ♀-3R, ♀-4L (U.S.N.M.).

Odynerus synagroides (Sauss.). New records: Stanleyville, Belgian Congo; 15 March; female, ♀-2L, ♂e-4L; and male, ♂p-3L (both A.M.N.H.). Coquilhatville, Belgian Congo; 15 October 1922; J. Bequaert; male, ♂e-5L.

Odynerus toas Cresson. Pierce, 1918, 489: Albuquerque, New Mexico; ♂ of *Pseudoxenos neomexicanus* described p. 463. Salt, 1927, 184: Valentine, Texas; male. El Paso, Texas, male. Steins, New Mexico; male.

Odynerus turpis Sauss. Robertson, 1910, 325: Inverness, Florida; 19 March; Chas. Robertson.

Odynerus vagans Sauss. Pierce, 1909, 181: Mound, Louisiana; 12 May; C. R. Jones; ♀ of *Pseudoxenos louisianæ* described p. 138.

Odynerus verus Cresson. Pierce, 1909, 181: in error for *O. hidalgi* Sauss.

Odynerus ziziæ Robt., mss. Robertson, 1918, Bull. Brooklyn Ent. Soc. 13, 85.

Rhynchium (See Odynerus).

Pachodynerus cubensis (Sauss.). Salt, 1927, 184: Soledad, Cuba; April; J. Bequaert; male, ♀3R, ♀-4L, ♀-4stL, ♂e-5R (♂ emerged in captivity).

Pachodynerus erynnis (Lepel.). Robertson, 1910, 325: Inverness, Florida; 10 Febr., 10 and 25 March; Chas. Robertson. Pierce, 1911, 506: Inverness, Florida; Chas. Robertson; ♀ of *Pseudoxenos erynnidis* described p. 499. Salt, 1927, 184: Lakeland, Florida; Wm. T. Davis. Inverness, Florida; Chas. Robertson. Miami, Florida; J. Bequaert.

New records: Inverness, Florida; Chas. Robertson; female, ♀-3L; male, ♀-3R, ♀-3L; male, ♀-2R, ♀-2L, ♂e-4R, ♂e-4L; and male, ♀3R, ♀-3L (all M.C.Z.). Punta Gorda, Fla.; 11 Nov. 1911; female, ♂p-3R, ♀-3L, ♀-3stL, ♂p-4L, ♀p-4R (A. M. N. H.). Royal Palm Park, Florida; 12-18 April 1923; male, ♀-4R (A.M.N.H.). Miami, Florida; 18 Dec. 1912; F. Knab; female, ♀-3L, ♂p-4R (U.S.N.M.).

Pachodynerus guadulpensis (Sauss.). Salt, 1927, 184: Santeurs, Grenada; Sept. 1910; Allen and Brues; female, ♀-3R.

Pachodynerus nasidens (Latr.). Salt, 1927, 184: Puerto Castilla, Rep. Honduras; J. Bequaert.

New record: Ypiranga, R. Iga-Putumayo, Brazil; 29 Aug. 1920; Cornell Univ. Exped.; female, ♀-2L, ♀-3R.

Pachodynerus præcox (Sauss.). New record: St. Benedict Mt., Tunapuna, Trinidad; 3 Sept. 1927; M. G. Netting; male, ♀-3R, ♂p-4L.

Pachodynerus punctulatus Brèthes. New records: Iguazu Falls, Argentina; 20-22 Jan. 1920; Cornell Univ. Exped.; female, ♀-3L, ♂e-4L, ♂e-4R. Paso de 1. Libres, Corrientes, Argentina; 12-14 Jan. 1920; Cornell Univ. Exped.; female, ♂p-4L, ♀-4R.

Ancistrocerus sp. *(auctus* (Fabr.)?) [*A. auctus* (Fabr.) = *A. parietum* (Linn.)]. Heyden, 1836, lxxiv: ♂.

Ancistrocerus albophaleratus (Sauss.). Pierce, 1911, 506 [as *A. capra* (Sauss.)]: Washington State; male, ♂e-4L U.S.N.M.). Salt, 1927, 184: Canaan, Connecticut; J. Bequaert. Halfway House, Mt. Washington, New

Hampshire; C. W. Johnson. Maine. Bilby, Alberta; George Salt.

New record: Edmonton, Alberta; 23 June 1924; George Salt; male, ♀-3L.

Ancistrocerus bacu (Sauss.). New records: Soledad, Cuba; 3 April 1926; J. Bequaert; female, ♂-e3L, ♂ 4R. Hoyo Colorado, Cuba; Oct. 1923; C. Enamorado; female, ♂ p-4L.

Ancistrocerus birenimaculatus (Sauss.). Salt, 1927, 184: Flushing, New York; J. Bequaert, Newfoundland, New Jersey.

New records: vicinity of New York, New York; ex nest; 1924; female, ♂ p-4L; male, ♂ p-3R; male, ♂ p-4R; male, ♂ p-4L male, ♂ p-4R (all A.M.N.H.).

Ancistrocerus bradleyi (Robt.). Robertson, 1910, 324 (as *A. clypeatus* (Robt.)); Carlinville, Illinois; 24 May, 31 May; Chas. Robertson. Salt, 1927, 183: no data.

Ancistrocerus campestris (Sauss.). Pierce, 1909, 180: Missouri; C. V. Riley; ♂ e (U.S.N.M.).

Ancistrocerus capra (Sauss.). Pierce, 1911, 506: in error for *A. albophaleratus* (Sauss.).

Ancistrocerus catskillensis (Sauss.). Salt, 1927, 184: Forest Hills, Massachusetts; L. H. Taylor. Auburndale, Massachusetts; C. W. Johnson. Keene Valley, New York; H. Notman. Colebrook, Connecticut; W. M. Wheeler. Salt, 1927, 184 (as *A. waldenii* (Vier.)): Forest Hills, Massachusetts; O. E. Plath.

New record: Put-in-Bay, Bass Island, Ohio; 1-10 July; C. H. Kennedy; male, ♀-4R.

Ancistrocerus clypeatus (Robt.). Robertson, 1910, 324:= *A. bradleyi* (Robt.).

Ancistrocerus fulvipes (Sauss.). Pierce, 1909, 180 (As *O. colon* Cresson): Mound, Louisiana; 12 May; C. R. Jones; ♀ of *Pseudoxenos jonesi* described p. 138. Salt, 1927, 184: Lee County, Texas; G. Birkman. New Braunfels, Texas; 27 June 1917; J. Bequaert; male, ♂ e-4L.

Ancistrocerus hæmatodes (Brullé). New record: Canary Islands; ♀-3L (Cornell Univ.).

Ancistrocerus histrio (Lepel.). Robertson, 1910, 325: Inverness, Florida; 20 and 24 March; Chas. Robertson. Pierce, 1911, 506: Inverness, Florida; 20 March; Chas. Robertson; ♀ of *Pseudoxenos histrionis* described p. 500. Salt, 1927, 184: Inverness, Florida; Chas. Robertson.

Ancistrocerus histrionalis (Robt.). Robertson, 1910, 324: Carlinville, Illinois; 5 and 27 Aug.; Chas. Robertson. Pierce, 1911, 506: Carlinville, Illinois; 27 Aug.; Chas. Robertson; ♀ of *Pseudoxenos robertsoni* described p. 501. Salt, 1927, 184: no data.

Ancistrocerus parietum (Linn.). Saunders, 1872, 44: Corcyra; Oct.; ♂ of *Pseudoxenos schaumii* described. Ogloblin, 1925, Bull. Ent. Pologne 3, 120: Mielnica, Poland; 20 Aug. 1922; V. Noskiewicz; male 4♂p, ♀, and triungulinids of *Pseudoxenos schaumii* Saunders. Salt, 1927, 184: Ithaca, New York.

Ancistrocerus pertinax (Sauss.). Pierce, 1909, 180: National Park, Wyoming; 31 July; male.

Ancistrocerus sexcingulatus Ashmead. Pierce, 1911, 507: Florissant, Colorado; 26 June 1907; S. A. Rohwer.

Ancistrocerus tigris (Sauss.). Robertson, 1910, 324: Carlinville, Illinois; 23 Sept.; Chas. Robertson. Pierce, 1911, 501: from above specimen describes ♀ of *Pseudoxenos tigridis*. Salt, 1927, 184: Ramsey, New Jersey; 6 and 16 June 1916; J. Bequaert; male, ♀-3R; male, ♂p-4L. Fort Lee, New Jersey; 3 Sept. 1916; female, ♂p-4L. Falls Church, Virginia; 18 Sept.; N. Banks; female, ♀-3L, ♂p-4R (M.C.Z.). Glencarlyn, Virginia; 26 Sept.; N. Banks; female, ♀-3L (M.C.Z.). Melsh, Pennsylvania; female, ♀-3L (M.C.Z.). Colebrook, Connecticut; 6 Sept. 1921; W. M. Wheeler; female, ♀-3L, ♀-4R. Colebrook, Connecticut; 23 Aug. 1919; W. M. Wheeler; female, ♀-4R.

New record: Put-in-Bay, Bass Island, Ohio; 1-10, July; C. H. Kennedy; male, ♀-3L.

Ancistrocerus waldenii (Vier.). Salt, 1927, 185: in error for *A. catskillensis* (Sauss.).

New record: Montreal, Quebec; W. Couper; female, ♂ p-4L (U.S.N.M.).

Monobia quadridens (Linn.). Pierce, 1909, 180: Wolfe City, Texas; 31 May; ♀. Orange, Louisiana; 23 Aug.; F. C. Bishopp; ♀ of *Monobiaphila bishoppi* described p. 139.

New records: Pensacola, Florida; 11-14 Oct. 1914; female, ♀-4L, ♀-4R (A.M.N.H.). New York, New York; male, ♀-3R, ♀-3L, ♂ e-5R, ♂ e-5L (A.M.N.H.). Yaphank, Long Island, New York; 12 July; male, ♀-3R, ♂ p-5L (A.M.N.H.). Paterson, New Jersey; 21 July; male, ♀-4L (A.M.N.H.).

Montezumia sp. near brunnea Smith. Salt, 1927, 183: Rio Salado, Chaco de Santiago del Estero, Argentina; female.

Montezumia infernalis (Spinola). Salt, 1927, 183: Villarica, Paraguay; 1923; female.

New records: Chapada, Brazil; March; female, ♂ p-4R, ♂ p-5L (A. N. S. P.). Paraguay; female, ♀-4L (A.M.N.H.).

Montezumia leprieurii (Spinola). Spinola, 1841, Ann. Soc. Ent. France 10, 128 (as *Odynerus leprieurii* Spinola): Cayenne, French Guiana; female, ♂ e-5.

Montezumia vigilii Brèthes. Brèthes, 1923, 45: Cordoba, Rep. Argentina; ♀ of *Montezumiaphila vigili* described.

Polybiinæ

Nectarina lecheguana (Latr.). New record: Tacna, Rio Putumayo, Peru; 28 Aug. 1920; Cornell Univ. Exped.; female, ♀-5R.

Polybia sericea (Olivier). Smith, 1859, 131: Brazil; female, ♀-4.

Mischocyttarus flavitarsis (Sauss.). Pierce, 1918, 490 (as *Megacanthopus flavitarsis* [Sauss.]): Stone Cabin Canyon, Santa Rita Mts., Arizona; 25 Aug. 1913; W. D. Pierce.

Clypeopolybia duckei Brèthes. Brèthes, 1923, 46: Bolivia; female, ♀ of *Clypoxenos americanus* described.

Belonogaster brunneus Ritsema. New record: Lenga Town, Liberia; 16 Aug. 1926; J. Bequaert; male, ♀-4L.

Belonogaster dubius Kohl. du Buysson, 1909, 236: female, 4L.

Belonogaster elegans Gerst. See *B. lateritius* var. *elegans* (Gerst.).

Belonogaster filiventris (Sauss.). Salt, 1927, 185: La Panda, Katanga, Belgian Congo; 2 Oct. 1920; Mich. Bequaert; female.

Belonogaster griseus (Fabr.). Saunders, 1872, 36: Africa; ♀. Saunders, 1872, 36 (as *B. rufipennis* Degeer): Africa; ♂e and ♀. du Buysson, 1909, 249; female, ♂p-4R.

New record: Boma, Congo; 16 June 1915; Lang and Chapin; female, ♂p-5L (A.M.N.H.).

Belonogaster guerini (Sauss.). du Buysson, 1909, 226: male, 5R.

Belonogaster junceus (Fabr.). Smith, 1859, 130: Tripoli; ♀. Salt, 1927, 185: Masinga Archipelago, Victoria Nyanza; J. Carl.

New records: Medje, Belgian Congo; Jan.; Lang and Chapin; female, ♂e-3R (A.M.N.H.). Stanleyville, Belgian Congo; 8 Aug. 1909; Lang and Chapin; male, ♀-4R (A.M.N.H.). Faradje, Belgian Congo; Sept. 1912; Lang and Chapin; female, ♀-3L (A.M.N.H.). Moala, Liberia; 3 Nov. 1926; J. Bequaert; male, ♂p-6L. Gbanga, Liberia; 12 Sept. 1926; J. Bequaert; female, ♂p-4L; female, ♀-4L; and female, ♂e-3L, ♂e-4L, ♀-4R.

Belonogaster lateritius Gerst. var. **elegans** (Gerst.). Zavattari, 1909, Ruwenzori Rel. Sci. 1, 212 and 271-273: Butiti, Uganda, July; ♀. Pierce, 1911, 498: from above specimen describes ♀ and triungulinids of *Belonogastechthrus zavattarii.*

Belonogaster pusillus Kohl. du Buysson, 1909, 239: worker, e-4L.

New record: Garamba, Belgian Congo; July 1912; Lang and Chapin; female, ♂ e-4L (A.M.N.H.).

Belonogaster rufipennis (Degeer). Saunders, 1872, 36:= *B. griseus* (Fabr.).

Belonogaster turbulentus Kohl. du Buysson, 1909, 240: female, ♀-4R.

Ropalidiinæ

Ropalidia cincta (Lepel.). Salt, 1927, 185: Gali, Belgian Congo; J. Bequaert; male.

Ropalidia ferruginea (Fabr.). Horne, 1870, 170: North-west Provinces of India.

Ropalidia nobilis (Gerst.). Salt, 1927, 185: Lisala, Congo; Oct. 1924; female, ♂ e-5R.

Polistinæ

Polistes spp. Saunders, 1872, 36: Caffra; ♂. Fenyes, 1901, Ent. News 12, 90: Mount Arlington, New Jersey (probably *P. fuscatus* var. *pallipes* [Lepel.]). Muir, 1906, Bull. Haw. S. P. Assoc. 2, 9: Honolulu, Hawaii. Pierce, 1909, 184: Virginia; ♂ (A.N.S.P.). Victoria, Texas; 27 June; C. R. Jones; 25 Sept.; J. C. Crawford; ♀ and ♂ p of *Xenos hunteri* described p. 130. Hat Creek, Sioux County, Nebraska; Aug.; ♀ and ♂ e of *Xenos bruneri* Pierce (described?). Schrader, 1924, 162: Connecticut; New York; Pennsylvania; District of Columbia; Maryland. Leonard, 1928, Cornell Univ. Agric. Exp. Station Memoir 101, 521: Staten Island, New York.

Polistes americanus Fabr. See *P. crinitus* var. *americanus* (Fabr.).

Polistes anaheimensis Provancher. Pierce, 1918, 489:=*P. fuscatus* var. *bellicosus* (Cresson).

Polistes annularis (Linn.). See *P. canadensis* var. *annularis* (Linn.).

Polistes aurifer Sauss. See *P. fuscatus* var. *aurifer* (Sauss.).

Polistes bellicosus Cresson. See *P. fuscatus* var. *bellicosus* (Cresson).

Polistes canadensis (Linn.). Pierce, 1909, 182: Texas; ♂e. See also *P. canadensis* var. *metricus* Say. Hoffman, 1914, Zool. Anz. 45, 99: Uruguay; Bohls; ♂, ♀, and triungulinids of *Xenos bohlsi* described.

Polistes canadensis (Linn.) var. **annularis** (Linn.). Brues, 1903, 242 and 246: Austin, Texas; May 1901; C. T. Brues; ♂ of *Xenos pallidus* described. Brues, 1905, 291: Texas; ♂ and ♀ of *Xenos pallidus* Brues, and ♂ and ♀ of *Xenos nigrescens* Brues. Pierce, 1909, 181 and 182: Paxton, Texas; 9 Aug.; W. D. Pierce; ♀. Rosser, Texas; Sept. and Oct.; F. C. Bishopp and C. R. Jones; ♂ and ♀ of *Xenos pallidus* Brues. Agricultural College, Mississippi; ♀. Bennington, Indian Territory; 28 Aug.; J. C. Crawford. Victoria, Texas; 16 July; W. E. Hinds; female, ♀-4R, ♀-5L (U.S.N.M.). Texas; G. W. Belfrage; male, ♂p-2R, ♂p-6L (U.S.N.M.). Plummer's Island, Maryland; Nov. 1907; W. P. Hay and W. L. McAtee; ♂p and ♀ of *Xenos pallidus* Brues. Pierce, 1918, 489: Louisville, Nebraska; 2 Aug. 1914; H. A. Jones and E. G. Anderson; 7 females, ♂ of *Xenos pallidus* Brues. Omaha, Nebraska; 20 Aug. 1913; L. T. Williams; female, ♀ of *Xenos pallidus* Brues. New Orleans, Louisiana; E. Foster. Salt, 1927, 185: Mongolia County, West Virginia; L. H. Taylor; male and 2 workers. Rau, 1929, Bull. Brooklyn Ent. Soc. 33, 231: Kirkwood, Missouri; P. Rau; 2 females.

New records: Orlando, Florida; 7 Dec. 1906; female, ♀-5L; female, ♀-5L; female, ♂e-2R, ♂e-3R, ♀-5R, ♀-5L; female, ♀-4L, ♂e-3R (all U.S.N.M.). Orlando, Florida; 17 June 1907; Chittenden; female, ♀-5R (U.S.N.M.).

Polistes canadensis (Linn.) var. **lanio** (Fabr.). New record: Las Loras, near Puntarenas, Costa Rica; 18 Sept. 1905; F. Knab; female, ♀-5R (U.S.N.M.).

Polistes canadensis (Linn.) var. **metricus** (Say). Note: Northern records of *P. metricus* Say refer to *P. fuscatus* var. *pallipes* (Lepel.). Pierce, 1909, 182 (as *P. canadensis* (Linn.); Mound, Louisiana; 20 Aug. 1906; F. C. Bishopp; female, ♂ e-3L (U.S.N.M.). Pierce, 1909, 183 (as *P. navajoe* Cresson): Metacomba Key, Florida; March 1898; G. N. Collins; female, ♂ e-3L (U.S.N.M.). Pierce, 1909, 184 (as *P. rubiginosus* Lepel.): Onaga, Kansas; Crevecoeur; female, ♂ e-3R (U.S.N.M.).

Polistes canadensis (Linn.) var. **unicolor** (Lepel.). Lepeletier, 1836, Hist. Nat. Ins. Hym. 1, 520: Cayenne, French Guiana; Doumerc; worker, ♂ e-5.

Polistes carnifex (Fabr.) Pierce, 1909, 182: Mexico; ♂ p and ♂ e. New record: "Colom"; C. F. Baker; female, ♂ p-4R, ♀-5L (U.S.N.M.).

Polistes cavapyta Sauss. Brèthes, 1923, 43; San Luis, Rep. Argentina; ♀ of *Xenos argentinus* described.

Polistes crinitus (Felton). Pierce, 1909, 182: See *P. crinitus* var. *americanus* (Fabr.). Pierce, 1918, 490: New Orleans, Louisiana; E. Foster (this record is very doubtful as *P. crinitus* probably does not occur on the American mainland). Salt, 1927, 185: Sanchez, Rep. Dominicana; 17-21 May 1915; female, ♂ p-4R; female, ♂ p-3L; female, ♂ p-3R; female, ♂ e-4L; female, ♂ p-3R, ♂ p-4L.

Polistes crinitus (Felton) var. **americanus** (Fabr.). Smith, 1859, 131: North America; female, ♂ e. Hubbard, 1892, Can. Entom. 24, 258: Florida. Pierce, 1909, 122 and 182 (based on Hubbard's specimens): Crescent City, Florida; 6 April; H. G. Hubbard; 14 ♂, ♀, and triungulinids of *Xenos hubbardi* (Pierce, 108, Proc. Ent. Soc. Wash. 9, 84). These three records are certainly erroneous as *P. crinitus* var. *americanus* (Fabr.) does not occur on the American mainland. Salt, 1927, 185: Mayaguez, Porto Rico; 16-16 Febr. 1914; female, ♂ p-4R; female, ♀-5L. Coamo Springs, Porto Rico; 17-19 July 1914; female, ♂ e-3L, ♀-5L. Manati, Porto Rico; 27-29 June

1915; female, ♀-5L. Cayey, Porto Rico; 30-31 May 1915; female, ♀-5R. Jayuya, Porto Rico; 6 Jan. 1915; female, ♂ p-3R. Aibonito, Porto Rico; 14-17 July 1914; female, ♂ p-3R.

New record: Porto Rico; female, ♀-3L (Hamburg Mus.).

Polistes cubensis Lepel. Pierce, 1909. 183 (as *P. lineatus* (Fabr.)): Cuba; Palmer and Riley; ♂ p and ♂ e (one specimen seen: female, ♂ e-4R (U.S.N.M.).

Polistes diadema Latr. See *P. gallicus* var. *diadema* (Latr.).

Polistes erythrocerus Cameron. Cameron, 1900, Ann. Mag. Nat. Hist. (7) 6, 419: Kamakura, Japan; George Lewis; female.

Polistes flavus Cresson. Pierce, 1909, 182=*P. fuscatus* var. *aurifer* (Sauss.).

Polistes fuscatus (Fabr.). See *P. fuscatus* var. *pallipes* (Lepel.).

Polistes fuscatus (Fabr.) var. **apachus** (Sauss.). Brues, 1903, 242 (as *P. texanus* Cresson): Austin, Texas; ♂ e. Anonymous, 1903, Ent. News 14, 274 (as *P. texanus* Cresson): Pecos, Texas. Pierce, 1909, 184 (as *P. texanus* Cresson): New Mexico; C. F. Baker; female, ♂ e-3R, ♂ e-3L (U.S.N.M.). Victoria, Texas; 7 July; C.M. Walker; ♂ p. Victoria, Texas; 25 July; C.R. Jones; ♀ and ♂ e of *Xenos texani* described p. 132. Pecos, Texas; 27 Febr., 25 and 30 Sept.; A. E. Brown; ♂, ♂ p, and ♀ of *Xenos pecosensis* described p. 128.

Polistes fuscatus (Fabr.) var. **aurifer** (Sauss.). Perkins, 1899, Fauna Hawaiiensis 1, 29: Lanai and Hawaii. Pierce, 1909, 182: Washington State; ♂. California; ♂ p. Folsom, California; 10 and 12 July; female, ♂ e-3R, ♂ e-4L; and female, ♂ e-4L (both U.S.N.M.). Pierce, 109, 182 (as *P. flavus* Cresson): Colorado; ♂ p (U.S. N.M.). Pierce, 1911, 507: Palo Alto, California; Febr. 1892; W. G. Johnston; ♂ e and ♀ of *Xenos auriferi* described p. 498. Terry, 1912, Proc. Haw. Ent. Soc. 2, 181: Hawaii. Ehrhorn, 1915, Proc. Haw. Ent. Soc. 3, 86: Honolulu, Oahu, Hawaii. Pierce, 1918, 489: Auburn, California; 14 Aug. 1915; L. Bruner; female, ♀. Williams, 1927, Proc. Haw. Ent. Soc. 6, 463: Hawaii.

New records: "W. T."; male, ♂p-4L (A.N.S.P.). No data; female, ♂e-3R (A.N.S.P.).

Polistes fuscatus (Fabr.) var. **bellicosus** (Cresson). Pierce, 1909, 182 (with doubt): Natchitoches, Louisiana; 15 Sept.; ♂. Pierce, 1918, 489: Stone Cabin Canyon, Santa Rita Mts., Arizona; 24 Aug. 1913; W. D. Pierce; ♂p. Pierce, 1918, 489 (as *P. anaheimensis* Provancher): Auburn, California; 23 July 1915; L. Bruner; male, ♀ of *Xenos californicus* Pierce (described?).

Polistes fuscatus (Fabr.) var. **pallipes** (Lepel.). Kirby, 1813, 116 (as *P. fuscatus* (Fabr.) .: Newbury, Massachusetts; ♂ and ♀ of *Xenos peckii* described. Austin, 1882, Journ. Bost. Zoöl. Soc. 1, 12 (as *P. metricus* Say): Reading, Massachusetts. Dury, 1902, 180 (as *P. fuseatus* [Fabr.]): Cincinnati, Ohio; ♂. Brues, 1903, 241 (as *P. metricus* Say). Pierce, 1909, 183: Marion, Massachusetts; 2-12 Sept.; F. C. Bowditch; ♂ and ♀ of *Xenos bowditchi* described p. 130. Cincinnati, Ohio; June-Sept.; ♂, ♀ ♂p, and ♀e of *Xenos bowditchi*. Pierce, 1909, 183 (as *P. metricus* Say): Colebrook, Connecticut; Aug.; W. M. Wheeler; ♂ and ♀ of *Xenos wheeleri* described p. 129. Washington, D.C.; 6 Sept.; ♂ of *Xenos wheeleri* (Pierce). Ithaca, New York; Aug. and Sept. Detroit, Michigan; ♂ and ♀ of *Xenos bruesi* described p. 124. Chicopee, Massachusetts; F. Knab; female, ♂e-3stR, ♂e-4R, ♂e-4L; and female, ♂e-4R (both U.S.N.M.). Pierce, 1909, 183 (as *P. instabilis* Sauss.): New Orleans, Louisiana; July; female, ♂e-4L (U.S.N.M.). Pierce, 1909, 184 (as *P. variatus* Cresson): Washington, D.C.; female, ♂p-3L, ♂e-4R (U.S.N.M.). Wheeler, 1910, 277 (as *P. metricus* Say): Colebrook, Connecticut; Aug. 1900; W. M. Wheeler. Pierce, 1911, 507 (as *P. metricus* Say): Cornell Univ., Ithaca, New York. Salt, 1927, 185: Colebrook, Robertsville, and Chapenville, Connecticut; W. M. Wheeler.

New records: Cincinnati, Ohio; 16 Sept. 1905; male, ♂ e-3L (U.S.N.M.). Pennsylvania; C.F. Baker; male, ♂ p-4R (U.S.N.M.). Washington, D.C.; Oct. 1884; male, ♂ e-4R, ♀ -5L (U.S.N.M.).

Polistes fuscatus (Fabr.) var. **perplexus** (Cresson). Pierce, 1909, 183: Texas; ♂ e.

Polistes fuscatus (Fabr.) var. **rubiginosus** (Lepel.). Brues, 1903, 242: Austin, Texas; Oct. 1901; C. T. Brues; ♂ and ♀ of *Xenos nigrescens* described p. 247. Brues, 1905, 290: Paris, Texas; 22 May; C. T. Brues: ♀ and triungulinids of *Xenos nigrescens* Brues. Pierce, 1909, 184: Round Mountain, Texas; ♂ e and ♀. Logansport, Louisiana; 6 June; W. D. Pierce; ♂ p and ♀ of *Xenos rubiginosi* described p. 132. New Boston, Texas; 26 Sept. 1906; F. C. Bishopp; male, ♂ e-3L, ♂ e-4R, ♂ e-4stR; and male, ♂ p-3L, ♂ e-4stL, ♂ e-5R (both U.S. N.M.). Henrietta, Texas; 5Oct. 1906; F. C. Bishopp; male, ♂ e-4L (U.S.N.M.). Mineola, Texas; 19 July 1906; Bishopp and Jones; female, ♂ e-2R, ♂ e2-L, ♂ e-3stR, ♂ e-4stL, ♀ -4L, ♂ e-4R, ♀ e-5L (U.S.N.M.). Waco, Texas; 29 Aug. 1906; F. C. Bishopp; female, ♂ e-3L, ♀ e-4R, (♀ removed?) of *Xenos pecosensis* described p. 128 (U. S.N.M.). Texas; ♀ of *Xenos maximus* described p. 132. See also *P. canadensis var. metricus* (Say). Pierce, 1911, 507: Arlington, Texas; 30 Sept.; ♂ e. Tallulah, Louisiana; 29 Jan. and 16 Febr.; V. I. Safro; ♂ e and ♀.

Pierce, 1918, 490: New Orleans, Louisiana; E. Foster.

New record: Victoria, Texas; 15 June 1904; female, ♂ e-2L (U.S.N.M.).

Polistes fuscatus (Fabr.) var. **variatus** (Cresson.) Brues, 190, 241: parasitized by *Xenos peckii* Kirby. Pierce, 1909, 184: in error for *P. fuscatus var. pallipes* (Lepel.). Robertson, 1910, 324: Carlinville, Illinois; 30 Sept.; Chas. Robertson. Wheeler, 1910, 377: Chicago, Illinois; W. M. Wheeler. Pierce, 1911, 507: Church's Island, Maryland; 3 Nov.; W. L. McAtee; ♂ and ♀. Pierce, 1918, 490: Clarksville, Tennessee; 10 Nov. 1915;

E. E. Crumb; 4 ♂ e. Lanham, Maryland; 24 Nov. 1915; H. F. Loomis; ♂ p and ♀. Salt, 1927, 185: Carlinville, Illinois; Chas. Robertson; male, ♀-5L.

Polistes gallicus (Linn.). Rossi, 1793, Bull. Sci. Soc. Philomath. Paris 1, 49: Italy; ♂ of *Xenos vesparum* described. Rossi, 1807, Fauna Etrusca 2, 136. Kirby, 1813, 116: Europe; ♂ and ♀ of *Xenos rossii* described. Jurine, 1818, Mem. R. Accad. Sci. Torino 23, 63; Italy. Heyden, 1836, lxxix: ♀. Rosenhauer, 1842, Stettin. Ent. Zeit. 2, 53: Germany. Saunders, 1853, 125: Albania. Saunders, 1866, Proc. Ent. Soc. Lond. (3) 2, 116. Saunders, 1872, 36: Europe; *Xenos jurinei* described p. 39. Rouget, 1873, 268: France. Nassanow, in Hofeneder, 1910, 3: Cairo, Egypt. Léveillé, 1895, Bull. Soc. Ent. France (1895), vi: Gryon, Canton de Vaud, Switzerland; Aug. 1894. Pierce, 1909, 183: Innsbruck, Austria; 28 Oct.; Karl Hofeneder; worker, ♂ e-3R, ♂ e-5L U.S.N.M.). Rabaud and Millot, 1927, C.R. Soc. Biol. 96, 944. Salt, 1927, 185: no data; worker, ♂ e-4R.

Polistes gallicus (Linn.) var. **diadema** (Latr.). Rouget, 1873, 268: France. Hofeneder, 1910, 5 footnote: female, 6 ♂ p.

Polistes hebraeus (Fabr.). Horne, 1870, 171; Maxwell-Lefroy and Howlett, 1909, 395; and Pierce, 1918, 490: =*P. olivaceus* (Degeer).

Polistes instabilis Sauss. Smith, 1859, 131: Brazil; female, 4 ♂ e and 5 ♀; incorrectly determined. Pierce, 1909, 183: in error for *P. fuscatus* var. *pallipes* (Lepel.).

Polistes lineatus (Fabr.). Pierce, 1909, 183:=*P. cubensis* Lepel.

Polistes major Beauvois. Pierce, 1918, 490: District Federal, Mexico; J. R. Inda; 4 ♂ e and 4 ♂ p.

Polistes marginalis (Fabr.). Schulz, 1905, Hymen. Studien. 15: Boma, Belgian Congo; worker, 5 parasites.

New records: Luvungi, Belgian Congo; 30 Jan. 1927; J. Bequaert; female, ♂ e-3L, ♂ e-4L, ♂ e-4R. Kwamouth, Belgian Congo; 13 Dec. 1926; J. Bequaert; male

♂e-3L, ♂e-3stL, ♀-3R, ♀-3R, ♂e-5R; and male, ♀-3stR, ♂p-4R, ♀-6L.

Polistes metricus Say. See *P. canadensis* var. *metricus* (Say) and *P. fuscatus* var. *pallipes* (Lepel.).

Polistes minor Beauvois. Pierce, 1918, 490: in error for? (*P. minor* does not occur in Louisiana, the locality given by Pierce).

Polistes navajoe Cresson. Pierce, 1909, 183: in error for *P. canadensis* var. *metricus* (Say).

Polistes olivaceus (Degeer). Horne, 1870, 171: North-west Provinces of India. Maxwell-Lefroy and Howlett, 1909, Indian Insect Life, 395; India; ♂. Pierce, 1918, 490: Pusa, Bihar, India; 12 April 1911; G. R. Dutt; ♂ and ♀.

Polistes opinabilis Kohl. Fahringer, 1919, Zeitschr. wiss. Ins. biol. 15, 48: Pola, Istria, Italy.

Polistes pallipes Lepel. See *P. fuscatus* var.*pallipes* (Lepel.).

Polistes perplexus Cresson. See *P. fuscatus* var. *perplexus* (Cresson).

Polistes rubiginosus Lepel. See *P. fuscatus* var. *rubiginosus* (Lepel.).

Polistes stigma (Fabr.). Horne, 1870, 172: North-west Provinces of India.

Polistes texanus Cresson=*P. fuscatus* var. *apachus* (Sauss.).

Polistes unicolor Lepel. See *P. canadensis* var. *unicolor* (Lepel.).

Polistes variatus Cresson. See *P. fuscatus* var. *variatus* (Cresson).

Polistes versicolor (Olivier). Brèthes, 1923, 44; Buenos Aires, Rep. Argentina; ♂ and ♀ of *Xenos bonariensis* described.

Vespinæ

Vespa acuta Lefebvre in Ann. Soc. Ent. France 4: xlv; 1835. (a nomen nudum).

Vespa carolina Linn. Pierce, 1918, 489: Clarksville, Tennessee; 19 Oct. 1915; S. E. Crumb; male, ♂ p.

Vespa concolor Kirby. Kirby, 1813, 118: ♂ e.

Vespa crabro Linn. Pierce, 1909, 181 Japan; female, ♀ of *Vespaexenos crabronis* described p. 134.

Vespa ducalis Smith, du Buysson, 1906, Revue d'Entom. 25, 11: Hué, Annam; E. Fleutiaux; worker, ♂ p-4R. Parasite extracted and described as the ♂ of *Vespaexnos moutoni* du Buysson. Pierce, 1903, 134: proposes *Vespaexenos buyssoni* new name.

Vespa lama du Buysson. du Buysson, 1906, 175 (additional data in du Buysson, 1905, 580) ; Sikkim, India; ♀-5R.

Vespa magnifica Smith. du Buysson, 1903, 175 (additional data in du Buysson, 1905, 526) : Yun-nam, China; male, ♂ p-4st. Tsé-kou, China; worker, ♀-5. ♀ of *Vespæxenos moutoni* du Buysson.

Vespa mandarinia Smith. du Buysson, 1903, 175 (additional data in du Buysson, 1905, 522) : Ngan-hoei, China; R. P. Mouton. Yng-chan, China. ♀ of *Vespæxenos moutoni* described p. 175 .

New records: Kyoto, Japan; female, ♀-5R; and female, ♀-5R (both A.N.S.P.).

Vespa mongolica André. New record: Kyoto, Japan; female, ♂ p-4R (A.N.S.P.).

Vespa nigrans du Buysson. du Buysson, 1903, 175: Yunnam, China. Tsé-kou, China. ♀ of *Vespaexenos moutoni* (du Buysson).

Vespa vulgaris Linn. Heyden, 1836, lxxiv: Stuttgart, Germany; Van Roser; ♀.

GROUPS STYLOPIZED

Our list includes members of eight of the eleven subfamilies of Vespidæ. The Euparagiinæ, Gayellinæ, and Stenogastrinæ are unrepresented. Of the Gayellinæ we have examined only about half a dozen specimens for

Strepsiptera, and of the Stenogastrinæ and Euparagiinæ fewer than fifty, so we are not surprised that parasitized examples have not yet turned up.

There are, however, some rather puzzling lacunæ. Among the Eumeninæ, *Synagris* forms one; we have deliberately examined over four hundred specimens without finding any evidence of stylopization. That more infested individuals of Polybiinæ, and especially of *Polybia, Metapolybia,* and *Mischocyttarus,* are not known is surprising when one considers their abundance in the tropics; we ourselves have examined some hundreds of specimens especially from the West Indies and Colombia without finding a single parasitized example. The genue *Vespa* contributes several species to the list but the common forms, of which one might expect numerous records if they are subject to strepsipterous attack, are conspicuously absent.

The data, however, are lacking rather than actually negative; and in spite of these contrary indications in certain groups it has frequently occurred to us, as we gathered the records, that sooner or later stylopized specimens will be found in most, if not all, of the genera of Vespidæ. The majority of the common genera are already known to be attacked, at any rate occasionally, and our lack of records for the rarer groups is not surprising when one considers the very low frequency of stylopization in the Vespidæ as a whole. Until 1927 no representative of the Zethinæ had appeared in the host lists; now five stylopized specimens belonging to three species are known. The Ropalidiinæ were long included solely on the basis of Horne's record from India; three specimens are listed above. It was not until 1909 that Pierce recorded the first case of stylopization in *Monobia,* and until 1923 that *Montezumia* was first found infested by Brèthes. In his monograph of *Nectarina,* du Buysson (1905*a*) mentioned expressly that he had not seen a stylopized specimen of that genus; Crawford (Pierce, 1909, p. 23) studied 2500 individuals of *Nectarina lecheguana* from one nest, without finding a single example parasitized; and we ourselves examined several hundreds of specimens before finding the infested one recorded above. It would seem, therefore, that infested individuals are eventually found in most groups. We hope that the publication of this list will stimulate those interested in the taxonomy of the Vespidæ to mention the stylopized examples contained in the collections they study.

THE FREQUENCY OF STYLOPIZATION

The frequency of stylopization, then, varies from zero in certain groups to as much as 25% in particular collections of *Polistes* (Wheeler, 1910; Schrader, 1924). In our search for stylopized specimens we have kept some count of the frequency of their occurrence in several collections and in different taxonomic groups, and are able to give the following figures. Unfortunately we did not always make notes upon the frequency, and while the following numbers are proportionate, they do not represent our entire search.

Vespidæ	of 16,932	specimens	157	stylopized, or	0.93%
Masaridinæ	256	"	0	"	0 %
Raphiglossinæ	8	"	0	"	0 %
Zethinæ	158	"	4	"	2.53%
Eumeninæ	14,926	"	138	"	0.92%
Eumenes	1,651	"	11	"	0.67%
Odynerus s. l.	4,316	"	35	"	0.81%
Monobia	271	"	4	"	1.48%
Montezumia	152	"	0	"	0 %
Synagris	443	"	0	"	0 %
Pterochilus	74	"	0	"	0 %
Alastor	65	"	0	"	0 %
Polybiinæ	623	"	8	"	1.28%
Ropalidiinæ	160	"	2	"	1.25%

No records were kept of the frequency of stylopized Polistes in collections because much more accurate data based on field counts are available for this genus (see Pierce, 1909, 1911, 1918; Schrader, 1924).

In the American Museum of Natural History is preserved a mud nest of *Ancistrocerus birenimaculatus*, and the twenty-two wasps which emerged from it. Five of these twenty-two wasps, or 22.7%, are stylopized; showing that the rate of parasitism in particular nests can be almost as high in *Ancistrocerus* as it has been reported for particular colonies of *Polistes*.

THE SEX OF THE HOST

As far as can be judged from our data both sexes of the host are attacked with equal readiness. The following is a summary of the cases in our list in which the sex of the host is known. In giving these and following figures we have not thought it necessary to incorporate the data so admirably summarized by Pierce (1909, 17-23; 1911, 487-489; 1918, 392-393, 396-397), and have confined ourselves to those in the above list.

	Males	*Females*		*Males*	*Females*
Masaridinæ	8	4	Montezumia	0	5
Zethinæ	1	4	Polybiinæ	4	15
Eumenes	7	8	Ropalidia	1	1
Odynerus s.l.	50	49	Polistes	13	56
Monobia	3	1	Vespa	2	6

Where, as in *Polistes* and the Polybiinæ, decidedly more female than male hosts are known, this must undoubtedly be attributed to the fact that females of these groups are much more commonly collected.

POSITION OF THE PARASITE IN THE HOST

As would be expected, the parasites extrude in about equal numbers on the two sides of the host. A summary of the cases in our list for which the side is recorded gives 132 on the right and 141 on the left.

A very strong preference is shown for a dorsal position. In our list only ten cases of extrusion between the sternites appear. One of these occurs in *Vespa* and was recorded by du Buysson. Of the nine cases which we have observed, seven occur in *Polistes* and two in *Pachodynerus*. In each of these nine cases the unusual, ventral position is obviously due to crowding, for in four cases the parasite appearing ventrally is one of three in the same host; in two cases one of four; in one case one of five; and in one case, where two parasites appear between the sternites, there are seven parasites present in the one wasp.

In an earlier paper (Salt, 1927) it has been shown that in *Odynerus (s. l.)* the female parasites usually occur under the third abdominal segment of the host and the males behind, under the fourth segment; while in *Polistes* the male parasites usually lie before, under the third and fourth segments, the females behind under the fifth. The same curious difference, together with additional facts, appear from a consideration of the cases recorded in our list; where the parasites are situated as follows:

Under abdominal segment number		*2*	*3*	*4*	*5*	*6*
In Eumenes . . .	♂ parasites	—	1	4	—	—
	♀ parasites	—	10	—	—	—
In Odynerus . . .	♂ parasites	—	5	17	7	—
	♀ parasites	1	25	24	—	—
In Pachodynerus. .	♂ parasites	—	1	9	1	—
	♀ parasites	3	13	4	—	—
In Ancistrocerus .	♂ parasites	—	2	12	—	—
	♀ parasites	—	8	3	—	—
In Monobia . . .	♂ parasites	—	—	—	3	—
	♀ parasites	—	3	3	—	—
In Montezumia . .	♂ parasites	—	—	1	2	—
	♀ parasites	—	—	1	—	—
In Belonogaster . .	♂ parasites	—	2	5	1	1
	♀ parasites	—	1	5	—	—
In Polistes	♂ parasites	5	26	27	5	1
	♀ parasites	—	3	3	14	1
In Vespa	♂ parasites	—	—	3	—	—
	♀ parasites	—	—	—	4	—

For the Masaridinæ, Raphiglossinæ, and Zethinæ the numbers are too low to be significant, and are not given. The parasites of *Eumenes* clearly take the same position as those of *Odynerus (s. l.)*, the females preferring a position under the third, the males under the fourth abdominal segment. Our separate notes for *Odynerus (s. st.)*, *Pachodynerus*, and *Ancistrocerus* serve to show that in these genera the parasites act similarly, and that our former treatment of them (1927) as a single group, *Odynerus s. l.*, was quite permissible. The numbers for *Monobia* and *Montezumia* are again very low but seem to indicate agreement with the condition found in *Odynerus*. The figures for *Belonogaster* suggest preference of both sexes for the fourth segment. The parasites of *Vespa* apparently agree with those of *Polistes*, the males lying anteriorly to the females. We have, then, the Eumeninæ forming one group, *Polistes* and *Vespa* another; the difference being clearly shown in the totals, as follows:

Under abdominal segment number		*2*	*3*	*4*	5	6
Eumeninæ . . .	♂ parasites	—	9	43	13	—
	♀ parasites	4	59	35	—	—
Polistes and Vespa	♂ parasites	5	26	30	5	1
	♀ parasites	—	3	3	18	1

Since, in the Vespidæ, the males have seven, the females only six visible abdominal segments, we have examined our records to see whether the sex of the host has any effect on the position of the parasite. Summarizing our records for the two groups shown above, we have the following:

Under abdominal segment number		*2*	*3*	*4*	5	6
Eumeninæ						
males	♂ parasites	—	4	22	6	—
	♀ parasites	2	23	12	—	—
females	♂ parasites	—	5	20	7	—
	♀ parasites	2	33	22	—	—
Polistes and Vespa						
males	♂ parasites	1	5	9	2	1
	♀ parasites	—	2	—	2	1
females	♂ parasites	4	21	21	3	—
	♀ parasites	—	1	3	15	—

The ♂ and ♀ Xenos found under the sixth abdominal segment of a male Polistes could not have extruded under this segment, of course, in a female host. With this exception no tendency for the parasites to move back in male hosts is apparent.

THE SEX OF THE PARASITE

The parasites listed above include 245 males and 206 females, divided as follows:

Parasites of	♂	♀	*Parasites of*	♂	♀
Masaridinæ . .	7	3	Monobia	3	8
Zethinæ	3	3	Montezumia . .	3	2
Eumenes . . .	6	12	Polybiinæ . . .	10	13
Odynerus . . .	32	59	Polistes	144	61
Pachodynerus . .	11	21	Vespa	5	8
Ancistrocerus . .	21	16			

It will be seen that male parasites are known, and indeed are common, in all groups; so that no such condition exists in the Vespidæ as in the bee genus *Halictus* where hundreds or even thousands of female parasites are found for each male. The preponderance of male Xenos in Polistes is striking, but except in Odynerus, where an excess of female parasites is indicated, the other numbers are too low to be worthy of discussion.

We have compared the sex of the parasites found in male and female hosts, but as there is no very significant result we do not give the summary in detail. As far as our data go, male and female parasites infest male and female hosts indiscriminately.

NUMBER OF PARASITES PER HOST

There is some difficulty in counting the number of parasites per host from published records, as it is not always stated definitely whether the host contained one or several parasites, or whether the several parasites mentioned came from one or more hosts. Our summary, therefore, includes only those cases of which we are quite sure, either from a personal examination of the specimen, or from a definite statement in the record. In the following list we give the average number of parasites per host, per male host, and per female host.

	host	*male*	*female*		*host*	*male*	*female*
Masaridinæ	2.	1.	4.	Monobia	2.25	2.33	2.
Zethinæ	1.2	1.	1.25	Montezumia	1.33	....	1.33
Eumenes	1.25	1.	1.5	Belonogaster	1.15	1.	1.20
Odynerus	1.34	1.15	1.52	Polistes	1.75	2.	1.68
Pachodynerus	2.38	2.5	2.29	Vespa	1	1.	1.
Ancistrocerus	1.14	1.	1.3				

In most groups, female hosts support a slightly higher average number of parasites than males.

In Pierce's table of maximum parasitism per individual (1909, p. 26; 1918, p. 397) and in our own notes (1927, p. 189), it is very noticeable that heavily infested Polistes contain largely or exclusively male parasites. Eleven Polistes bearing four or more parasites are mentioned in those tables and four others in the present list; the entire fifteen containing parasites as follows: 1-2 ♂ 2 ♀, 1-3 ♂ 1 ♀, 1-4 ♂, 2-5 ♂, 1-3 ♂ 3 ♀, 1-6 ♂, 1-6 ♂ 1 ♀, 2-7 ♂, 1-8 ♂, 1-9 ♂, 1-10 ♂, 1-11 ♂, 1-15 ♂. There are here included 100 ♂ and 7 ♀. One is led to recall the interesting discovery of Cobb, Steiner, and Christie (1927) who have shown the striking preponderance of male nematodes in heavily infested hosts. In stylopized Eumeninæ as well as in infested bees the opposite seems to hold, and in cases of heavy stylopization, female parasites are in the majority.

THE GEOGRAPHICAL DISTRIBUTION OF STYLOPIZED VESPIDÆ

Our list includes vespid hosts from all the continental areas and many islands, and where records are lacking we must, at the present state of our knowledge, attribute their absence to insufficient collecting or study.

Some interesting problems in distribution are furnished by the Strepsiptera. The chance of their establishment in isolated insular regions must be very remote, much more so than that of their host. Yet the first record of an Odynerus from Bermuda, the holotype and only known specimen of *Odynerus bermudensis* Bequaert, bears a female Strepsipteron. *Polistes fuscatus* var. *aurifer*, which was introduced into the Hawaiian Islands fairly recently, through the agency of man, carried its parasite with it. We list above several stylopized specimens from various islands, more or less remote, of the West Indies, the East Indies, and the Canary Islands.

Since the powers of flight of the host are impaired by stylopization, and female hosts are frequently rendered sterile, it is probable that the introduction of Strepsiptera into distant regions is brought about in the triungulinid stage. Several of these minute larvæ could cling to the body of a perfectly healthy host without seriously burdening it. Brues, indeed, has already reported (1924) the occurrence of triungulins, presumably of the meloid *Horia maculata*, on a bee *(Xylocopa transitoria)* from the Galapagos Islands.

THE PROBLEM OF HOST SPECIFICITY

It seems to have been generally assumed that Strepsiptera obtained from different species of hosts are themselves specifically distinct. Pierce (1909, p. 70) stated that as a rule species of Strepsiptera are confined to single species of hosts; and in his classification used tribes as divisions of convenience to unite genera of parasites infesting different families of hosts. Following a decision to unite the vespid groups *Leionotus*, *Ancistrocerus*, etc., with *Odynerus*, the same author (1911, p. 498) combined the genera *Leionotoxenos* and *Pseudoxenos* parasitic on those groups. Many species and several genera in the Strepsiptera are based solely on the unsatisfactory characters of the female together with the name of the host, which latter one sometimes feels is the more valuable part of the description.

It is not our intention to discuss here the validity of this tacit assumption of host specificity in the Strepsiptera, but some points arising from our redetermination of several hosts deserve mention. Our records for *Polistes fuscatus* var. *pallipes,* for instance, include hosts reported under the names *P. fuscatus, P. metricus, P. instabilis,* and *P. variatus;* and parasites described as *Xenos peckii, X. bowditchi, X. wheeleri,* and *X. bruesi. Polistes fuscatus* var. *rubiginosus* likewise becomes the host of *Xenos nigrescens, X. rubiginosi, X. pecosensis,* and *X. maximus.* The parasites become similarly scattered among the host species. Until this interesting problem has been seriously investigated it should not be assumed that the hosts and their parasites are related, species to species, and genus to genus; and new species described in the Strepsiptera should stand on their own morphological characters, not on the identity of their hosts.

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ANATRICHIS MINUTA DEJ. A single specimen was taken in Framingham, Mass., on May 10, 1908, and no more have been seen until September 15, 1929, when I found 5 specimens by treading about in the soft soil in a dried-up pond in Acton, Mass. On September 22, I again visited the place and took four more. They were hiding among the small grass-like plants and prostrate vegetation. There is but one record in the New York list of insects.

C. A. Frost, Framingham, Mass.

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PSYCHE

VOL. XXXVI DECEMBER, 1929 No. 4

OBSERVATIONS ON THE BIOLOGY OF TWO REMARKABLE CIXIID PLANT-HOPPERS (HOMOPTERA) FROM CUBA.[1]

BY J. G. MYERS,

Imperial Bureau of Entomology.

Our knowledge of the biology of those families of Auchenorrhynchous Homoptera which reach their greatest development in the Tropics is scanty in the extreme. This is especially the case with the Cixiidae, the intermediate stages of which are passed underground. There are not half a dozen species of these small but very interesting plant-hoppers of which the life-history is known.

The two species considered here present highly remarkable features, the one, *Mnemosyne cubana,* for its association with Ponerine ants, and for peculiar features in its metamorphosis, and the other, *Bothriocera signoreti* from its fossorial habits and modified front legs in the nymph.

These notes, which are by no means complete, were made during the tenure of an Atkins Research Fellowship at the Harvard Tropical Laboratory in Cuba. They constitute the seventh paper on the Hemiptera studied at Soledad. For acknowledgments see the first of the series *(Contr. Harvard Inst. Trop. Biol. and Med. III:* pp. 63-110, 1926).

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[1] Studies from the Harvard Biological Laboratory and Botanic Garden in Cuba (Atkins Foundation).

Mnemosyne cubana Stal 1866.

Myers, *Harv. Biol. Lab.* and *Bot. Gdn. Cuba. Studies on Cuban Insects 1.*, p. 15, 1928.

I saw no specimens of this, the largest of Cuban Cixiidae, at Soledad, during February, March and most of April, but Mr. R. M. Grey took eighteen specimens (3 males and 15 females) on the 27th and 28th of April, just after my departure.

The nymphs were discovered by Dr. George Salt while we were collecting together near the Mina Carlota, in the Trinidad Mountains of Cuba, on 23rd March. He has kindly allowed me to quote his detailed notes extensively, as follows:

"A rotten tree stump about 3 feet high on the west side of a gully running south of the mine, revealed several large brown and black ants *(Odontomachus haematoda insularis pallens* Wheeler) when split open by Myers. The ants are able to inflict a most painful sting, grasping the skin with the jaws and then doubling the abdomen underneath to plunge the sting rapidly in several places within its reach.

"The ants were traced down in the trunk and below the surface of the ground, a few immature stages being found. A small colony of a tiny brown ant was found apparently entirely enclosed in the larger ant's colony and later another of these small colonies of only 2″ diam., in a large chamber surrounded by galleries of the larger ant. This later colony taken.

"Two patches of white silky material were noticed among the galleries but as parts of them were composed of short radiating wheel-like threads, it was thought to be a fungus. In one, however, was found a Fulgoroid nymph which crept out of this white chamber and which I attempted to catch. It was protected by three ants, which, when the nymph was lifted, grasped it in their mandibles and were themselves carried up by it. Later others were found of various instars, from the 2nd to the 5th; many having a whorl of radiating short white silky threads attached to the tip of the abdomen.

(These "tails" were often larger than insect itself). They were always in or near the silk material first noticed. A number were found arranged in a linear series along a root of about 3/16″ diameter; the root for a length of 4″ being covered with their silk masses. The arrangement seemed to be perfect that the older nymphs were at that end of the root lower in the soil and towards the ant nest—the younger nearer to the surface of the ground and farther from the nest. Ants well in attendance and in two places of this series a large drop of clear yellowish fluid, sweet to the taste, was found. This particular root was about 3 inches below the surface of the soil running almost horizontal but a little higher towards the hill. Most of the nymphs found were thus situated, under the ground, but two chambers were found in a cavity in the rotten stump at about the surface of the ground but covered with trash of dead leaves etc., and in the dirt and debris of very rotton wood. Roots of a small vine twining around the stump passed close to the chambers.

"That the ants attended the nymphs is without doubt. Not a single nymph of about 30 was out of the company of ants, and one found under a bit of rotton log about 3′ away as well as one found through on the other side of the stump had ants in attendance.

"Nymphs ——— were active when disturbed and could jump quite well."

In the same nest was a tiny but advanced nymph of another species of Cixiid (?) with no signs of a flocculent tail-appendage.

The next day another nest of the same ant species was found *under* a log in the same general locality. We exposed a gallery along a root ¼-½ inch thick and exuding a milky juice when cut. In this gallery were numerous nymphs of *Mnemosyne* and several more of the much smaller Cixiid (?). When the ants were disturbed by the digging they became very much entangled in the flocculent material secreted by the plant-hopper nymphs. In the same gallery were also a wood-louse, a cockroach and specimens of the curious scale-insect, *Mixorthezia sp.*[1]

This is one of the few known cases of Ponerines attending Homoptera.

A number of the *Mnemosyne* nymphs were preserved in alcohol for description later, while live ones were provided with decayed wood, rootlets and nest-material, but no ants; and an attempt was made to rear them. This was successful only with some of the older nymphs; but the exigencies of travelling made the test an unfair one. From these nymphs the first adult—a female—emerged on the 14th April. A second female appeared on the 18th and a third in the early morning of the 19th. The only male came out on the 20th. One female survived in captivity until the 25th and was then preserved for the journey north.

Professor S. C. Bruner, since my return to England, sent me nymphs of apparently the same species, attended by the same ant, at the roots of sugar-cane,—a very different habitat from that in which we found them.

Description of the nymphs:

Neither the eggs nor the younger nymphs were found, nor could adults be induced to lay in captivity.

In the preserved material on which the descriptions are based, it was found that in the same instar, some had longer abdomens than others, apparently according to the time since they had moulted. The total lengths given below have been measured all on specimens with long abdomens, —thus near the end of stadium concerned.

Antepenultimate nymph: (Figure 1, outline only).

Length, 4.3 mm. Colour white, the more strongly "chitinised" dorsal sclerites of thorax and of abdomen faintly

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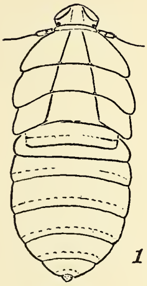
[1] This Coccid was taken in or near the nests of the following three other species of ants (kindly determined by Dr. Wheeler), *Brachymyrmex heeri obscurior* Forel, *Euponera* (*Trachymesopus*) *stigma* F. and *Camponotus santosi* Forel; and in that of Termite, *Anoplotermes* sp. (kindly determined by Dr. T. E. Snyder).

No ants were seen attending these Coccids nor was there any indication that the association was anything but accidental.



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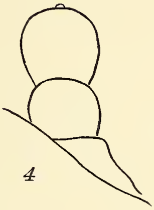

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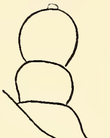

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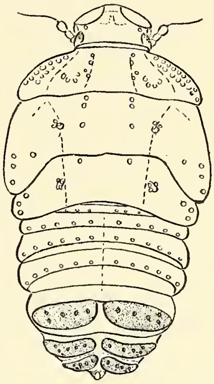

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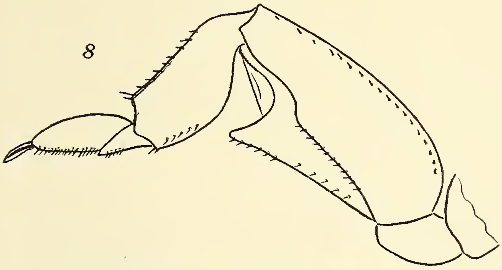

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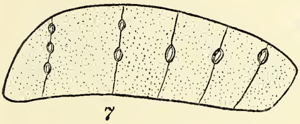

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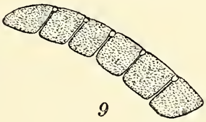

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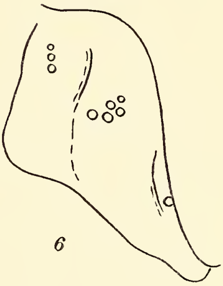

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1. *Mnemosyne cubana.* Antepenultimate nymph.
2. *Mnemosyne* antenna of antepenultimate nymph.
3. *Mnemosyne* antenna penultimate nymph.
4. *Mnemosyne* antenna last nymph.
5. *Mnemosyne* penultimate inster nymph.
6. *Mnemosyne* right hind-wing pad of last instar nymph.
7. *Mnemosyne* first left wax-plate of last instar nymph.
8. *Bothriocera signoreti,* last instar nymph, outer view of first left leg.
9. *Bothriocera signoreti* first left wax-plate.

yellowish. Eye-spots pink. Several large sensoria on head, thoracic nota and the 1st-6th abdominal tergites. A pair of large dorsal wax-plates on segments VI-VIII inclusive (strictly, on the intersegmental membranes). First wax-plate with three pores, in a row parallel to the long axis of the plate. Second and third plates also with 3 pores. Antennae shown in Figure 2.

Penultimate instar: (Figure 5, antennae, fig. 3.)

Length, 6.4 mm. (measurement of a long-abdomen form, but the figure represents an individual with short abdomen), white, the head and the other more strongly "chitinised" dorsal sclerites of thorax and abdomen yellowish. Sensoria more numerous and grouped as in the figure. On the wax-plates, extra pores have appeared as follows:—on first plate, 2 pores in a line parallel to long axis of body, and lateral to the original three; on the second, 3 such pores; and on the third, again two. Eyes larger and red.

Last instar: (Figures 4, 6 and 7.)

Length, 10.0 mm., colour as before, but the chitinised pieces a brighter brownish yellow. Large circular sensoria arranged as follows: 2 roughly parallel longitudinal rows on each side of disc of front, 2 or 3 on each side of disc of vertex, about 12 on expanded lateral border of pronotum, and 2 groups and a solitary one on each side of its disc; several scattered over tegminal pad, and a close row on its lateral margin; 2 groups and a solitary one on each side of disc of mesonotum; several on wing-pad (fig. 6), and two groups and a solitary one on disc of metanotum (each side); a single transverse row along every abdominal tergite at least up to and including *V;* a close row of minute ones, 6 or 7, in a yellowish "chitinised" lateral sclerite (pleural?) at the lateral border of each of the three wax-plates. Posterior edge of metathoracic pleuron edged strongly with dark red. First wax-plate (fig. 7) with 3 single pores, in a transverse row followed by two longitudinal rows, the first with 2 and the second with 3 pores, making 8 altogether; second and third wax-plates like the first. The number of pores varies somewhat, however, even on the two sides of the same insect. The pores are connected, in a fore and aft direction, with their fellows before and behind or with the posterior and anterior edge of the plate. These lines, which are apparently fine grooves, are smooth and shining, as also are the pores themselves; but the wax-plate surface is dull dead white, due to a minute hexagonal sculpturing like that of many insect choria.

Towards the end of an instar the abdomen lengthens greatly (fig. 1.) At other times the abdomen is shortened and turned slightly upward, so that the three pairs of wax-plates occupy by far the greater part of the dorsal aspect of the abdomen, the tergites of segments I-V being squeezed considerably.

Curiously enough, while the penultimate instar hind wing-pad (fig. 5) has 3 large circular sensoria near its apex, the last instar has only one, which just misses being covered by the growing tegminal pad. The other two, which would be covered and thus presumably unable to function, have become obsolete.

Bothriocera signoreti Stal, 1864.

Myers: *loc. cit.* p. 15.

The striking, dark brown-marked adults of this species, with a curiously squarely-expanded head were swept during March, when the dry season was at its height from vegetation of various types, but nearly always in close proximity to water. Thus it occurred on flowering heads of papyrus in the Botanical Garden, on *Commelina nudiflora,* on two species of ferns growing in moist but not shaded situations, almost plentifully on pure stands of *Polygonum acre* along a nearly dry ditch and finally from a tangle of bushes, trees and lianes in a creek-bed.

The tegmina, in life, are held perfectly flat, like those of certain small moths, which these hoppers resemble also in general appearance.

Two adults were taken under stones in a nearly dry creek-bed of a patch of rocky forest near the laboratory. Here also the nymphs described below lived in a truly remarkable association. Under the same stones occurred large cockroaches, land-crabs[1] *(Epilobocera armata* Smith), cray-fish,[1] (*Cambarus cubensis consobrinus* Sauss.), Phrynids, numbers of tiny frogs *(Sminthillus limbatus* Cope) and an occasional blind snake *(Typhlops lumbricalis* (L.)

Advanced nymphs only were found during March. These were in crevices under the stones, or in depressions in the soil itself. Across these cavities stretched various rootlets, on some of which were colonies of a queer yellowish aphid, with a white abdominal fringe (kindly determined by Dr. P. W. Mason as *Prociphilus* sp.) Under adjacent stones were other aphides *(Ceratoglyphina* sp., Mason) attended by ants which I failed to catch, but there were no signs of ants near the *Bothriocera* nymphs. *Cyphomyrmex rimosus minutus* Mayr (kindly determined by Dr. Wheeler) were cultivating fungus on caterpiller faeces, in their nest under another neighbouring stone.

Usually two or three or even five of the nymphs occurred together, covered entirely by fine white flocculent material. Often they occupied a narrow crevice lined throughout with this waxy fluff. An adult was sometimes found (14th March) waiting beside its cast nymphal cuticle, in a kind of transparent cell of the same material.

Last instar nymph: (Figures 8, 9).

Length (long-abdomen stage) 4.5mm.

Dorsal surface dark unicolorous brown, with a median paler dorsal stripe, under-surface paler.

"Frons" swollen, smooth, passing without distinction in one round curve into the crown, but separated from the swollen clypeus by a sinuate groove. An irregular double row of small sensoria on extreme edge of "frons". None on clypeus. Rostrum just passing base of hind coxae. Crown with an irregular triple row of lateral sensoria, the inner two series large and circular; a single row of small ones continued nearly all round posterior margin. First and second segments of antennae short and very stout, the second greatly swollen. Eyes small, sunken between antenna and edge of crown.

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[1] Kindly determined by Dr. T. Barbour.

Pronotum with small, roughly circular sensoria as follows:—a double row (4-4) on disc, bordering median pale stripe, a single row on outer side of fore-border, continued as a triple row along lateral border; a sinuate group of six near posterior lateral border. Some of the larger sensoria have each a very tiny one contiguous.

Mesonotum with one sensorium anteriorly, on each side of median line, a diagonal row of five, graduated in size, outside this, and a number of scattered groups on the tegmen-pad.

Metanotum with one sensorium anteriorly on each side of median line, a diagonal row of three outside this; and one sensorium on the hind-wing pad just before it is covered by tegmen-pad. (There are none on the hind-wing pad below the tegmen.)

Abdomen in the specimens described long and distended preparatory to ecdysis, but normally with part of IV and all of VII and VIII segments partially retraced and turned more or less upwards as in *Mnemosyne.* IIIrd tergite with one sensorium on each side of disc; IV with a row along posterior margin, except medially, becoming double laterally; V is similarly supplied, but the posterior edge of VI has none, save at the extreme lateral margin where there is a small group of 4, close together. The VIth tergite is rather shorter and is followed by the first wax-plate, as in *Mnemosyne* the second and third following the still shorter tergites, VII and VIII respectively. VII and VIII bear only two or three sensoria, just beneath the extreme lateral margin (i. e. occupying a ventral position.)

Wax-plates of first pair with 5 pores, all situated along anterior border and connected with posterior border by grooves, wider proportionately than in *Mnemosyne* and dividing each wax-plate into 6 divisions (see fig. 9), roughly rectangular except the outermost, which is approximately triangular. Second and third pairs of wax-plates similar, though restricted in size by the decreasing width of their respective segments.

First pair of legs markedly fossorial (fig. 8), with quite a strong resemblance to those of a cicada nymph, especially in the swollen femur.

The only comparable structure in the Fulgoroidea is that of the first pair of legs in the North Australian Cixiid, *Cajeta singularis* Stal, of which only the adult is known. I have examined this insect (a male specimen) in the British Museum, and to me the legs in question do not look at all fossorial, but rather raptorial! The femur is swollen, with two minutely-toothed ridges beneath, between which the tibia would seem to fit. Observations on the habits of this very rare plant-hopper would be of extreme interest.

NOTES ON COCOONS AND PARASITES OF *MELISSODES OBLIQUA* AND NESTS OF *PERDITA OPUNTIAE* (HYMENOPTERA-APOIDEA)

By Clarence P. Custer

Melissodes obliqua Say

I have recently described the nests of *Melissodes obliqua* Say in The Canadian Entomologist.[1] Since then I have bred 102 cocoons, obtained from the nests of the species, with the following results:

Of the 102 cocoons, 72 contained larvæ of the host and 30, those of the parasites, revealing a parasitic ratio of approximately 30%,—or about one parasite to every two hosts. Of the 72 hosts, 48 were male and 24 were females, the males reaching maturity somewhat earlier and in larger numbers than the females. This gives a sex ratio of two to one in favor of the males. Of the thirty parasites, all died except one, *Triepeolus concavus* Cresson, which reached maturity after 10 months incubation (August to June).

Since there is no fundamental difference between the cocoon containing the host and that containing the parasite, one can conclude that this Triepeoline Bee is carnivorous.[2] For in order to develop in the cocoon of the host the parasite must have postponed its feast until the pollen and honey were consumed and the cocoon spun. It is interesting to note that the parasitic larvæ possess two rows of dorsal

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[1] On the Nesting Habits of Melissodes Latr. (Hymenop.). Canadian Entom., vol. 60, p. 28, 2 figs. (1928).

[2] Reinhard, in a recent publication on wasps, states that the cocoon of the parasite, *Nysson hoplisivora,* is indistinguishable from that of its host, *Hoplisus costalis,* except for its slightly smaller size. If his observations are correct, my conclusions must be regarded with reservations. Only time can reveal the answer. The problems of parasitism have, to say the least, wide fields for future study.

tubercles which are more highly developed than in the case of the host.

The average cocoon is 15 x 7.3 mm. (extremes 13 to 17 and 7 to 7.5 respectively) ; shape cylindrical, the ends symmetrically rounded; color dark brown; upper end covered by cap of excrement 3 mm in thickness; below this, four or five closely related, thin, shining, light amber-colored membranes of a circular shape moderately interwoven with brown fibrils; below this, the domeshaped roof of the cocoon, dark amber-colored, more abundantly supplied with fibrils and presenting a dull finish internally; wall of cocoon composed of three layers from without inward as follows: (1) Thin dull brownish membrane closely adherent to clay wall of cell; (2) Thick dull brownish membrane; (3) Very thin, glistening, light amber-colored membrane sparsely supplied with interlacing fibrils.

In the first paper, I remarked that there were large numbers of parasites flying about and entering the nests of *Melissodes obliqua* Say. The parasitic ratio of 30%, as shown by the incubation of the cocoons, tends to bear this out. However, in view of the fact that 29 of the 30 parasitic larvae failed to reach maturity (possibly due to my transferring them from an incubator at 28° C. to room temperature) I have no doubt that there are other species of *Triepeolus* besides *concavus*, which are parasitic on this bee. It is such a set of mortality statistics which so often brings our experiments in the incubation of the larvæ of wild bees to an unfortunate conclusion.

Perdita opuntiæ Cockerell

In my paper in Psyche,[1] concerning the nests of *Perdita opuntiæ*, it appears that there is room for some misunderstanding as to whether the bee actually nests in firm stone or makes use of various cracks and faults in which to construct its tunnelways. Mr. S. A. Rohwer, of the United States Department of Agriculture, in particular has called

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[1] The Bee That Works in Stone; *Perdita opuntiæ* Ckll. Psyche, vol. 35, No. 2, pp. 67-84. (1928).

my attention to the fact and states that the paper gives "the impression that the bee would not be able to live within the stone if it were not for some crack or fault on its surface".

No doubt the misinterpretation arose from Fig. 1 which represented a typical nest, all of the tunnelways being in the same plane. The entrances to this particular nest *were* in a crack. I had chosen it for the illustration because I could show all the ramifications of the tunnelways in two dimensions. In this respect it was not a typical nest.

The actual condition is this: Dozens of nests of *Perdita opuntiæ* are found in the firm stone at White Rocks, Colorado. Each nest has two or more entrances. In a small percent. of the nests the entrances are found in cracks or faults in the stone. *But in the majority of the nests the entrances are situated in solid stone in the immediate vicinity of which there is not the slightest sign of a crack or fault.* In these latter nests one finds the entrances irregularly distributed over the surface of the stone in such a manner that they could not be connected together by a crack. Also upon excavating these nests one finds that the tunnelways are not confined to individual planes (as would be the case if they were in faults) but ramify in all three dimensions throughout the stone. So there is no doubt that the bee actually nests in solid stone.

I might mention in passing that in the original paper, page 75, I stated that I had found no report in the literature of a wasp digging its nest in stone. Since then I have learned from Dr. Davidson, in California, that years ago he had published a paper describing the habits of a wasp that nested in a soft sandstone.

DESCRIPTIONS OF FOUR NEW FORMS OF ERIOPHYES.[1]

By James Kendall

Bussey Institution, Harvard University.

Preliminary to a study of four Eriophyid galls occurring very commonly in Massachusetts, New York, and New Jersey, it was necessary to determine the taxonomic position of the causative parasites. As a result of examinations of many specimens from each gall collected over a period of several months these mites were determined to be new forms of *Eriophyes* and a detailed description was made to indicate the relationship of each of these forms. Comparisons with already known and described species are given in the case of each mite hereafter described, together with a figure showing the more characteristic distinguishing features.

The material from which the present data were taken was collected primarily in the Arnold Arboretum, Forest Hills, Mass.; additional material was collected from southern New York and northern New Jersey. The mites and the host or hosts with which each is associated are as follows: *Eriophyes celtis,* sp. n. on *Celtis occidentalis* L. and *Celtis occidentalis canina; Eriophyes rudis dissimilis,* subsp. n. on *Betula lutea* Michx. f.; *Eriophyes eucricotes multistriatus,* var. n. on *Lycium halimifolium* Mill.; and *Eriophyes fraxinivorus americanus,* var. n. on *Fraxinus americana* L.

The taxonomy of the Eriophyidæ has been and still is a problem. The rules for the systematic separation of the forms have been given in some detail by Nalepa (1924) but have been the source of disagreement between himself and Cotte (1925). Part of the trouble hinges on the question of the importance of physiological differences. What status

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[1] Contributions from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 325.

shall be given to a form that is similar to another but is limited to a different host species? Shall we regard it as a variety, a species, or what?

The discussion of varieties Nalepa brushes aside with the remark: "Für den prakticken Cecidologen ist die Kenntniss der Varietäten der Arten and Unterarten bedeutungslos." According to his dictum one must distinguish between the fluctuating variations of a species within itself and the constant variations in a biological sense. Then: "Als Varietäten werden wir grundsätzlich nur jene Variationen des Arttypus bezeichnen, die das gleiche Cecidium auf verschiedenen, jedoch verwandten Wirtspflanzenarten verursachen." And ". . . erzeugen die Subspecies verschiedene Gallenformen auf ihrer gemeinsamen Wirtpflanze."

Cotte protests that much of Nalepa's work is useless and that a system of taxonomy can be acceptable only if fixed by common consent, not by one person. He condemns the subjugation of morphological to biological characters practiced by Nalepa, a new host is not sufficient evidence to establish a new variety. The objections of Cotte are justified provided Nalepa's rule is followed without any further confirming data. If distinct morphological characters are not forthcoming to distinguish the form in question, then controlled observations on the physiological limitation of this form to a certain host plant are necessary to justify establishing it as a variety or subspecies of another similar or even identical morphological form on a closely related species of host.

Where it has not been possible to control the infestation and so determine whether the mite forming an identical or similar gall is limited to the specific host and where the morphology of the mite itself is relatively close to a known species, but still different, after allowing for the variations within the species, I have considered it to be a variety of the species already described from a similar gall on a plant of the same host family. This is the case with the two new varieties presented in this paper. In the case of the one new subspecies, *E. rudis dissimilis,* the separation is based on differences of morphology in the mite and the gall form with which it is associated as well as its limitation to the single host. It was possible in the case of *E. celtis* to check the limitation of the mite to the specific host and find that it was not adaptable to the host which is affected by what would appear to be morphologically a closely related form.

For a key to the genera of the family and the features used in classification one is referred to the work of Nalepa or of Hassan.

TECHNIQUE

The importance of reliable permanent preparations and the fact that the methods for making permanent collections have long been unsuccessfully sought justifies giving some attention to the methods and media used when new members of the various genera or species are described. It is very easy to obtain great numbers of these mites by drying a quantity of galls in open vials ringed inside at the top with glycerine to prevent the mites escaping. If these vials are then placed in a desicator out of any strong light or heat most of the mites will leave the galls in a few hours and will be found wandering about the sides of the vials (s. Nalepa, 1906 and Hassan, 1928). The question then arises how they can be kept permanently and studied at any time under the microscope. Various media have been tried and found quite useless for anything more than immediate study. In all these media (glycerine, glycerine and acetic acid, glycerine jelly, balsam, euparal, gum arabic solutions, water, alcohol, etc.), the mites are more or less distorted and shrunken or become almost transparent, so that in a short time the mounts are useless and new specimens are needed. Until recently, it was necessary to use alcohol for permanent collections and make new mounts from this material each time one desired to study the mites in question. The alcoholic material becomes hardened and breaks so easily that the specimens are useless for taxonomic work a few years after collection. Other media have the same or additional drawbacks. Apart from the temporary nature of these collections there are the factors of distortion and shrinkage to be considered, as well as the improbability of being able to re-examine the same specimens at any time.

Recently, Hassan (1928) developed a method for making permanent mounts of the Eriophyidæ by modifying a method for manipulating small organisms. The mites are killed and cleared by heating them in a 10% solution of potassium hydroxide that is poured over them in the collecting vials after the plant tissues have been carefully removed. This solution containing the cleared mites is poured through a short piece of small glass tubing having at one end a guncotton plug in which the mites are caught as the solution passes through. The mites and the plug are then washed thoroughly with distilled water before the alcohols of various grades are passed through the tube to dehydrate and harden the specimens. After treating with absolute alcohol the guncotton plug is removed together with the entangled specimens from the tube and placed in a vial containing a solution of absolute alcohol and ether in equal proportions by volume. In this solution the guncotton dissolves and the mites settle to the bottom of the resulting weak solution of celloidin thus formed. A drop or two of this solution and great numbers of the mites can be easily removed by a pipette to a slide smeared with albumen fixative; the alcohol and ether evaporate rapidly leaving the mites embedded in a thin layer of celloidin. After reaching this stage the slides can be kept indefinitely before proceeding or they can be colored immediately in acid fuchsin, dehydrated, and cleared in carbol-xylol before sealing on a cover glass with balsam or euparal. This method has two disadvantages that necessitate careful checking of the specimens thus mounted and those freshly mounted in other media. The first of these results from the destruction of the body contents by the use of potassium hydroxide solution, thus removing the most reliable indicator of the maturity of the females, that is, the content of eggs within their bodies. Since the classification is based primarily on the mature females it is important that only mature individuals should be used when making measurements for descriptive purposes. Secondly, there is a disadvantage in the position the specimens assume when mounted by this method; the setæ and any slight curvature of the body become fixed during the hardening process and cause the specimens to roll upon their sides when transferred to the slides. The lateral aspect thus presented in these mounts makes it difficult, if not impossible at times, to determine the dorsal and ventral characters accurately.

An easier and quicker method that gives better temporary mounts for studying the specimens to be described and for checking the characters of specimens mounted in celloidin, is the iron-acetocarmine method of Belling (1926), which is used widely in cytology for studying pollen mother cells. Large numbers of mites and their eggs can be dislodged by dipping small pieces of the galls into a drop or two of this stain placed in the center of a slide. This must be done rapidly and a cover glass placed on immediately to prevent evaporation of the stain. The mites are fixed without distortion and only sufficient of the stain enters the body, unless the mite has been crushed during removal from the gall to the slide, to make the contents distinguishable. If the cover glasses are sealed on by several applications of gold size, euparal, or balsam, it is possible to keep such mounts a reasonably long period. They have the advantage of being very thin and specimens are spread out to display the ventral and dorsal aspects in most cases, rather than the lateral aspects presented in the celloidin mounts. The darker background of the stain together with the slight internal staining of the body makes it easier to distinguish many of the morphological characters. Neutral red may be used with much the same result as the acetocarmine. The advantages of these mounts are counterbalanced by their fragility and probable lack of permanence, though specimens mounted in this manner have been kept for a year in a state of good preservation.

Eriophyes celtis, sp. n.

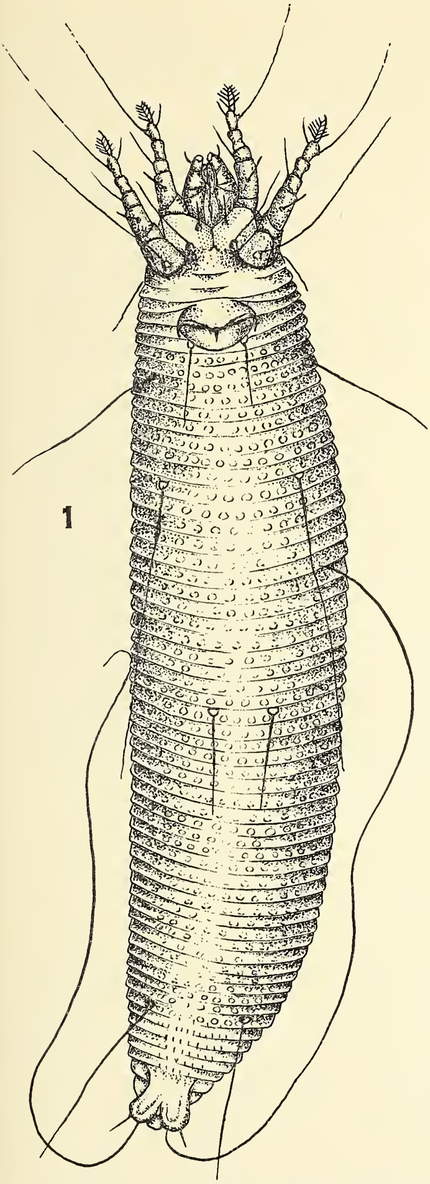
Hosts: *Celtis occidentalis* L., *Celtis occidentalis canina.*

In 1903 Di Corti described a mite, *Eriophyes bezzii*, from specimens found in colonies in deformed buds of *Celtis australis* L. The gall resulting from the parasitism of these mites is limited, according to his descriptions, to the arresting of the buds and their subsequent swelling. In the northeastern United States there is a common gall consisting of a bud deformation associated with a witch's broom development, that has been reported many times on *Celtis*. It has been attributed to the work of mites by some reporters and to the work of a fungus by others. No mites have ever been described from the gall though they were observed to be present in the buds. Kellerman and Swingle (1888) first observed this gall on the hackberry and attributed it to the activity of a fungus, which they described as *Sphærotheca phytoptiphila,* associated with a species of gall mite. Reuter, in 1903, cited it as an interesting case of coparasitism on the basis of their investigations, while Cook (1904), Chadwick (1907), and Felt (1917) considered the mites alone responsible but did not study the gall or mites. In examinations of these galls I have always found an abundance of the mite, *E. celtis,* and usually the mycelia of a fungus as well in the swollen buds where the gall formation has its origin. Only experimentation will be able to decide as to the part played by each of the factors present in these galls. It seems very likely that the mites are mainly responsible, since the fungus, if it is the one described by Kellerman and Swingle, belongs to a group not associated with witch's broom formations.

The morphological characters of the mites found in these deformed buds of *C. occidentalis* differ quite distinctly from those of *bezzii* described by Di Corti. The body size is nearly twice as large, although part of this difference may be attributed to the shrinkage of Di Corti's specimens which were preserved in alcohol. The shield has a clear design of ridges and is more nearly semi-circular than semi-elliptical; the sternal ridge is bifurcate, not simple; and the setæ are all much longer and have different relative lengths. The accessory setæ are present, not lacking as in *bezzii.* Figure 1 illustrates the characters that are given in the following description of *celtis.*

The cylindrical body of the mature female is more than four times as long as broad, about 270 microns in length and 60 microns in width. The thoracic shield is semicircular with three distinct ridges usually in the center field projecting above the plane of the shield and giving it a jagged anterior border; in the side field a ridge curves back from the region of the anterior border of the shield to the region above the setal tubercles near the posterior border. The dorsal setæ (c. 34 microns) arise from the prominent tubercles at the posterior border of the shield. The legs are short and comparatively stout; the tibia and tarsus are equally long (c. 6 microns) ; the feathered claw is large and five-rayed; the bristle claw of the first pair of legs is as long as the feathered claw while that of the second pair slightly overreaches it; the epimera are short; the sternal ridge is distinctly bifurcate and reaches to the level of the inner corner of the epimera. The first pair of thoracic setæ are short (c. 10 microns) and stiff, the second pair are of medium length (c. 30 microns), and the third pair are very long (c. 50 microns). The abdomen tapers slightly in the posterior fourth and ends in a small telson that bears the long flagellate caudal setæ (c. 120 microns) and the short (c. 6 microns), acicular accessory setæ. The rings of the abdomen are broad, about 60 in number, and there are numerous tubercles relatively close together on the ventrum but usually lacking on the dorsum. The last five rings are without any tubercles but have longitudinal striations ventrally. The epigynum is broad (c. 30 microns) with a smooth anterior flap and an arched, slightly keeled, posterior one. The genital setæ (c. 25 microns) are more or less posterior to the plane of the genital opening. The lateral setæ arise about three striæ posterior to the plane of the epigynum and are about the same length as the dorsal setæ (c. 34 microns). The first pair of ventral setæ are the longest (c. 75 microns), the second pair are the shortest (c. 20 microns) and the most nearly median of the ventral setæ, the third pair are about 38 microns long and comparatively coarse. Measurements of other setæ: outer setæ c. 30 microns, maxillary setæ c. 6 microns, claw bristle of the first pair of legs c. 8 microns, of the second pair of legs c. 10 microns, femoral setæ c. 12 microns.

Although it does not at any time effect a witch's broom formation, there is another factor to be considered in the deformation of the buds of the same hosts as those of *E. celtis.* This is the hemipteron, *Pachypsylla gemma* Riley, which often causes galls involving the deformation of buds



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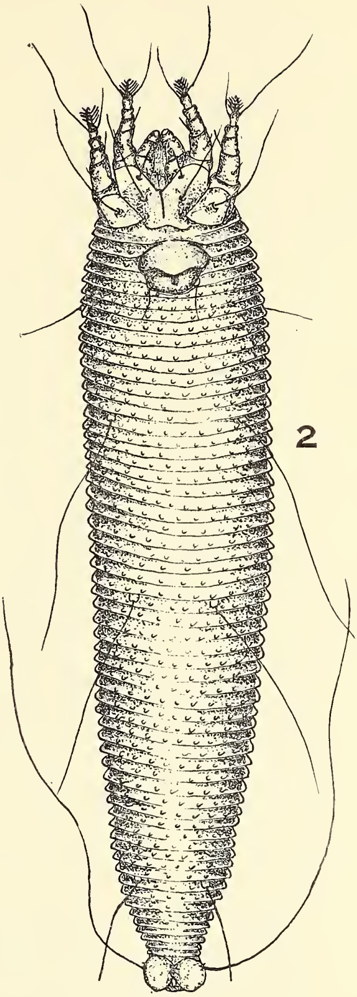

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Fig. 1. Ventral view of *Eriophyes celtis* sp. n.
Fig. 2. Ventral view of *Eriophyes rudis dissimilis* subsp. n.

into woody capsules. In one case it was observed that both it and the mites had attacked the rudimentary leaves of the same bud. The close association and limitation of these two parasites to the same host and same portion of the host may possibly be used to explain the very wide distribution of the mites over the same plant and over all the host plants in the neighborhood, even when these are widely scattered. The mature mites may be disseminated by the winged *Pachypsylla* females when the latter seek out the new buds in the early spring migration. This migration period of the hemipteron coincides nicely with the requirements of the mites for favorable infestation, occurring as it does before the buds expand.

In a mixed group of species of *Celtis (C. australis, C. Bungeana, C. Douglasii, C. laevigata, C. occidentalis,* and *C. occidentalis canina)* in the Arboretum it was possible to experiment with the limitation of the mite to its host plant. To make sure that it was not because it could not reach the other species of the same genus of host plant artificial infestations were carried out. None of the other species of the host unaffected under natural conditions reacted to the mites placed in their buds, or else the mites failed to find the host suitable and did not attack it. These infestations merely substantiate the condition of limitation or specialization of a species to a single host species, a condition that appears to be very general in the Eriophyidæ.

Eriophyes rudis dissimilis subsp. n.

Host: *Betula lutea* Michx. f.

The typical species of this mite was described by Canestrini from *Betula verrucosa* Ehrh. and *Betula pubescens.* Nalepa (1898) attributed to it the formation of both the erineum of the leaves and the bud deformation of these hosts. Later, in 1919, he differentiated the form producing the bud deformation and associated with a witch's broom formation on *B. verrucosa* as a subspecies, *calycophthirus,* of the typical *rudis* found in the erineum. In their list of galls and producers Ross and Hedicke (1927) give *B. nana,* *pubescens, urticifolia,* and *verrucosa* as hosts of this subspecies; it has also been considered as the cause of the bud deformations of *B. lutea.* However, the mite found in the deformed bud masses of this latter host differs distinctly from either the typical species or the subspecies described by Nalepa. It has a larger body size, more striæ, and a pair of accessory setæ setting it off from the typical species. From the subspecies mentioned it differs in the possession of the accessory setæ, larger body size, and shortened shield. The gall produced by *dissimilis* is quite different from that of the other two forms mentioned and appears to be limited to the single host from all reports and collections, as well as not being associated with a witch's broom formation. The early descriptions of the gall were made without any attempt to give the species of mite causing it. In 1909 Stebbins described the gall again from the same host and attributed it to a new species of mite, *Eriophyes betulæ,* without examining the mite and giving a description of it. Unfortunately, the name thus chosen had already been used by Nalepa to designate the species of mite producing the pouch gall on *Betula verrucosa* in middle Europe and southern Tyrol. Figure 2 represents the morphological characters of the mite whose description follows.

The body is cylindrical, tapering gently from the thoracic shield to the telson; the female measures about 240 microns in length and about 55 microns in width. The thoracic shield is semi-elliptical, clearly delimited posteriorly and rounded off anteriorly; the center field has three full length wavy ridges traversing it, the two outer ones diverge toward the posterior border of the shield; on the side there is usually an indistinct ridge from the region of the anterior border curving back about the setal tubercles near the posterior border. The dorsal setæ are coarse and about 20 microns in length. The rostrum is short, stout, and ventrally curved. The legs are relatively short; the tarsus and tibia are equally long (c. 5 microns) ; the claw bristle (c. 10 microns) is curved and slightly overreaches the feathered claw of the second pair of legs and equals that of the first pair; the feathered claw is large and four-rayed; the outer setæ are long (c. 25 microns) and fine; the inner setæ are very short. The sternal ridge reaches to the region of the inner corner of the epimeron and is not forked. The first pair of thoracic setæ are short (c. 8 microns), the second are anterior to the plane of the posterior end of the sternal ridge and about 30 microns in length, the third pair are the longest (c. 45 microns). The abdominal rings, about 80 in number, have a distinct row of small, well separated tubercles along their posterior border but in the last five these are replaced by ventral longitudinal striations. The epigynum is about 20 microns in width and lies immediately posterior to the cephalothoracic region; the lower flap is hemispherical and slightly keeled; the upper is smooth and either flat or slightly arched. The genital setæ are lateral and about 12 microns in length. The lateral setæ are below the plane of the epigynum, are fine, and are about 20 microns in length. The first pair of ventral setæ are the longest, about 60 microns, the second are the most median in arrangement and about 50 microns in length, the third are the coarsest and shortest (c. 20 microns). The short, broad telson bears the long caudal setæ (c. 90 microns) and the very minute accessory setæ (c. 4 microns).

Eriophyes eucricotes multistriatus var. n.

Host: *Lycium halimifolium* Mill.

The typical form of this species was described by Nalepa in 1892 from specimens collected from pustules of the leaves of *Lycium europæum* L. and *Lycium mediterraneum* Dun. occurring in southern Europe and Algiers. The mite from *Lycium halimifolium* produces a gall very similar to that of the typical species, namely, a pustule on the leaf, but in addition attacks the young twigs, petioles, floral leaves, stamens, and ovaries of the host. Besides its apparent limitation to a different host there are constant morphological characters that distinguish *multistriatus* from the typical form: the abdominal striæ are uniformly greater in number, the tuberculation of the abdominal rings is both dorsal and ventral in distribution, is finer and more abundant, and the stature of the mite is larger. Figure 3 illustrates most of the distinctive characters which are given in the following description of this variety.

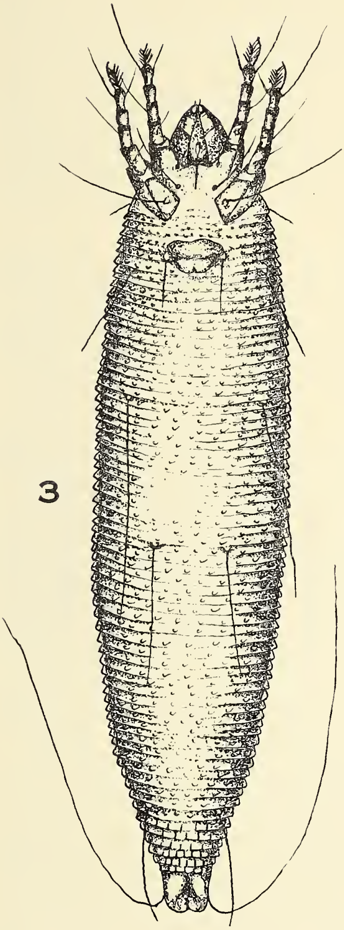
The mature female is orange-yellow and measures about 250 microns in length and 70 microns in width, compared to 210 microns by 50 microns in the typical species. The thoracic shield is very small, triangular, and either smooth or traversed by indistinct ridges. The dorsal setæ arising from large tubercles at the posterior edge of the shield are long (c. 40 microns) and slender. The legs are relatively short and weak; the feathered claw is five-rayed, the claw bristle of the first pair of legs is shorter than that of the second but still exceeds the length of the feathered claw. The sternal ridge is not forked and does not reach quite to the line of the inner corner of the epimeron anterior to which the second pair of thoracic setæ (c. 20 microns) arise. The third pair of thoracic setæ are the longest, about 60 microns, the second pair are the shortest, as usual, and anterior to the plane of the anterior end of the sternal ridge. The rings of the abdomen are relatively narrow, about 80 in number, with abundant fine tuberculations both dorsally and ventrally—the typical form has 60 rings with widely separated tubercles. The epigynum is very small, about 16 microns broad, with an unmarked cover-flap. The lateral setæ are about as long as the dorsal ones and are approximately in the plane of the epigynum. The first pair ventral setæ are the longest (c. 65 microns) ; the second pair are the shortest and most median (c. 30 microns) ; while the third pair are relatively coarse and about as long as the dorsal setæ. This last pair of setæ reach over the telson which is comparatively small and bears the long flagellate caudal setæ (c. 120 microns) and accessory setæ that are coarse and about 7 microns in length.

This variety of mite was very convenient for carrying out experimental infestations to determine the connection between the mites and the various abnormalities observed in the plants tissues. Experiments were carried on in the greenhouse during the winter with plants grown from seeds and cuttings. Unaffected plants of *Lycium* were readily infested by mites taken from old galls on the leaves of others. Beginning with a single gall the infestation spread over the young plant so rapidly that by the time it had grown several inches in height the expanding leaves had their surfaces entirely covered with the developing pustules. Young plants growing from seed in the same pot as the infested cutting showed galls on their first foliage leaves but not on the cotyledons. The spread of the infestations can readily be followed upward over the new hosts. Other species of Solanaceous plants, *Solanum capsicastrum, Nicotiana Langsdorffii, Datura Wrightii,* and *Capsicum pyramidale* were used in these experimental infestations without any positive results.

Eriophyes fraxinivorus americanus var. n.

Host: *Fraxinus americana* L.

In 1885, Karpelles described a mite, *E. fraxini,* which he found abundant in the galls commonly known as "Klunkern" occurring on ash and described by Löw in 1874. These galls were found to arise from the deformation of the floral parts of *Fraxinus excelsior* L. and *Fraxinus viridis* Bosc. into a monstrous ball-shaped mass covered with an almost colorless pubescence and resembling the upper parts of the cauliflower. In America there has been some confusion and uncertainty concerning the relationship between like masses of tissue and the gall mites. Felt (1906) reported fringed, lobulated balls of deformed staminate flowers of the white ash and considered the mite that he found in them as a new species, *E. fraxiniflora,* without describing it or comparing it with that already described by Karpelles from a similar gall in Europe. Another gall arising from the deformation of the terminal buds of the white ash where development is arrested and a mass of small twisted leaf ends replaces the normal foliage was first reported by Garman in 1882. Failing to find any mites in his specimens he considered it was probably a fungoid growth. On the basis of Felt's assurance that mites were found in the masses arising from staminate flowers this other foliose mass was also listed as resulting from mite parasitism without any search for or study of the mites themselves.



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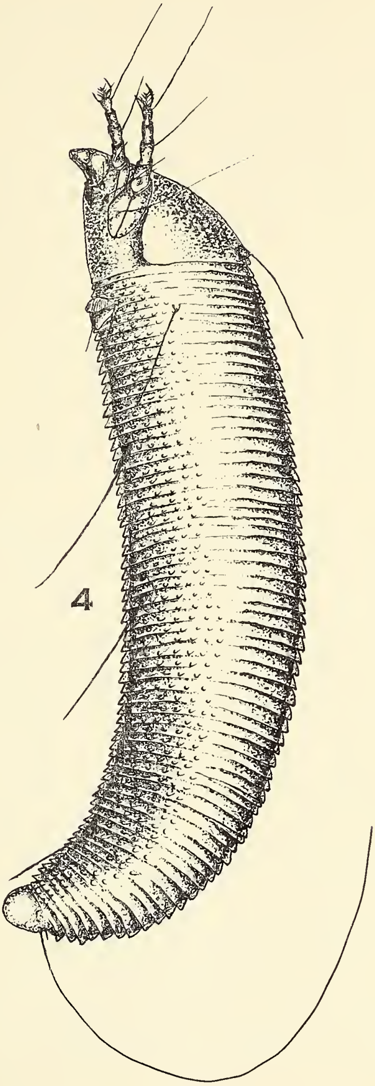

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Fig. 3. Ventral view of *Eriophyes eucricotes multistriatus* var. n.

Fig. 4. Lateral view of *Eriophyes fraxinivorus americanus* var. n.

The gall of *americanus* is the one characterized by a mass of fasciated foliage tissue that Garman noted. I was not able to obtain any of the flower galls described by Felt so could not determine if the same variety of mite is responsible for the two deformations. Large numbers of mites were collected from the foliose masses and determined as a variety of the typical form first described by Karpelles as *fraxini* but known now as *fraxinivorus* Nal., since the former name had been used by Garman two years prior to Karpelles to designate the mite producing capsule galls on ash leaves. Figure 4 is a lateral view of the variety *americanus* whose description follows.

This mite is to be distinguished from the typical species, apart from the differences of host and parts involved, by the unforked sternum, greater number of striæ, differences in the relative lengths of the ventral setæ, shorter accessory setæ, and much greater body size.

The body is long, about 250 microns in length and 55 microns in width for the female, and has a small cephalothorax. The thoracic shield is semi-elliptical, smooth, or traversed by indistinct longitudinal ridges. The dorsal setæ arise near the posterior border and are about 30 microns in length. The legs are short and slender, the tarsi are longer than the tibiæ; the feathered claw is four-rayed; the bristle claw, about 10 microns, is longer than the feathered claw of either pair of legs; the patellar setæ are about 24 microns in length; the inner setæ of the tarsi are about 4 microns, the outer ones about 25 microns long. The first pair of thoracic setæ are very short and lie forward of the plane of the anterior end of the sternum; the second pair are median in length and lateral to the posterior end of the sternal ridge which is not forked; the third pair are the longest, about 40 microns. The abdomen has 75-80 rings that are tuberculated rather finely on the ventrum but with more sparsely distributed tubercles on the dorsum; the last five rings are without such tubercles and are longitudinally striated ventrally. The abdomen ends abruptly in a short telson that bears the very short accessory setæ, about 6 microns, and the caudal setæ that are about half the length of the body. The epigynum is comparatively small with the anterior flap longitudinally striated and the posterior one slightly keeled. The lateral setæ are in the same plane as the epigynum and about 30 microns in length. The first pair of ventral setæ are the longest (c. 44 microns), the second pair are about the same length as the lateral setæ but coarser, the third pair are rather coarse and the shortest (c. 20 microns) of the three pair.

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IS NECROPHYLUS ARENARIUS ROUX THE LARVA OF *PTEROCROCE STOREYI* WITHYCOMBE

By William Morton Wheeler

Nearly a century ago, in 1833, J. L. F. P. Roux, in a letter addressed to Baron Férussac and published in the "Annales des Sciences Naturelles" mentioned and figured a remarkable insect, with the prothorax continued anteriorly into an enormously elongate and attenuate "neck," broad mesothorax, metathorax and abdomen, long, slender legs and small head with falcate mandibles. It measured nearly 11 mm. and was "found running over the sands which encumber the interior of tombs hollowed out in the rock of the environs of the pyramids of Gizeh," near Cairo, Egypt. To this insect which he believed "should necessarily constitute a new genus among the hexapod Aptera," Roux gave the name *Necrophylus arenarius* (p. 76). The editor (probably Audouin) in a foot-note asks whether it is not more probably the larva of some insect, "perhaps that of Mantispa or Raphidia." Turning to the explanation of the two illustrations (Figs. 3 and 4) on p. 78 and their legend on Pl. 7 we find in both places the name of the insect given as *Necrophilus arenarius.* This change in spelling is very probably due to the editor (Audouin), and has been followed by all the subsequent authors who have referred to the insect. The generic name thus becomes a homonym of Necrophilus (Coleopt.) Latreille (1929). But it is not improbable that Roux wished the name to signify "associated or allied with the dead," instead of "loving the dead." If this was his intention, we might have expected him to use the form "Necrophylius," but the Greeks seem occasionally to have preferred the shorter form "phylos" as in "emphylos." Be this as it may, however, our rules of nomenclature require us to return to Roux's original spelling of the generic name, and this precludes its homonymy with Necrophilus Latreille.

In 1857 Schaum, in the first article of the first volume of the "Berliner Entomologische Zeitschrift," gave a description and excellent figures of what he regarded as Roux's insect, with an account of the alimentary canal and nervous system, drawn from some 20 specimens which he had captured in 1852 in the dust of tombs at Beni-Hassan, near Cairo. Schaum was strongly of the opinion that the insect was a larval Nemoptera. Westwood had previously reproduced Roux's figure in the second volume of his "Introduction to the Modern Classification of Insects," (1840) and had ventured the suggestion that the insect from its size might either produce a Nemoptera, Bittacus or Panorpa." Within more recent years Roux's or Schaum's figures have been reproduced in various other general accounts of the Neuroptera, such as those of Sharp, Navas and Maxwell-Lefroy.

The mystery which has so long enveloped the affinities of Necrophylus has been recently dispelled by G. Storey, entomologist of the Egyptian Ministry of Agriculture, and C. B. Williams (Eltringham 1923, Withycombe 1923-b, 1924), who found it near Cairo, in the dust accumulated on the floors of desert caves or under rocky ledges and succeeded in rearing the imago. This proves to be a Crocine Nemopterid, to which Withycombe (1923a) has given the name *Pterocroce storeyi.* Storey reared a few adults from larvæ taken about 1915 from a cave some four miles from Wadi Digla, where Williams obtained his specimens in 1922. Eltringham and Withycombe have published excellent figures of the larva, (one of which is here reproduced as Fig. 1), and the latter has also described an allied form, *Nina joppana,* males and females of which had been reared in 1921 by Aharoni (Blair 1920-1921) from larvæ taken in the sand of caves near Jaffa, Palestine. The larva of this species closely resembles that of *Pterocroce storeyi* but has a distinctly shorter "neck."

Both Eltringham and Withycombe seem to believe that the introduction of the new name *Pterocroce storeyi* is justified for the insect reared by Storey and Williams. Eltringham offers the following comment on Roux's drawing of *Necrophylus arenarius*: "The drawing referred to is evidently incorrect in several details. The position of the front legs is wrong and the shape of the body is not fully indicated, whilst a slightly enlarged drawing of the head shows a structure of the mandibles and antennæ not found in the specimens examined by the writer, nor evidently in those described by Schaum." And Withycombe disposes of Roux's species in a foot-note: "I am not able to identify this larva with *Necrophilus arenarius* Roux. Roux's figure and description are totally inadequate, and seeing that *Nina cho-*

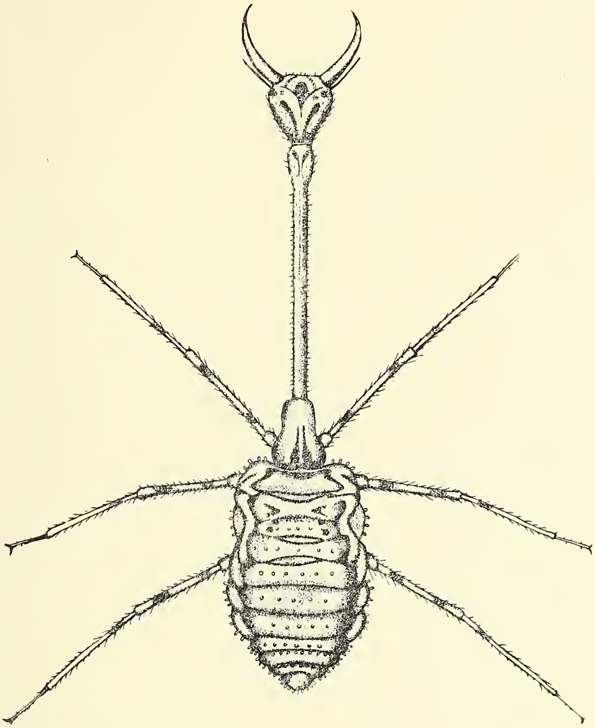

Fig. 1. Larva of *Necrophylus arenarius* Roux (*Pterocroce storeyi* Withycombe) After Eltringham.

bauti McL. also occurs in the same locality (Wadi Digla), this might equally be Roux's *Necrophilus*. The larva of *Nina joppana* sp. n. is also very similar to the present larva as will be seen." Neither of these statements seems to me to furnish adequate reasons for introducing the name *Pterocroce storeyi*. There are really two questions involved, namely: Is Roux's larva *Necrophylus arenarius* the same as Schaum's *Necrophilus arenarius*? and is Schaum's *N. arenarius* the same as Withycombe's *Pterocroce storeyi?* If both questions admit of an affirmative answer, Roux's and Withycombe's species are obviously identical.

The first question is the more complicated, since it involves a problem of fact and one of nomenclature. It is true that Roux's drawing is crude, but it was made on a journey and from an insect whose true affinities were quite unsuspected. Even the editor (Audouin) in the above-mentioned foot-note remarks that "the drawing by the author leaves much to be desired." But who expects drawings made nearly a century ago to represent minute structural details with the accuracy demanded by the present-day entomologist? The position of the forelegs and shape of the abdomen in Roux's Fig. 3, criticized by Eltringham, are of little significance because such distortions may be due to the method of mounting or the state of preservation. The more serious discrepancies in the enlarged head (Fig. 4), especially the swollen basal antennal joints and small hairs on the inner borders of the mandibles, are in all probability due to faulty observation. These characters are not indicated in the drawing of the whole specimen (Fig. 3), which would have to be regarded as the first and more authentic figure. It should also be noted that even in the excellent illustrations of Eltringham and Withycombe the joints of the very delicate antennæ beyond the first are not indicated, and an entomologist of the year 2030 might say that these organs consist of a single basal joint with a long apical bristle. There is really no basis for Withycombe's statement that Roux's larva may be the unknown larva of *Nina chobauti,* since the "neck" of *N. joppana* is distinctly shorter and it is therefore more probable that the congeneric *chobauti* would have a "neck" of the same or very similar dimensions. The fact that Williams took a single female of *chobauti* "at light" at Wadi Digla is no evidence that Roux's specimen was of that species. It is certainly more probable that it belonged to the common larva in the same and other localities about Cairo and that larva is the one identified by Withycombe as *Pterocroce storeyi.* The nomenclatorial problem centers about Schaum's interpretation of Roux's larva. The German entomologist evidently entertained no doubt that his specimens belonged to the same species. He may therefore be said to have validated Roux's generic and specific names as those of his own specimens even if it can never be proved that the specimens taken at Gizeh and Beni Hassan are cospecific.

I believe the answer to the second question, that of the identity of Schaum's and Withycombe's larvæ, is even more clearly affirmative. In the rather extensive collection of larval and pupal Neuroptera accumulated by Dr. H. Hagen during his long association with the Museum of Comparative Zoology, I find two of the 20 larvæ collected by Schaum in 1852. One of them measures 8.5 mm., and is therefore nearly full grown, the other 7.3 mm. They bear Schaum's original label, with the remark: "Häufig auf dem Schutt der Felsengräber von Beni-Hassan, 400′ über d. Nil, freilaufend. Schaum," and additional labels in Hagen's handwriting with an English rendering of the foregoing and "223. Nemoptera sp.—Necrophilus arenarius Roux. Hagen pl. f." These specimens are mentioned by Hagen in his paper on the Nemopteridæ (1888). After expressing his opinion that the larva of *N. arenarius* described by Roux and Schaum is probably that of *Nemoptera (Brachystoma) olivieri,* he adds: "types of the larva are in my collection." On comparing these types, or paratypes as we should now call them, with Eltringham's and Withycombe's figures of the larval *Pterocroce storeyi,* I am quite unable to detect any differences, except in coloration. Withycombe figures and describes a more and a less pigmented "form" of larva, and Hagen's specimens are slightly paler than the latter. This, I am convinced, is due to bleaching by the alcohol in which the specimens have been preserved for nearly 78 years. I conclude, therefore, that Roux's, Schaum's and

Withycombe's larvæ all belong to the same species of Crocine Nemopterid, which should bear the name *Necrophylus arenarius* (Roux) Schaum.

The Crocini obviously constitute a peculiar tribe of Nemopteridæ, with strongly marked larval and adult characters, both morphological and ethological. The adults are small, frail insects with a strongly produced beak-like front, short antennæ and very long, thread-like hind wings. The larvæ have the prothorax produced into a slender and elongate "neck" anteriorly but the attenuation and elongation of this region differ considerably in different genera, being very great in Necrophylus, less pronounced in Nina and much feebler in Croce, as shown by the observations of Maxwell-Lefroy (1909, 1910), Ghosh (1910), and Imms (1911) on the Indian *Croce filipennis.* Withycombe (1924) has been able to study the first instar larva of one of the true Nemopteras *(N. bipennis)* and has shown that it has a very short prothorax and neck, even shorter than in antlion (Myrmeleontid) larvæ.

Ethological observations on the Crocini show that they are to be regarded as cavernicolous insects. The larvæ of the species of Necrophylus and Nina, as we have seen, live in the dust and sand of tombs, caves and rock-cavities, and those of *Croce filipennis* are common in the dust that accumulates on the floors of disused rooms and bungalows, where they feed on Psocids, Lepismids, etc. The adult Crocini fly at dusk or, if during the day, in dark corners, within the confines of the caves, cavities or human dwellings. This is also true of the Spanish *Josandreva sazi,* which was found by Navas (1910) flying at dusk in the cavities of walls and especially in those containing sand or dust. In all probability the larvæ of this delicate insect lives and hunts its prey in these accumulations. The adults of the genus Nemoptera, however, live in the open and may fly by day. At any rate I took quite a number of *N. bipennis* flying or resting on the sparse vegetation of the sun-baked hills about Ronda, Spain (June 30, 1925), at a considerable distance from walls or rock-cavities. The larvæ probably live in the dust or sand of the open fields like many of the Myrmeleontid larvæ that do not make pits.

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A CLASSIFICATION OF THE PSOCIDÆ

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For a long time it has been customary to divide the Psocidæ into two sections according to the number of joints in the tarsi, two or three. By this division certain genera (as Myopsocus and Mesopsocus) were placed with the Trimera, although their venation is practically the same as the typical genus, *Psocus,* with two-jointed tarsi. The venational peculiarity of these higher Psocidæ is in a certain form of stigma, as well as in the modification of the cubital fork to form what is called an "areola postica." The three-jointed tarsi is a primitive character, and should not have as much weight as a special development within the family. I have prepared the following table placing emphasis on this areola postica and the stigma. The number of tarsal joints I would consider as of not more than tribal value; hardly, if any, more valuable than the forked media in hind wing, also a primitive character.

The use of the number of antennal joints as a primary character is open to the same objections as that of the number of tarsal joints, with the added force that the groups overlap. The use of the character of anal and axillary vein in forewing being separate throughout or united at the tip transfers the Amphientominæ from the other scaly-winged species to the group of the true Psocidæ. While there is no doubt that Amphientomum approximates nearer than does any other scaly-winged form, to the true Psocidæ, yet the venation (except for this condition in the anal region) is so close to that of other scaly-winged forms, and so different from the true Psocidæ that it cannot be neglected with reason. Moreover the head of Amphientomum, as well as pronotum, is much more like that of Perientomum than of any of the true Psocidæ. The presence of scales is also a character of some value. Moreover the genus Psyllipsocus has the anal and axillary ending together, and this surely is not allied to the true Psocidæ.

Perhaps it would be better to consider the scaly-winged species to belong to two families rather than two subfamilies, but I think that the differences between them are not as important as between them and the true Psocidæ. Indeed I think that they form a tendency to run into the Psyllipsocidæ. Embidopsocus I have united with Archipsocus in one family, although it might be better to put each in a family; both are primitive as to the pronotum and some other characters, but have a reduced rather than primitive venation. It is among the scaly-winged species that we find the more primitive forms. On the one side there has been a reduction of pronotum and specialization in venation to the true Psocids, and on the other side a reduction in wing-characters toward the Atropidæ.

The old family Psocidæ I would consder as a superfamily, Psocoidea with the following families, subfamilies and tribes as in the table.

Zorotypus I would also include in the order Corrodentia as the superfamily Zorotypoidea.

I would place *Hemipsocus* in the *Cæciliinæ*; the venation (outside of the cross-vein) is more that of *Cæcilius* than of *Psocus*.

Certain *Epipsocus* show that the separation between the *Cæciliinæ* and *Psocinæ* is not of great moment, and perhaps it would be better to reduce these groups to tribes.

Vulturops Towns. will go in the family *Psoquillidæ*. *Heteropsocus* is the same as *Psoquilla*, but the species is distinct. *Psocinella* and *Psocathropos* differ in length of hind femora. *Notiopsocus* and *Allopsocus* go in the *Peripsocini*. *Rhyopsocus* goes in the *Psylloneurinæ*.

1. No wings, or only scale-like wings without definite venation; no ocelli; tarsi three-jointed, antennæ 15 or more jointed; pronotum visible above *Atropidæ*
   Wings with definite venation present 2

2. Forewings with a definite stigma; cubital fork developed into an "areola postica" with a narrowed base, or else no cubital fork; the first fork of median vein never reaches back to near base of stigma; anal and axillary end in one point; wings not scaled; 3 ocelli; pronotum rarely distinct from above; antennæ 13 jointed; tarsi two- or three-jointed *Psocidæ*
No distinct stigma, if one apparent then wing scaled and the first fork of median vein reaches back nearly as far as base of apparent stigma; no areola postica with narrowed base, the cubital fork is a normal fork, usually long; anal and axillary often separate at tip; ocelli present or absent, antennæ usually more than 13 jointed; tarsi three-jointed; pronotum often distinct from above 3

3. Wings clothed with scales; both wings present, veins reach to margin *Perientomidæ*
Wings not with scales 4

4. No hind wings, or extremely minute; venation reduced, some very long bristles; no ocelli; anal and axillary separate, meso- and metathorax separated, pronotum visible from above *Psoquillidæ*
Hind wings of fair size; usually ocelli 5

5. Venation complete, that is all main veins reach margin, two or three branches end in costa, pronotum not particularly prominent from above; antennæ 20 or more joints *Empheridæ*
Venation reduced, some veins not reaching tip; pronotum very prominent from above; meso-and metanotum separate; antennæ 13 to 15 jointed, eyes not hairy *Embidopsocidæ*

TABLES TO SUBFAMILIES AND TRIBES

Atropidæ

Claws without tooth; meso- and metanotum separated; antennæ 22 or more joints, wings absent or scale-like *Atropinæ*

Claws with a tooth; meso- and metanotum united, antennæ 15 jointed; no wings *Troctinæ*

Psoquillidæ

The few genera do not readily separate into groups.

Embidopsocidæ

Two longitudinal veins unbranched *Embidòpsocinæ*
Two longitudinal veins branched and connected *Archipsocinæ*

Empheridæ

Hind wings with median forked *Empherinæ*
Hind wings with median simple *Psylloneurinæ*

Perientomidæ

Anal and axillary end in one point antennæ 13 jointed or a few more; no closed cell near middle of fore wing; media of hind wing simple *Amphientominæ*

Anal and axillary separate at tip; usually a small closed cell near middle of fore-wings; median of hind wings forked; antennæ 20 or more jointed. *Perientominæ*

Psocidæ

1. In hind wing median vein forked; wings sometimes partly netted .... *Calopsocinæ*
   Median vein of hind wings simple 2
2. Areola postica (sometimes absent) free, or if connected to media then its end is as far out as end of stigma *Cæcilinæ*

   Areola postica present and either united at top to media or connected by a cross-vein, and usually ending before end of stigma 3

3. Radius (near base of radial fork) connected a second time to the media, thus forming two closed cells near middle of wing .... *Thyrosophorinæ*
   Radius connected but once to media, and thus forming but one closed cell near middle of wing .... *Psocinæ*

Calopsocinæ

Hind edge of head sharp; venation partly netted .... *Calopsocini*
Hind edge of head rounded; venation not netted .... *Ptiloneurini*

Cæcilinæ

1. Stigma veined, no cubital fork .... *Neurostigmini*
   Stigma not veined 2
2. No cubital fork .... *Peripsocini*
   Cubital fork present 3
3. Tarsi 2 jointed 4
   Tarsi 3 jointed, head broad at eyes .... *Mesopsocini*
4. Hind edge of head rounded .... *Cæcilini*
   Hind edge of head sharp .... *Dypsocini*

Psocinæ

1. A cross-vein between stigma and radius .... *Stenopsocini*
   No such cross-vein 2
2. Tarsi 3 jointed .... *Myopsocini*
   Tarsi 2 jointed .... *Psocini*

Thyrsophorinæ

The few genera here do not require tribes.

FOUR NEW SPECIES OF PSAMMOCHARIDÆ

By Nathan Banks
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Cryptocheilus cressoni sp. nov.

♀ Black, antennæ mostly yellow, wings yellowish except dark base and tip; body only moderately hairy, also coxæ, femora only slightly above. Third joint of antennæ much longer than the fourth; lateral ocelli much nearer to each other than to eyes; pronotum angulate behind; propodeum coarsely transversely ridged, these ridges often weaker in the middle area of the posterior face; long spur of hind tibiæ about one-third of basitarsus; second ventral segment of female with two humps more or less distinct. Third cubital cell but little longer than the second, reaching much beyond the radial cell. The subgenital plate of the male has a median, elevated, punctured, spatulate area not reaching tip of plate, but with a median projection toward the tip.

Length 15 to 20 mm.; forewing 17 mm.

Specimens come from Fedor, Dallas, and Austin, Texas. Others from N. Mex., Arizona, Utah, and California have the elevated part of subgenital plate longer. It has been considered as *C. flammipennis* Smith which is a San Domingo species.

Lophopompilus azotus sp. nov.

♀ Black; head, thorax, abdomen and basal joints of legs strongly sericeous; the lower part of pronotal lobes almost snow-white, and also the lower lateral edges of the dorsal plates of abdominal segments one to three. Pilosity and structure similar to *L. æthiops,* but the hair is rather shorter and less dense, most noticeable on the head; the emargination of clypeus is as deep as in *L. æthiops.* It may prove to be but a variety of that species, but the coloration is so different that it deserves a name.

From Springfield, South Dakota 14 Sept. (H. C. Severin).

Aporinellus semirufus sp. nov.

♀ Head and thorax black, sericeous, especially on the clypeus; abdomen wholly red above and below; legs mostly black, tarsi brown, hind femora and tibiæ red; antennæ black. Pronotum and part of pleura sericeous. Wings hyaline, apex dark. Vertex considerably narrowed above, hind ocelli much closer to the eyes than to each other; third joint of antennæ plainly longer than the fourth; front tarsi with comb of long spines. Wings short and small, marginal cell fully twice as long as broad, submarginal short, not one and and a-half times as long as high, the two sides nearly meeting above, first recurrent vein received before the middle, second recurrent interstitial with end of the submarginal cell.

Length 6 mm.

From Martin, South Dakota, 12 Sept. (H. C. Severin). At once separated from *A. rufus* by thorax and base of antennæ black. In structure it is near to *A. ferrugineipes,* both in wings and head, but differs in the red abdomen.

Planiceps hesperus sp. nov.

Black; clothed with minute appressed pubescence, on vertex, pro- and mesonotum rather brownish, on clypeus, propodeum, pleura, and coxæ white; last dorsal segment of abdomen of female red-brown; wings nearly uniform blackish. Face broad, scarcely narrowed above, vertex straight across, lateral ocelli about as near to eyes as to each other; pronotum long, fully two-thirds as long as broad in female, in male much shorter, nearly straight behind; propodeum without distinct furrow; legs with few very short spines on tibiæ, long spur of hind tibia little more than one-half of basitarsus in the female, in male fully two-thirds of basitarsus. Wings with marginal cell small, more than twice its length before tip of wing, second sub-marginal cell small, triangular, receiving both recurrent veins, the discoidal cell below this very short, basal vein strongly bowed basally.

Length ♀ 4.5 mm., ♂ 3 mm.

Lone Mt., San Francisco, Calif., 25 April, 4 July (F. X. Williams).

In venation as well as general structure it is very similar to the eastern *P. pulchellus,* but separated by the black abdomen.

ON THE DRYOPID BEETLE GENUS LARA

By P. J. Darlington, Jr.

Collecting at North Bend, Washington, in July, 1927, yielded a large series of the dryopid genus Lara, which was described in 1852 by Leconte (Proc. Acad. N. S. Philadelphia 5, 1852, p. 42.) to contain a single species from California. Superficial examination showed at once that there were two species represented in the Washington material. Comparison with the type of *L. avara* Lec. proved further that the insect I had at first identified as that species was at least subspecifically distinct, so that it is now possible to discriminate two new forms and at the same time to give a brief account of their habits.

In our fauna Lara is an isolated genus of the Potamophilini, seeming to be, as Leconte says in the original description, "the desired link connecting the anomalous Eurypalpus (Psephenus) with the true Parnidæ. There are several apparent relatives, such as Disersus, in Central and South America, however. Leconte's description of Lara is sufficiently full, and the genus has been figured by Horn in the Trans. American Ent. Soc., 10, 1882, Plate 6, fig. 16.

Key to the Species of Lara

Pronotum with the hind angles acute, but scarcely more prominent than the middle lobes; elytral pubescence uniform *L. gehringi*

Pronotum with the hind angles acute and prominent; alternate elytral intervals with the pubescence less decumbent, so that the elytra appear dark with sericeous lines.

- Size larger; elytra wider as compared with the prothorax; pronotum proportionately longer, narrower, and with more prominent front and hind angles. *L. avara amplipennis*
- Characters opposed to those above *L. avara avara*

Lara gehringi sp. nov.

Text figure "a".

Black throughout. Punctuation and pubescence above and below almost as in *Lara avara,* except that there is no alternation of pubescence on the elytral intervals. General form similar to that of *L. avara,* but the pronotum less strongly convolved and its side margins less strongly sinuate throughout. Hind pronotal angles only moderately prominent, scarcely more so than the sides of the pronotum at middle. Genitalia of ♂ definitely more decurved apically than in *L. avara.*

Length to apex of elytra 5.7—6.5 mm.

The ♂ holotype and one ♂ paratype are from NORTH BEND, WASHINGTON, July 28, 1927. One ♂ paratype is from BARTLETT SPRINGS, CALIFORNIA, collected by A. Fenyes. The holotype is in my own collection, the North Bend paratype in the collection of Dr. J. G. Gehring, and

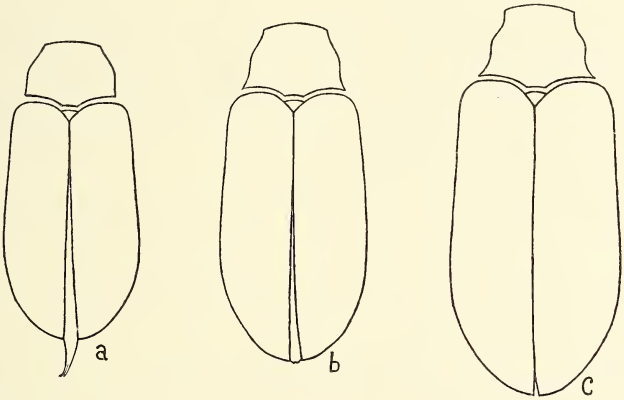

Fig. 1. Outlines of pronotum and elytra of **a**, *Lara gehringi;* **b**, *Lara avara avara;* **c**, *Lara avara amplipennis.* All are magnified about 6.5 diameters.

the Californian paratype is returned to Mr. H. C. Fall, who very kindly loaned the specimen to me for the present study.

The important diagnostic characters of *Lara gehringi* are set forth in the key. The Californian specimen differs from the other two in being a little more shining above.

I take great pleasure in naming this species for Dr. John George Gehring, who was almost my first entomological correspondent, and to whom I owe my western trip of the summer of 1927.

Lara avara amplipennis subsp. nov.

Text figure "c".

Generally similar in form and sculpture, as well as genitalia, to typical *Lara avara,* but larger, with the elytra a little wider as compared with the prothorax. The pronotum is proportionately a little longer and narrower, with both the anterior and posterior angles more prominent. These differences taken together give the insect a recognizably modified appearance, although they do not impress one as being of specific value. There seem to be no external differences between the sexes.

Length to apex of elytra	(*amplipennis*)	7.3—8.1 mm.
	(*avara*)	6.8—7.2 mm.
Length of an elytron	(*amplipennis*)	6.1—6.5 mm.
	(*avara*)	5.2—5.4 mm.

Since the total length depends partly on the insect's position at death, the measurements of elytral length show the comparative size of the two subspecies more accurately.

Holotype ♂ from NORTH BEND, WASHINGTON, July 28, 1927, in my collection. Paratypes: 49 ♂♂ ♀♀ from the type locality, July 27-31; 2 ♂♂ from REVELSTOKE, BRITISH COLUMBIA, August 14, 1927. Paratypes in the Museum of Comparative Zoölogy, the United States National Museum, the California Academy of Sciences, the Canadian National

Collection, and the private collections of Mr. H. C. Fall, Dr. J. G. Gehring, and the writer.

This series of *amplipennis* has been compared with the type and one other Californian specimen of true *Lara avara* in the Leconte Collection in the Museum of Comparative Zoölogy at Cambridge. For the privilege of making this comparison I am indebted to the authorities of the museum, and particularly to Professor Nathan Banks, Curator of Insects.

Horn speaks of having seen a specimen of *Lara avara* on a log under water in a swift stream. I found the genus only on log jams in large streams which were both swift and cold. The insects behave much like Psephenus, but are, perhaps, less alert, for they are usually found on the lower sides of projecting stubs or in crevices, just at water level. They are among the most resourceful of beetles in the presence of danger, for they can choose between crawling down a log into deep water, flying, or dropping into the current, which whirls them swiftly away. The majority ride the current for a yard or two and then take wing. I owe my fine series of the genus almost entirely to a systematic but temporarily unsuccessful search for *Amphizoa striata* Van Dyke, of which North Bend is the type locality.

THE TRACHEAL SYSTEM OF THE MATURE LARVA OF *PYRAUSTA NUBILALIS* HUBN.[1]

BY MILTON F. CROWELL

The tracheal system of the larva of the European cornborer, *Pyrausta nubilalis* Hubn. (Lepidoptera; Pyralididæ) is of the peripneustic type. There is one pair of functional spiracles on the thorax, and eight pairs on the abdomen. (Fig. 1). These spiracles open into short stout tracheæ which lead, on each side, to a large longitudinal trachea which runs throughout the length of the body, and from which branches go to the various body organs.

The Spiracles

The spiracles are of the type described by Kranchner, according to Packard (1909), as "bearing lips." The lips are represented by a chitinous ring surrounding the elliptical opening through the body wall. They are "roof-like," or bent inwards, and are hairy. (Fig. 2). From the spiracle a short stout trachea joins the adjacent longitudinal trunk. (Fig. 3).

The Tracheal Closing Apparatus

The tracheal closing apparatus (Fig. 3) surrounds the short trachea between the spiracle and the main trunk. On one side of the trachea, extending about half around it, is a chitinous band, the *closing bow.* Attached to one end of this bow is one extremity of the *closing lever.* The closing lever runs parallel with a line joining the ends of the closing bow, to a point almost halfway between the ends of the bow. Here the lever turns abruptly away from the center of the trachea at approximately a right angle. The projecting arm thus formed is somewhat larger than the other arm and swells slightly toward its free end. The lever is chitinous. Between the apex of the lever and the end of the closing bow opposite to that to which the lever is attached is a third chitinous piece. This is the *closing band.*

The contraction of a muscle extending between the free arm of the lever and the closing band causes the lever to move. The attachment of the lever to the closing bow becomes the fulcrum, and the action of the muscle pulls the apex of the angle of the lever inward, causing the space between the lever and the closing bow to become constricted. The closing band is so attached to the apex of the angle that the end of the band is depressed inward, causing the space between it and the closing bow to be constricted. The trachea is thus pinched together.

This structure is cast with the exuvia when molting takes place.

Kranchner (1880), who first described the tracheal closing apparatus of insects, expresses the opinion that it originates as a local thickening of the tænidium.

The description of the spiracles and closing apparatus is taken from a former paper, (Crowell, 1926).

The Longitudinal Tracheæ

In the embryo the tracheal system arises as ectodermal invaginations which grow deeper, and from which branches are sent out. One running forward fuses with one running backward from the next anterior spiracle, and one running backward fuses with one running forward from the next posterior spiracle. Thus, longitudinal connections are formed between the spiracles, and these connections form the main longitudinal tracheæ. In the thorax there is a longitudinal system on each side dorsal to the main system. It is formed by the joining of dorsally running branches.

The longitudinal tracheæ lie on each side in an area between the small dorso-recti muscles and the great ventro-recti muscles. In this area there are no longitudinal muscles, but it is crossed by sterno-tergal muscles.

Lying in front of all of the spiracles, except those in the prothorax, is a sterno-tergal muscle, and the longitudinal trachea except in the mesothorax and in front of the first abdominal spiracle, passes between these muscles and the body wall. In the prothorax the sterno-tergal muscle lies behind the spiracle. In the metathorax a large branch from the main trachea passes beneath this muscle. In the mesothorax the muscle is present and a trachea arising in a manner similar to the branch in the metathorax passes between it and the body wall. Thus in each body segment through which the main trachea runs it is held to the body wall by a muscle passing over it. (Fig. 4. The trachea is much longer in proportion to its thickness than here indicated).

According to De Guyse (1926) the primitive position of the spiracle located on the prothorax was in the membrane between the prothorax and mesothorax, and it has moved ahead to its present position. That would account for the fact that the sterno-tergal muscle lies behind the spiracle rather than in front of it, as in the abdomen.

DeGuyse (1926) explains the positions of the muscles in front of the first abdominal spiracle, and in the mesothorax, from a consideration of the larvæ of *Sthenopis* (Hepialidæ), as follows:

> The thoracic spiracles are situated at a much lower level than those of the abdomen. In the abdomen the anterior lateral branch arising from the short spiracular trachea passes under the sterno-tergal muscle and anastomoses with the posterior lateral branch from the next preceding segment. The anterior lateral branch from the first abdominal spiracle passes as usual under the muscle, but since the second thoracic spiracle is at a much lower level, its posterior lateral branch fails to meet the anterior lateral branch from the abdomnial spiracle. The latter loses itself among the dorsal muscles. At the same time the lower visceral branch is found greatly enlarged, and anastomosed with a posterior branch of the first thoracic spiracle. The

second pair of spiracles thus loses its connection with the general respiratory system and ceases to function.

That means that the apparent branch in the metathorax, arising from the apparent main trachea and passing beneath the muscle, is, in fact, the main trachea, and the apparent main trachea is a branch. But it is hard to explain the tracheal branchings in the mesothorax on this basis.

The branch from the first abdominal spiracle passing forward beneath the sterno-tergal muscle, does not, in *Pyrausta nubilalis* "lose itself among the dorsal muscles," but becomes a part of the dorsal longitudinal system, sending branches to the metathoracic leg and to the wing-bud.

Figure 5 and figure 6 show the branches arising from the first and fourth abdominal spiracles, respectively. In the case of the branches arising from the first abdominal spiracle it is evident that the presence of the appendages of the metathorax, legs and wings, has made necessary more tracheal branches than are called for in the fourth segment where such appendages are absent.

But a study of the branches arising from the fourth abdominal spiracle fails to show any that takes over the role of the main trunk, if we consider that the branch from the first abdominal spiracle from which spring the tracheal supplies to the alimentary tract, the wing-bud, and leg, to be the anterior branch, or "main tracheal trunk" from that spiracle.

The apparent main tracheæ, the "lower visceral branch" of de Guyse, does not meet the posterior branch from the prothoracic spiracle until after it throws out branches in the mesothorax that are at least analogous with the branches from the first abdominal spiracle. (Fig. 7). It is rather difficult to see how these branches arose as secondary branches from the lower visceral branch from the first abdominal spiracle and the posterior branch from the prothoracic spiracle.

The Transverse Tracheæ

The longitudinal tracheæ of each side are connected by transverse tracheæ in every spiracle bearing segment, except, possibly, the first abdominal. There is one in the mesothorax, although that segment does not bear a functional spiracle. There is one in the head.

The transverse trachea in the head lies in front of the supraœsophageal ganglion and just behind the body of the tentorium. The posterior arms of the tentorium pass above the trachea, close to its junctions with the main longitudinal tracheæ. This transverse trachea lies above the commissures between the supra- and subœsophageal ganglia. (Fig. 8).

Peterson (1912) describes and figures a cross trachea in the larva of the tomato-worm, *Protoparce carolina,* lying above the commisures between the supra- and sub-œsophageal ganglia, but in the tomato worm this trachea crosses the subœsophageal ganglion. In *Pyrausta nubilalis* it lies well in front of the ganglion. Peterson says nothing about the relation of this trachea to the tentorium, but from his figure, the trachea must lie well behind it.

The next cross trachea, which I have numbered 2-a, is a secondary branch. The primary branch from which it springs comes from the main trachea just after it leaves the prothoracic spiracle and its other branches will be described later.

Trachea 2-a runs on the outside of the muscle layer, and beneath the central nervous system.

In the prothorax there is a transverse system of tracheæ dorsal to the alimentary tract. These tracheæ are arranged in such a manner that I term the system the *diamond.* (Fig. 9).

A large branch arises from the thoracic spiracle. It runs forward a short distance, then branches into two good sized tracheæ, the larger being in front. Each of these branches meets a corresponding branch from the opposite side, and the double Y thus formed gives the shape that justifies my name for the arrangement. From the forward apex of the diamond branches go into the head. From the posterior apex a long branch goes backward and joins a branch from the main trunk that runs backward from the prothoracic spiracle Thus, counting each branch separately there are three transverse connections crossing the ailmentary tract between the prothoracic spiracles.

Peterson (1912), in the tomato-worm, finds that in all cases except the transverse tracheæ described above, the cross tracheæ lie ventral to the nervous system. This is not always true in *Pyrausta nubilalis.*

Just behind the prothoracic spiracle there is a trachea, which I have numbered 1. This lies on the inner surface of the muscle layer. It crosses the nerve cord dorsally, terminating, usually, in the prothoracic ganglion. Near the base of the ganglion the trachea meets the corresponding trachea from the other side, and a cross connection, dorsal to the nervous system, and ventral to the alimentary tract, is formed (Fig. 10). Trachea 1 varies. It may be much reduced, forming only a very weak connection with the central nervous system, with the corresponding trachea of the opposite side entirely absent (Fig. 11). Sometimes the trachea to the ganglion is obviously from the left side, with the trachea from the right meeting it (Fig. 12), and sometimes the opposite is true. The branches from trachea 1 usually supply the muscles, but in one specimen a large branch ran to the nerve cord in front of the mesothoracic ganglion. (Fig. 13). In the figures the size of the tracheal connections with the ganglion is exaggerated.

Trachea 1 lies, apparently, at the junctions of the longitudinal muscles of the prothorax with those of the mesothorax, and is a useful landmark in locating the limits of these segments.

The next transverse trachea I have numbered 2 (Fig. 14). It lies in the mesothorax on the outer side of the muscle layer. It passes beneath the central nervous system just in front of the mesothoracic ganglion. In relation to the muscles and the nervous system and to tracheæ 1 and 3, which will be described next, it is, if not homologous to trachea 2-a, analogous to it.

Trachea 3 lies on the inner surface of the muscle layer and approximately marks the limits of the mesothorax behind and of the metathorax in front. It is a transverse trachea much as is trachea 1. A branch to the mesothoracic ganglion meets a branch from the opposite side, forming a cross tracheal connection dorsal to the nervous system and ventral to the alimentary tract (Fig. 15).

Trachea 4 lies in the metathorax. It is on the outside surface of the muscle layer and crosses just in front of the metathoracic ganglion. It is similar to trachea 2.

The system of numbering is now evident. Beginning with the first trachea behind the prothoracic spiracle lying on the inside of the muscle layer, extending toward the mid-ventral line of the body, which trachea I have called 1, the tracheæ in each segment behind this that lie on the inner surface of the muscles at about the line between the segments have *uneven* numbers. Those transverse tracheæ lying in the segment and on the outer surface of the muscle layer have *even* numbers.

Trachea 5 is not a transverse trachea; and the tracheæ in the abdomen analogous to tracheæ 1, 3 and 5, are not transverse tracheæ.

Trachea 6 lies in the first abdominal segment. From its position on the outside of the muscles and from the distribution of its branches, which will be discussed later, it is analogous, if not homologous to the other tracheæ of like position (those with even numbers). But unlike tracheæ 2 and 4, and unlike the corresponding tracheæ in the abdominal segments, trachea 6 is not, as a rule, a transverse trachea. In one specimen I found a connection with the corresponding trachea from the opposite side. I doubt if that was typical. But it must be considered in connection with the transverse tracheæ because of its position. (Figs. 16, 17).

Behind the first abdominal segment there is a transverse tracheal connection in each spiracle bearing segment. From the second to the seventh segments inclusive, this transverse trachea is analogous to tracheæ 2 and 4, except that they lie behind, rather in front of, the ganglia.

In the eighth segment there is a stout connection between the spiracles lying above the alimentary tract.

Peterson (1912) in speaking of the tomato worm says: "In the case of the eighth abdominal segment, only one minute dorsal cross trachea was found, while in the prothoracic region two distinct cross tracheæ were observed."

Pyrausta nubilalis differs from the tomato worm in that the cross trachea in the eighth segment of the abdomen is not minute, but is a stout connection. In the prothorax the connections are apparently similar, but Peterson shows no tracheal connection between the posterior apex of the diamond and the main trunk.

Tracheæ from the Prothoracic Spiracle

The arrangement of the tracheæ from the prothoracic spiracle (Fig. 18), from which the organs of the prothorax and head are supplied, is much more complicated than that in the regions of the body behind the prothorax. It is easier to describe these tracheæ as from the prothoracic spiracle than to attempt to correlate them with the study of the tracheal supplies to various systems of organs.

From the spiracle two large branches extend towards the head. One of these I believe, for reasons to be set forth later, represents the main longitudinal trachea, or the anterior branch from the spiracle. The other branch forks a short distance in front of the spiracle, and its inner branch forms the stem of the Y which makes up one side of the dorsal transverse tracheæ to which I have referred as the diamond. The outer branch goes forward into the head. There it branches, and apparently supplies the great mandibular muscles lying in the side of the head. One branch was traced to the region of the base of the antenna, but I was unable to follow it into that organ.

The other large branch going into the head from the spiracle branches almost immediately. This first branch sends out a small branch, and three larger branches of about equal size. The small branch goes toward the head. The branch nearest the head of the other three branches passes at once to the outer surface of the muscle layer. It runs toward the middle of the body, and sends a branch to the prothoracic leg. It continues, and sends a branch upward to the prothoracic ganglion. Then it meets the corresponding trachea from the opposite side, forming a transverse connection ventral to the central nervous system. In its position and its branching to the ganglion, but not to the leg, it resembles the transverse tracheæ to which I gave even numbers, and is the trachea which I designated as 2-a.

The middle of the three branches runs on the inner surface of the muscle layer and sends branches to the prothoracic and subœsophageal ganglia, and to the muscles.

The hindmost branch also runs on the inner surface of the muscle layer. It crosses the muscles, and bending ventrally sends a branch to the prothoracic leg.

The middle and hindmost branch, taken together, are, in their position and distribution so similar to trachea 3 that I believe them to.be at least analogous to the tracheæ with uneven numbers. Therefore I have numbered them together as branches of trachea 1-a.

The next large branch from the main trachea runs largely across the dorsal surface of the muscles inside of the head, apparently supplying them.

A small branch runs from the main tracheal system to the supraœsophageal ganglion.

Just in front of this ganglion, and lying so that the main tracheal branch is just behind the body of the tentorium, is the first transverse trachea described above. There are two branches from this trachea extending backward. Sometimes they go to the subœsophageal ganglion (Fig. 18), and sometimes they end in the nerve cords anterior to it. In sending these branches to the nervous system, this trachea resembles tracheæ 2, 4, etc., but in lying above the neural commissures it differs from them.

In describing the main tracheæ from the spiracle I said that two large branches extend toward the head. From one springs the half of the dorsal transverse system forming the diamond. From the other spring branches 2-a, 1-a, the trachea to the supraœsophageal ganglion, and the first transverse connection, I believe that these branches indicate that this trachea is the main longitudinal trunk, and not the one giving rise to the diamond. For, as will be shown, the transverse tracheæ supplying the ganglia of the body segments posterior to the prothorax always spring directly from the main trunk near the spiracle. If it is true that the anterior arm of the tentorium is formed from an invagination of the body wall representing the spiracle of the mandibular segment (Comstock and Kochi 1902), it is not unreasonable to imagine that the first transverse tracheæ indicate, at their point of origin, the positions of the branchings from a spiracle, and that it is here that the main longitudinal trachea ends, rather than at the prothoracic spiracle.

From just in front of the base of the transverse trachea two tracheæ of about equal size run forward. The inner one ends in two short branches, one to the maxilla, and one to the labium. The outer trachea sends branches into the mandible, and a branch to the region of the base of the antenna. I was unable to trace this into the antenna. A small branch from the trachea to the supraœsophageal ganglion runs forward and joins one of the mandibular branches.

The other tracheæ arising from the prothoracic spiracle are the posterior branch going into the formation of the main longitudinal trachea, and a branch also running backward which joins the trachea to the posterior apex of the diamond. Branches also go from this backward running branch to muscles and fat bodies, and a branch divides into tracheæ supplying the appendages of the mesothorax.

Tracheæ to the Nervous System

The tracheæ to the supra- and subœsophageal ganglia, and to the prothoracic ganglion have been described.

The mesothoracic ganglion is supplied with air by tracheæ 2 and 3. Trachea 2 sends a branch backward to the ganglion, and trachea 3 sends one forward as described.

Trachea 3 lies on the inner surface of the muscle layer and sends many branches to the muscles (Fig. 15). Its main branch runs around the edge of the muscle layer and, turning downward, extends into the mesothoracic leg.

Trachea 5 differs from trachea 1 and 3 in that it does not connect with the corresponding trachea from the opposite side. It sends branches to the muscles and its forward branch runs around the edge of the muscle layer, and turning downward, enters the metathoracic leg. It also sends small branches to the metathoracic and first abdominal ganglia. (Fig. 19).

The metathoracic ganglion receives, in addition to the small branches from trachea 5, branches from trachea 4. These run backward, one on each side, to the ganglion. (See Fig. 14, representing trachea 2).

The first abdominal ganglion receives, on each side, a small branch running forward from trachea 6, as well as branches from trachea 5. (Figs. 16 and 17).

The abdominal ganglia receive their air supply from the transverse tracheæ. In the abdomen these all are found on the outside surface of the muscle layer. The tracheæ corresponding to tracheæ 1, 3, and 5, do not enter the nervous system. Another difference is that in the thorax the transverse tracheæ of even number, 2 and 4, lie in front of the ganglia and send their branches backward to them, while in the abdomen the transverse tracheæ lie behind the ganglia, and the branches to the ganglia run forward. The tracheæ that form the transverse tracheæ in the abdomen divide into an anterior and posterior branch. It is the posterior branch that meets the corresponding trachea from the other side, forming the transverse connection, and from this branch, also, that the branch divides that supplies the ganglion. The anterior branch may send branches to the ganglion, but apparently more often it does not. (Fig. 20).

The seventh and eighth abdomnial ganglia have coalesced and lie in the seventh abdominal segment. The trachea that normally would supply the seventh ganglion here supplies both. There is no separate connection between the eighth ganglion and the tracheal system. (Fig. 21).

Peterson (1912) figures two transverse tracheæ in the tomato-worm larva sending branches to these ganglia, the one supplying the seventh passing under the eighth, and the trachea sending branches to the eighth is apparently the transverse trachea between the spiracles of the eighth abdomnial segment. Careful search failed to discover any trachea from this transverse trachea to the nervous system in *Pyrausta nubilalis*.

The commissures between the ganglia are usually supplied by branches from the transverse tracheæ. In the abdomen there are branches between the branches to the ganglia, that run backward, usually one on each side of the mid-ventral line, and small branches from these sometimes enter the commissures. (Fig. 22). Lubbock, (1860) states that he found the commissures of adult Lepidoptera to be without tracheæ, but the commissures in the larvæ well supplied.

Occasionally the nerves from the ganglia have short tracheæ in them. This is more often the case at their origin, where a branch from the ganglion-supplying trachea often enters them (Fig. 23). Sometimes a small branch from the thoracic tracheæ, 3 and 5 will go to the nerve trunk (Fig. 24). In one specimen the anterior branch from the transverse trachea in the seventh abdominal segment sent a branch to a nerve originating in the seventh abdominal ganglion. (Fig. 25).

Tracheæ to the Appendages. (Fig. 26)

The tracheæ to the mandibles, maxillæ and labium have been described above. In the section describing the tracheæ from the prothoracic spiracle the courses of the tracheæ to the prothoracic leg were described. To briefly review:

The ventral trachea 2-a sends a branch to the leg; so does a branch of trachea 1-a. Both 1-a and 2-a spring from the same branch from the main trunk. The tracheal supply of the prothoracic leg, combined as it is with the supply to the nervous system, differs from that of the meso- and metathoracic legs, but resembles, somewhat the tracheal supply of the abdominal prolegs.

The mesothoracic leg receives its tracheæ from three sources. First a large branch from near the prothoracic spiracle runs backward. This sends a branch to the posterior apex of the diamond. Behind this branch, the trachea divides into a Y, the inner arm of which runs on the outer surface of the muscle layer toward the middle of the body, and forms the anterior stem of the leg tracheæ. The outer arm of the Y runs backward and joins, in the wing-bud, with a forward running branch of the next large outer branch of the main trachea. This large branch springs from the main trunk behind, and on the opposite side to, trachea 3. It runs forward and its second branch is the outer arm of a Y which joins, in the wing-bud, the outer branch of the Y in the other trachea. The inner arm of this Y runs toward the center of the body, forming the posterior stem of the leg trachea, and anastomosing with the inner arm of the Y from the trachea arising near the prothoracic spiracle and the trachea formed by this union goes to the leg. Thus the mesothoracic leg is supplied by tracheæ from origins before and behind. Also, a branch of trachea 3 ends in the leg, making the supply from behind a double one.

The tracheæ to the metathoracic leg are similar to those to the mesothoracic leg. There is an anterior stem, arising from a branch from the main trunk, and a posterior stem arising from a forward directed branch of the main trunk. The branches of the main trunk also send branches out that meet in the wing-bud. These branches joining in the wing-buds of the meso- and metathoracic segments constitute the dorsal longitudinal trunk of the thorax. Trachea 5 sends a branch to the metathoracic leg in the same manner as does trachea 3 to the mesothoracic leg.

In the pupa of *Antheraæ pernyi* Guer., according to Enderlein, (1902), the arrangement of the tracheæ to the legs is very different from that of the larva of *Pyrausta nubilalis.* The prothoracic leg is supplied by two branches from the trachea to the antenna, and by two branches from a branch to the supraœsophageal ganglion, making four tracheæ enter this appendage. The meso- and metathoracic legs are each supplied by a single trunk.

Peterson (1912) figures the tracheal system of *Protoparce carolina* without showing the distribution of the branches, except in the case of the legs, and here he shows but a single trachea to each of them.

Chapman (in Comstock 1918) figures the tracheation to the meta- and mesothoracic legs in the pupa of *Antheræa roylei,* and his figure agrees, in the main, with the distribution shown by *Pyrausta nubilalis.* He does not show the supply to the prothoracic leg.

Regarding Enderlein's figure, Chapman says: "The conditions of the tracheæ seem to be so constant in representatives of this order (Lepidoptera) which have been studied that it would seem very improbable that there should be such a great difference between two members of the same genus as Enderlein's figure would indicate."

Peterson's figure was drawn from a ventral dissection, and in the case of *Pyrausta nubilalis,* the tracheal supply to the prothoracic leg cannot be properly seen from this aspect, for the spreading of the insect breaks the transverse trachea 2-a, and the leg then appears to have either but one branch to it, or if two branches are seen to enter the leg, the transverse character of 2-a cannot be seen. With regard to the meso- and metathoracic legs, the least that can be said is that in the European corn borer their supply is very different from this supply as shown by Peterson in the tomato-worm.

The tracheal supply to the proleg of the third abdominal segment is shown in Figure 27. It is a branch running almost directly downward from, and at right angles to, the posterior branch of the trachea supplying the ganglion of the segment. The proleg trachea divides shortly after leaving the main branch, and two branches enter the leg. The anal proleg is supplied by a long branch running backward from near the eighth abdominal spiracle in a manner suggestive of the branch running forward, in the head, to the mandible. (Fig. 28).

The tracheal supply to the wing-buds has been described, and is apparent in the figure (Fig. 26).

Tracheæ to the Alimentary Tract, Fat Bodies, Silk Glands and Malpighian Tubules

The tracheæ to the alimentary tract, fat bodies, silk glands and Malpighian tubules must be treated largely under the same heading, for they are all branches from the same stems.

A large branch arises from the main tracheal trunk near its junction with the spiracular trachea. This branch runs across the body cavity and splits into branches, most of which supply the alimentary tract. These branches from the main trunk are found arising from near the first to the eighth abdominal spiracles. None rise in the thorax.

Alimentary Tract

The trachea to the alimentary tract arising from near the first abdominal spiracle is different in origin from that observed in the other tracheæ supplying the tract. It does not arise directly from the main trachea, but is the first branch from the trachea that also gives rise to the posterior stem of the metathoracic leg tracheæ. The other tracheæ to the alimentary tract arise directly from the main longitudinal trunk.

The figure illustrating the tracheæ to the alimentary tract, (Fig. 29), shows the trachea arising near the first abdominal spiracle, and supplying that part of the tract just behind the œsophagus. In the figure this portion of the alimentary tract is shown much distended. As a rule the alimentary tract behind the œsophagus, from which it is distinctly separated, is of more or less uniform diameter throughout its length. This particular specimen is chosen for illustration, however, because the enlargement spreads the tracheæ, making their distribution easier to trace.

The supplying trachea arises as a branch of a trachea arising from the longitudinal trachea near to the spiracular trachea. The supplying trachea runs forward and upward, breaking into four main branches, one running forward and one running backward on the dorsal surface of the tract, and one running forward and one running backward on the ventral surface. These, with their branches, enclose the tract in a sort of basket of tracheæ.

This same arrangement appears in the tracheæ to the alimentary tract behind the first abdominal segment.

The œsophagus is poorly supplied with tracheæ. Sometimes a very small branch will enter it, but there is no basket-work of tracheæ around it, and no main tracheal branch to it.

Fat Bodies

The fat bodies are large masses of white material distributed within the body cavity somewhat as follows: A mass on each side of the alimentary tract in the forward end of the thorax; a large mass which extends across the thorax below the alimentary tract, and which, therefore lies on both sides of the tract as well as beneath it; next come two large masses which largely fill the cavity of the abdomen; two masses, one on each side of the alimentary tract in about the seventh abdomnial segment; and a large mass in the caudal end of the body which lies on each side of the alimentary tract, and ventral to it. The large middle masses, one on each side, extend from about the first to the seventh abdominal segments; they are made up of large lobes, and each segment apparently has a lobe lying in it. No definite distribution of these bodies is made here with regard to the individual body segments, either in the thorax or abdomen, since they overlap each other. These are the large masses of fat that have been said to be storage of nutriment for metamorphosis, not the fat tissue about the body organs.

The first thoracic mass gets its air supply from the branch of the main trachea that also sends a branch to the apex of the diamond, a branch to the leg, and one to the wing-bud. Apparently the second thoracic fat body receives its trachea from the same source.

From the tracheal branches arising from the main longitudinal tracheal trunk near the spiracular tracheæ in the second to sixth abdominal segments, and which supply the alimentary tract, branches that supply the lobes of the largest fat body originate. The tracheæ from near the second and third spiracles apparently each supply a lobe of the fat body. The tracheæ arising near the fourth, fifth and sixth spiracles send branches into the lobes on each side of them, one forward, and one backward.

The supply to the fat lobe in the seventh segment is apparently a single branch from the trachea to the alimentary tract. The fat body in the eighth segment receives a branch from the tracheæ that run to the digestive system from each side of the body.

To reach the alimentary tract the tracheæ from the spiracles in the second to eighth segments cross the fat bodies dorsally.

Silk Glands

The tracheæ to the silk glands are small branches from the tracheæ supplying the fat bodies and alimentary tract. I only found them springing from the tracheæ in the second and third segments of the abdomen. (Fig. 30).

Malpighian Tubules

Two malpighian tabules on each side extend forward along each side of the alimentary tract from the caudal part of the body to opposite the fourth abdominal spiracle, where they turn and run backward. In the sixth, seventh and eighth abdominal segments, but mostly in the last two, the tubules become very convoluted and intertwine, and their individual characters are lost in the tangle.

Although carefully sought, no tracheal connections with the Malpighian tubules were found, except in the seventh abdominal segment. Here small branches arising from the trachea supplying the fat bodies and alimentary tract were traced to the walls of the Malpighian tubes. (Fig. 30). Figure 31 is a sketch of a branch broken from the supplying trachea to the alimentary tract which showed very plainly the small tracheal branches to a urinary tube.

Circulatory System

The circulatory system consists of a delicate tube in the dorsal part of the body. This is supplied by the ends of the large branches of tracheæ that also supply the dorsal muscles and the fat lying between them and the body wall. The tracheal endings in the circulatory organ are very fine, not numerous, and somewhat difficult to see.

Near the eighth abdominal spiracle several of the branches break up into a great number of very fine tracheæ (Fig. 32). These fine tracheæ lie in, or on, a membrane. They are not connected with the alimentary tract, except incidentally, for removal of the tract leaves most of them undisturbed. Such structures do not occur in the branchings from any other spiracle. That they have anything to do with the circulatory system is a question. But on the suggestion of Prof. C. T. Brues that they may aerate the blood, I tentatively place them in the group of tracheæ to the circulatory system.

Reproductive System

The gonads are two whitish kidney-shaped bodies lying on each side, adjacent to the heart, in the fifth abdominal segment. They resemble, somewhat, the adipose tissue in which they are imbedded.

In the fifth abdominal segment the tracheæ, which in the other abdominal segments supply the dorsal muscles, the heart, etc., send two branches to the reproductive organs. There is a branch to the muscles, etc., then a branch to the gonad, another branch to the muscles, etc., followed by another branch to the gonad, and another branch to the muscles, etc. It is a fan-like arrangement, with the first, third, and fifth branches to the muscles, fat tissue and circulatory organ, and the second and fourth branches to the gonads.

The tracheæ to the gonads divide into several branches, just as they reach the organs, and branches are sent to various parts of the reproductive organs. (Fig. 33).

Tracheæ of the Muscles

The muscles lying between the longitudinal tracheæ and the mid ventral line receive their air from branches from the transverse tracheæ, and also from those tracheæ of uneven number that lie adjacent to the origin and insertion of the muscles at the edges of the segments.

The muscles lying between the longitudinal tracheæ and the heart receive the principal branches of those branches that end in the heart.

Figures 14 and 15 show the distribution of tracheæ 2 and 3 with their branches to the muscles and illustrate the muscular supply.

Fat Tissue

The fat tissue surrounding the organs, not the fat bodies, receives its air supply from small branches of the tracheæ to the organs. Figure 22 shows tracheæ to fat tissue about the central nervous system.

Acknowledgement

The material used in making the above study was mature hibernating larvæ of the Massachusetts strain of *Pyrausta nubilalis*. They were given to me by Mr. D. W. Jones, Entomologist in charge of the United States Department of Agriculture Field Laboratory at Arlington, Mass. I wish to acknowledge the kindness of Mr. Jones, and of other members of the Arlington Laboratory staff, who have shown interest in the work.

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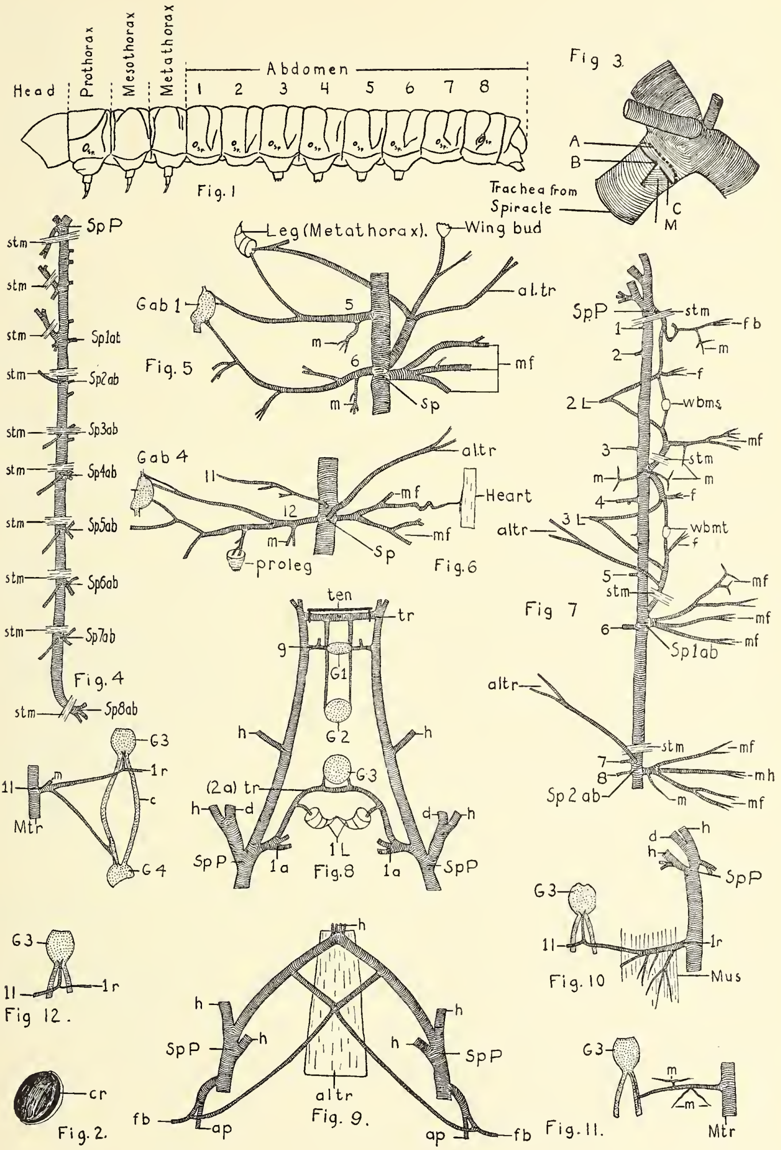

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DESCRIPTION OF PLATES

Plate I

Fig. 1. Sketch showing positions of spiracles.

Fig. 2. Prothoracic spiracles viewed so that interior can be seen.

Fig. 3. Trachea from spiracle with tracheal closing apparatus.

Fig. 4. Main longitudinal trachea showing positions of sterno-tergal muscles.

Fig. 5. Tracheæ arising from first abdominal spiracle.

Fig. 6. Tracheæ arising from fourth abdominal spiracle.

Fig. 7. Distribution of tracheæ between prothoracic and second abdominal spiracles.

Fig. 8. Transverse trachea in head, and ventral transverse trachea in prothorax.

Fig. 9. Dorsal transverse tracheæ between prothoracic spiracles: The Diamond.

Figs. 10, 11, 12, 13. Trachea 1, and some of its variations.

Plate II

Fig. 14. Transverse trachea 2.

Fig. 15. Trachea 3, showing relation to ganglion and muscles.

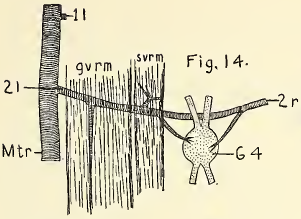


Fig. 14.

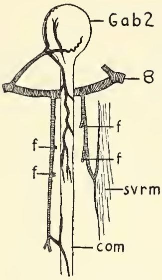


Fig. 22

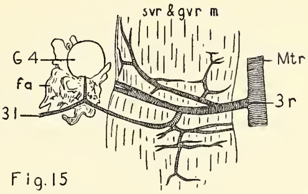


Fig. 15

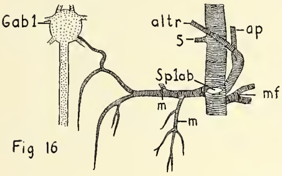


Fig 16

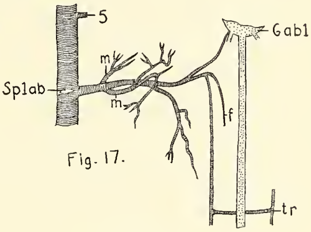
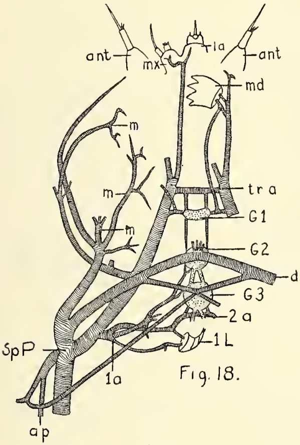


Fig. 17.



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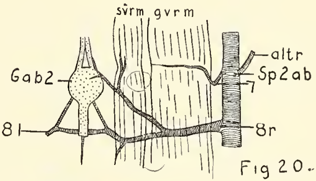
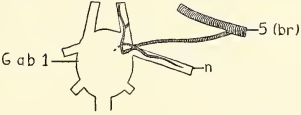


Fig 20.

Fig 23


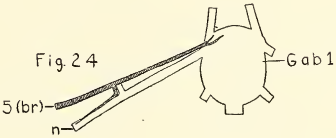


Fig. 24

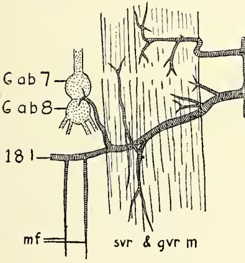


Fig 21

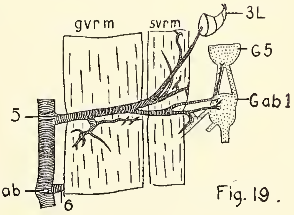


Fig. 19.

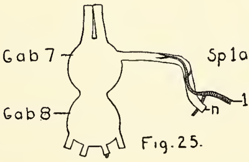


Fig. 25.

Crowell-Tracheal System of *Pyrausta nubilialis*.

Fig. 16. Trachea 6.

Fig. 17. Trachea 6, showing a transverse connection.

Fig. 18. Tracheæ arising from prothoracic spiracle.

Fig. 19. Trachea 5.

Fig. 20. Tracheal supply to second abdominal ganglion.

Fig. 21. Tracheæ to seventh and eighth abdominal ganglion.

Fig. 22. Tracheæ to neural commissures.

Figs. 23, 24, 25. Tracheal supply to nerves.

Plate III

Fig. 26. Tracheæ to thoracic appendages.

Fig. 27. Trachea to proleg of third abdominal segment.

Fig. 28. Trachea to anal proleg.

Fig. 29. Trachea to alimentary tract.

Fig. 30. Tracheæ to fat bodies, silk gland, and Malpighian tubules.

Fig. 31. Detail of tracheal supply to a Malpighian tubule.

Fig. 32. Showing fine tracheæ, arising near eighth abdominal spiracle, and placed tentatively with tracheæ to circulatory system.

Fig. 33. Tracheæ to the gonads.

Abbreviations Used on Figures

A. closing bow of tracheal closing apparatus.
a. fat body in posterior part of thorax or in first abdominal segment.
altr. alimentary tract, or tracheæ to alimentary tract.
ant. antenna.
ap. tracheæ to appendages.

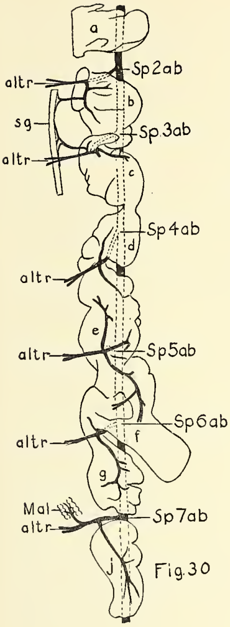


Fig.30

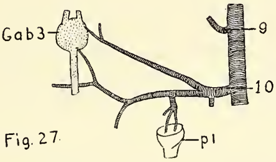


Fig. 27

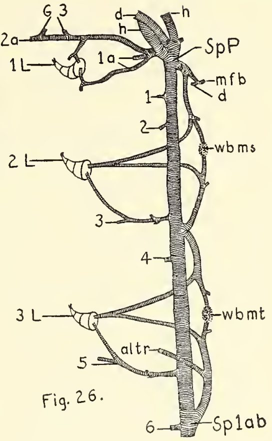


Fig. 26.

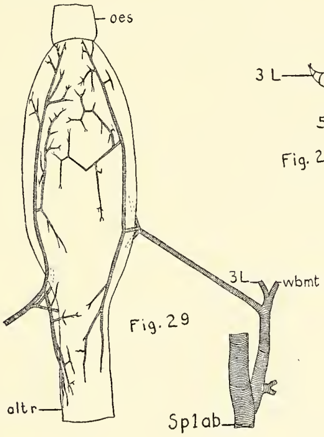


Fig. 29

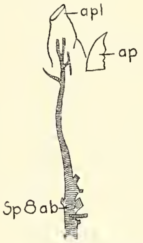


Fig. 28.

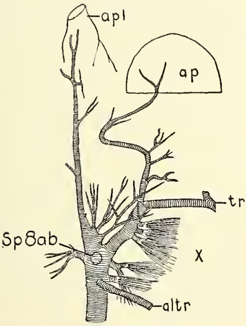


Fig. 32

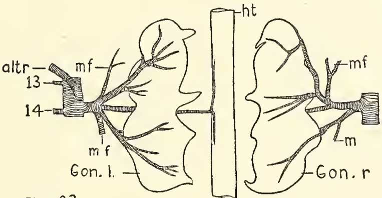


Fig. 33.

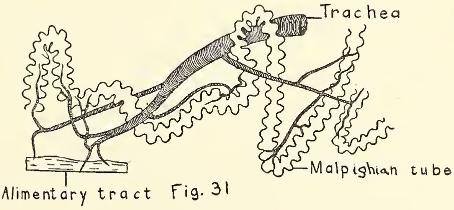


Fig. 31

Crowell-Tracheal System of *Pyrausta nubilialis.*

ap. (Figs. 28 and 32) anal plate.

apl. anal proleg.

1a, 2a. Tracheæ 1a and 2a.

B. Closing lever of tracheal closing apparatus.

(br.) Branch. (Number preceding indicates from which trachea.)

bg. (Fig. 30). Large fat body in 2nd to 7th abdominal segments.

C. Closing band of tracheal closing apparatus.

c. neural commisure.

com. commissure.

cr. chitinous ring.

d. trachea to diamond.

f. tracheæ to fat tissue.

fa. fat tissue.

fb. tracheæ to fat bodies.

g. trachea to supraœsophageal ganglion.

G1. supraœsophageal ganglion.

G2. subœsophageal ganglion.

G3. prothoracic ganglion.

G4. mesothoracic ganglion.

G5. metathoracic ganglion.

Gab. abdominal ganglion. Number attached indicates abdominal segment to which ganglion belongs.

Gon. gonad (l) left; (r) right.

gvrm. great ventro-recti muscle.

h. trachea to head.

ht. heart.

j. fat body in 7th abdominal segment.

L. leg, or trachea to leg; 1, prothoracic, 2, mesothoracic, 3, metathoracic.

la. labium.

M. muscle of tracheal closing apparatus.

m. tracheæ to muscles.

Mal. Malpighian tubule.

md. mandible.
mf. tracheæ to muscles and fat tissue.
mfb. tracheæ to muscles and fat body.
mh. tracheæ to muscles and heart.
Mtr. main longitudinal trachea.
Mus. muscle layer.
mx. maxilla.
n. nerve.
oes. œsophagus.
pl. proleg.
Sp. Position of spiracle. SpP., prothoracic, Sp. 1 ab. to Sp. 8 ab., abdominal spiracles. Numbers indicate segments.
Strm. Sterno tergal muscle.
svrm. small ventro-recti muscle.
ten. tentovium.
tr. transverse trachea.
wbms. mesothoracic wing-bud.
wbmt. metathoracic wing-bud.
1-18. Tracheæ of such numbers.

DESCRIPTIONS OF FIVE NEW SPECIES OF VESPOID WASPS (HYMENOPTERA)

By Raymond Roberts

University of Nebraska, Lincoln, Nebr.

While working on a taxonomic study of the superfamily Vespoidea, the writer has discovered a number of species that are new to science. Following are descriptions of, and comments on five new forms, the type specimens of all of which are in the collection of the University of Nebraska. Acknowledgment is made of the assistance of Professor Myron H. Swenk in the progress of this work and for criticisms in the preparation of this paper.

Paratiphia magna n. sp.

♀. Length 13 mm. Robust. Black, covered with yellowish pubescence. Face below the antennæ wide, transverse at the apex, with a distinct frontal ridge running completely across between the eyes. Clypeus and mandibles red, the mandibles black on their apices. Antennæ black. Head roughened on the vertex, but only slightly reticulated. Punctures large, dense on the lower half of the front, sparse on the upper half. Puncturation of the dorsal surfaces of the pronotum sparse, more dense on the sides, the punctures becoming quite dense on the pleural surfaces of the pronotum, which are reticulated but not striated. A broad impunctate band on the posterior border of the pronotum extending to the tegulæ at the sides. Mesonotum, scutellum and metanotum sparsely punctate on a median area. Wings hyaline, the stigma and first nervure black, the remaining nervures rufous. Tegulæ red. Legs deep reddish, the tibiæ of the mesothoracic and metathoracic legs flat on their outer surfaces and coarsely spined. Propodeum coarsely striated on the entire pleural surfaces. Dorsal surface of the propodeum with a triangular area, the entire area raised and not bearing a central keel. Abdominal segments 2 to 5 bordered with a fringe of coarse golden hairs. Pygidium finely, densely, rugose papillose on the entire apical half.

Holotype.—Pocatello, Idaho, "73", ♀.

This species agrees quite closely with the description of *P. robusta* Cameron, but differs in the puncturation, being more sparsely punctured on the pronotum and on the pleural surfaces of the entire thorax. There is a broad impunctate area in the center of the mesonotum extending back to the apex of the scutellum, as in *P. robusta*, but there is no impunctate lateral border. The pleural surfaces of the thorax are reticulated but not striated. The wing veins of *P. robusta* are described as being entirely black while those of *P. magna* are rufous. Cameron states that the pygidium of *P. robusta* is smooth, but the writer has not seen a species of *Paratiphia* in which the female has a smooth pygidium.

Sapyga interrupta n. sp.

♀. Length 13 mm. Black. A line extending from the middle of the inner orbits of the eyes upward to and practically filling the emarginations, a short line on the cheeks behind the eyes, an interrupted band on the anterior edge of the prothorax, a spot on the upper part of the mesopleura, two small dots on the metanotum, an interrupted dorsal band on abdominal segments 2, 3, 4 and 5 and a dorsal spot on abdominal segment 6, yellow. Two small ventral spots on abdominal segment 2 and a ventral band on the following segments, interrupted on 4, yellow. Mandibles black. Antennæ black above, rufous beneath, except on the first three and last five segments. Antennæ set into deep frontal grooves. Front elevated, bearing a distinct transverse ridge slightly above its junction with the clypeus, below which it is constricted to make the clypeus narrowly joined to the front. This constricted frontal area is flat and depressed on either side of a median ridge extending from the transverse frontal ridge to the clypeus, the two ridges forming a rough T. This flat, depressed, frontal area bears three transverse rows of punctures. Legs black to tips of femora, except the front legs which have a long yellow femoral stripe beneath, extending over half of the length of the femora. Middle and hind tibiæ entirely yellow, fore tibiæ marked with black. Tarsi rufous, darker toward the apices. Wings dusky violaceous, darker on the anterior edge of the front wing.

Holotype.—Pikes Peak, Colorado, July 20, 1906, 10,000 feet elevation (L. Bruner), ♀.

Sapyga interrupta most closely agrees with the characterization of *Sapyga americana* Cresson, as given by him in his key to the North American Species of *Sapyga* (Trans. Amer. Ent. Soc., viii, p. xx). It differs from that species, however, in having the clypeus immaculate. The writer has not had the opportunity of examining specimens of *Sapyga americana,* which species Cresson described from a specimen from New York State, but *Sapyga interrupta* differs from all specimens that he has identified, except the following, in having medially interrupted (not complete) yellow bands on dorsal abdominal segments 2 to 5. The first dorsal abdominal segment is unmarked, while segment 6 bears a complete, transverse, broad yellow band. The ventral surface of the abdomen also bears yellow markings on each segment except the first.

Sapyga russellensis n. sp.

♀. Length 10 mm. Black. A small spot on each side of the clypeus, a line extending from the middle of the inner orbits of the eyes upward and practically filling the emarginations, a small dorsal spot on each side of abdominal segment 2, with dorsal bands on segments 3 to 6, narrowly interrupted on 3 and 4, more widely interrupted on 5, yellow. The clypeus joined to the front a little below the frontal ridge, there being but a single transverse row of large punctures on the constricted, flat, depressed frontal area below the frontal ridge and between it and the junction of the front and clypeus. A distinct ridge extends from the frontal ridge to the attachment of the clypeus, the two ridges forming a rough T. All legs, except a short stripe on the fore femora, black to the tibiæ. Tibiæ black beneath, yellow above. Tarsi yellow at the bases, almost black at the apices. Wings hyaline, somewhat cloudy in the marginal cell. Stigma rufous, nervures black. Antennæ black on bases and apices, rufous in the center.

Holotype.—Russel, Colorado, June 25, 1907 (L. Bruner), ♀.

Sapyga russellensis is related to *Sapyga emarginata* Cresson, but lacks the emargination of the second dorsal abdominal segment. The clypeus bears a small dot on each side near the superior angles instead of a crescent-shaped spot. *Sapyga russellensis* can easily be separated from *Sapyga interrupta* by its being considerably smaller, having the bands of dorsal abdominal segment 2 reduced to mere dots, and the presence of black stripes on the tibiæ. It can also be easily indentified by the shorter, less punctured constricted area of the front.

Eusapyga intermedia n. sp.

♀. Length 10.5 mm. Black. Mandibles except apices, apical three-fourths of the clypeus, an inverted T-shaped mark on the front above the clypeus, the inner and hind orbits of the eyes to the tops of the eyes (leaving only the tops of the eyes black), a spot on each side of the head on top, a broken anterior and complete posterior collar on the pronotum, spots on the scutellum and metanotum, a large part of the mesopleura and propodeum, and wide bands on all dorsal abdominal segments near the posterior margin and on all but the first ventral abdominal segment, yellow. Antennæ red. The clypeus joined broadly to the front and with no transverse frontal ridge present, in which characters it differs from the species of *Sapyga*. Legs with coxæ and trochanters entirely black, the hind femora black except an anterior apical spot, the middle femora with the anterior side and the anterior femora with the posterior side, yellow. Middle and hind tibiæ marked on the inner side with black, the anterior ones entirely yellow. Tarsi rufous, yellow at bases. Head with the raised spots smaller and the ocelli larger than in other species of the genus which the writer has studied, the spots being slightly larger than the ocelli. Wings clouded, stigma rufous, nervures black.

Holotype.—Auburn, California, August 10, 1918 (L. Bruner), ♀.

This species may easily be distinguished from all others described up to the present time by having the raised impunctate spots on the front small, and by the larger size of the ocelli, they being, in this species, about equal in size to the raised impunctate spots.

Myrmosa bradleyi n. sp.

♂. Length 11 mm. Black, clothed with black pubescence. Palpi black, covered with short white pubescence. Mandibles black with a slight reddish tinge in the center, with three teeth, the inner one of which is very short, the second one extending two-thirds of the distance from the first to the tip of the third. Both of the first two teeth are weak, the third tooth is strong. Pubescence on the mandibles long, light colored toward the tips. Scape of antennæ pubescent, bearing a number of long black hairs, the pedicel about one-fourth as long as the first segment of the flagellum, the flagellar segments subequal in length, the apical segments becoming slightly longer. Clypeus flat. A frontal ridge extending forward between the antennæ and connecting with the clypeus. Head densely punctate with large, shallow punctures. Punctures on prothorax, scutellum and metanotum similar to those on the head. There are two subparallel lines on the mesonotum and a deep groove at the base of the scutellum. Dorsal surface of the propodeum with a longitudinal groove crossed by a transverse ridge at about two-fifths of the distance from the base, and separating the dorsal from the posterior surface of the propodeum. Punctures on the propodeum smaller but continuing in abundance. Wings clouded, stigma and nervures black. First segment of the abdomen with a recurved hook, segment 2 with a minute hook at the base. Pygidium grooved above on the apical half.

Holotype.—Sacramento, California, August 25, 1916 (L. Bruner), ♂.

Dr. J. Chester Bradley mentioned this species, of which he had a broken specimen, in a paper on the North American Myrmosidae (Trans. Amer. Ent. Soc., xliii, p. 251). He did not name and describe the species, due to the fact that the head was lacking on his specimen.

Myrmosa bradleyi may be easily separated from *Myrmosa unicolor* Say by the difference in size (*bradleyi* 11 mm., *unicolor* 8 mm.), in the much darker wing color of *bradleyi,* and in the difference in the coloration of the pubescence.

SOME ADDITIONAL REMARKS ON THE MASARID WASPS (HYMENOPTERA)

By J. Bequaert

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While my study of the Masaridinæ was going through the press for the June 1929 issue of "Psyche", two important papers have been published dealing with these insects. It seems worthwhile to consider in how far the new information they present agrees with the conclusions I had reached.

A. v. Schulthess' "Contribution to the Knowledge of African Masaridæ" (May 1929, Ann. Mag. Nat. Hist., (10) III, pp. 498-511) contains descriptions of ten new species and one new genus. While it confirms what I had to say about the possibilities of future discoveries in this group, it does not call for any change in the map I gave of the general distribution of these wasps. *Masariella* (?) *testaceopicta* v. Schulthess is, I take it, the undescribed species of *Jugurtia,* from Northern Nigeria, which I mentioned in my paper.

Three of v. Schulthess' new species are placed doubtfully in *Masariella,* one of them being from North Africa, one from Northern Nigeria, and the third from South Africa. In how far these species are strictly congeneric with the genotype, *M. alfkeni* (R. du Buysson), is impossible to decide, since the mouth-parts are not described. While v. Schulthess rightly doubts that the relative development of the scutellum and postscutellum is sufficient to distinguish between *Masaris* and *Masariella,* his statement that "the most important criterion remains the number of the joints of the maxillary palpi (two in *Masariella,* four in *Masaris*)," must be due to an oversight. Bradley, who has made the most careful study of the mouth-parts of the Masaridinæ, says that in *Masaris* the maxillary palpus is "reduced to a single segment represented by a mere tubercle". He was unable to make out that of *Masariella,* but writes merely that they are "said by Brauns to be two-segmented." It will be noted that the difference is very slight indeed, and, Bradley's opinion notwithstanding, I greatly doubt its value as a generic character. In my recent paper I provisionally placed all the South African species in *Masariella* and those from the Mediterranean Subregion in *Masaris*; but it remains to be shown whether this purely geographical segregation is supported by a consistent difference in the mouth-parts or by other valid generic characters. As for the species from Northern Nigeria doubtfully placed in *Masariella* by v. Schulthess, a careful study of the antennal characters will have to decide whether it is not rather a *Jugurtia* (of which one species is known from Gambia). The shape of the clypeus I can hardly regard as of generic value.

It may be noted that v. Schulthess now expressly synonymizes his genus *Ceramiellus* (1922) with *Masariella,* a course which I had followed in my paper.

The six new species of *Quartinia,* described by v. Schulthess, are all from South Africa and bring the total number of species of that genus up to 14 (8 of them South African).

By far the most interesting addition though is the new genus *Quartiniella,* proposed for a new species, *Q. waterstoni,* of the Cape Province, South Africa. This little wasp, 3½ mm. in total length, is unique, not only among the Masaridinæ but among the entire group Diploptera as well, in the reduction of the wing venation. The fore wing has only one closed cubital and one closed discoidal cell. That the single cubital cell corresponds to the true first cubital of the other Diploptera (and not to the combined first and second cubital cells), is reasonably certain from the course of the only recurrent vein which ends a little beyond the apex of the cubital cell (as stated in the text, while the drawing shows it interstitial). Otherwise the genus is said to be closely allied to *Quartinia,* but the mouth-parts are not described.

Celonites rugiceps Bischoff, 1928, Abhandl. Naturwiss. Ver. Bremen, XXVII, 1, p. 86, which was overlooked by me at the time, increases the number of species of *Celonites* of the Mediterranean Subregion to 10.

In discussing the wing venation, I have overlooked one peculiarity of some importance, to which my attention has been called recently in a discussion with Prof. T. D. A. Cockerell. In all the genera of Masaridinæ known to me, the marginal (or radial) cell (2d R1 + R2) of the fore wing is more or less truncate at the apex, its extremity being distinctly removed from the costal margin and generally provided with an appendicular vein. As pointed out by Bradley (1922, Univ. of California Publ. Ent., I, No. 9, p. 376), the Masaridinæ share this peculiarity with the Euparagiinæ and Gayellinæ, while a truncate or appendiculate marginal cell is rather exceptional among the remainder of the Diploptera. I have seen it in certain species of *Zethus, Labus, Ancistrocerus, Odynerus, Pterochilus, Monobia,* and *Montezumia,* where it occurs rather sporadically, but it never seems to be present in the true social wasps of the subfamilies Ropalidiinæ, Polistinæ, Polybiinæ, Vespinæ and Stenogastrinæ.

Although not of absolute value, the shape of the marginal cell may afford some help in tracing the affinities of the fossil insects that have been referred to the Diploptera. Since in fossil insects the venation of the wings is often much better preserved than the other parts, one is fully justified in using them to the utmost. The value of such work, however, depends entirely upon the reliability of venational characters among the living members of the particular group to which the fossil supposedly belongs.

Fossils referred by various authors to the Diploptera have been found in Europe in the Tertiary of Chaumerac, France, in the Prussian amber (probably Lower Oligocene), in the Lower Oligocene of Aix in Provence, in the Oligocene of the Isle of Wight, England, in the Lower Miocene of Rodoboj in Croatia, in the Miocene of Parschlug in Steiermark, and in the Upper Miocene of Oeningen in Baden. In North America all the specimens described thus far as Diploptera have been obtained in the (supposedly) Miocene shales of Florissant, Colorado. For many of these fossils the characters mentioned in the descriptions are such that their correct placing among the folded-winged wasps is extremely uncertain.

At the Museum of Comparative Zoology of Harvard University I have carefully studied types (or cotypes) of five of the ten species described by Cockerell from Florissant and placed by him in this group.

Of *Palæovespa gillettei* Cockerell (1906, Bull. Mus. Comp. Zool., L, 2, p. 55) I have seen five specimens. They are in such a condition that the true family, subfamily and generic characters used in the Vespidæ (such as the structure of the eyes, clypeus and thorax, and the number of tibial spurs) cannot be made out. In some of the specimens the fore wing appears to be plaited and, where details of the venation can be traced, they agree perhaps better with those of certain species of *Vespa* than with those of any other genus of living Hymenoptera. The marginal cell is decidedly pointed at the apex, which lies close to the costal margin; the first discoidal cell is much longer than the submedian; the basal vein joins the subcosta a fair distance from the broad stigma (about as in the living *Vespa carolina* Linnæus; but this feature of the wing varies considerably within the genus *Vespa*) ; the two recurrent veins enter the second cubital cell rather farther apart than is usual in *Vespa* (although *V. carolina* differs less in this respect from many *Polistes* than most other species of the genus). The hind wing is not visible in any of the specimens. None of the characters indicated above are, however, decisive in tracing the probable affinities of *Palæovespa.* If one examines an extensive collection of *Polistes* and *Vespa,* he soon realizes the futility of attempting to define these genera upon the venation of the fore wing. As a matter of fact, the fore wing of *Vespa carolina* can well be matched in the genus *Polistes,* while it differs in several important particulars from that of certain other species of *Vespa* (*V. crabro* Linnæus, for example). Nor can the possibility be wholly eliminated that *Palæovespa* might be rather related to the subfamily Polybiinæ, which contains in the living fauna several genera with a broad (not stalk-like) first abdominal segment and a venation very similar to that of the fossils here under discussion. To judge from the specimens I have seen, at any rate, I can only conclude that *Palæovespa gillettei* is probably a diplopterous wasp and that it most likely belongs in one of the subfamilies of social genera. I have also examined a specimen of *P. florissantia* Cockerell and of *P. scudderi* Cockerell, both very poorly preserved.

The one specimen I have seen of *Odynerus præsepultus* Cockerell (1906, Bull. Mus. Comp. Zool., L, 2, p. 57) is not sufficiently well preserved to allow of its being placed without reservations among the Diploptera. So far as I can make out, the first discoidal cell is not longer than the submedian and there is no clear evidence that the wings were plaited. This fossil might equally well be a fossorial wasp.

I feel quite positive, on the other hand, that *Odynerus palæophilus* Cockerell (1906, *loc. cit.*, p. 56) is not one of the Diploptera. The triangular shape of the high marginal cell and the short first discoidal cell would be a unique combination in that group, while it reminds one strongly of some of the parasitic Hymenoptera. Professor Brues, to whom I have shown this fossil, shares my opinion, and has suggested that it might be related to the Aulacidæ. The wing, it is true, appears to be plaited, but one cannot be sure that this is not due to one of the hazards of fossilization. Moreover, the longitudinal plaiting of the fore wing is not in itself sufficient to place a hymenopterous insect in the Diploptera, as this character occasionally occurs in other groups (Leucospinæ, Gasteruptionidæ, *Galesus*). I have recently taken in Yucatan one of the Psammocharidæ in which the fore wings are distinctly folded longitudinally when at rest.

From the evidence at hand, it is probably safe to conclude that the Diploptera as a group had become differentiated from the other Aculeates before or at the beginning of Miocene times. Cockerell's statement, however, that "the indications are that we must go to the Eocene or even to the Cretaceous, to find the beginning of most of the modern genera of wasps" (1910, Schrift. Phys.-Oekon. Ges. Königsberg, L, p. 1), seems to the writer hardly warranted by the facts.

C. H. Hicks' paper entitled "*Pseudomasaris edwardsii* Cresson, another pollen-provisioning wasp, with further notes on *P. vespoides* (Cresson)" (1929, Canad. Entom., LXI, pp. 121-125) is an extremely valuable contribution to our scant knowledge of masarid biology. The author was fortunate in discovering in California the nests of *P. edwardsii*: they are built of clay and attached to rocks, often filling depressions in them, the number of cells per nest varying from one to ten. Pollen masses were found stored in the cells of some of the nests. Hicks also bred a number of parasites from these nests: a mutillid of the genus *Photopsis*, a chrysid (*Chrysis densa* Cresson), and some chalcids which may have been hyperparasites. According to Timberlake, *P. edwardsii* is common at Riverside, California, during May when it visits the flowers of *Phacelia*.

The same paper contains an interesting observation of the mating of *P. vespoides*, made in Colorado on May 29, 1927. "A male, after sipping nectar from the flowers or going for a short flight, had a habit of returning to a rock close to the ground and resting on its surface in the sun. Before alighting he would hover above the spot, then alight and remain with wings outstretched, nearly but not quite at right angles to his body. At 11.45 A. M. this male was found copulating with a female on a flower of *Pentstemon acuminatus*. The female was in position for obtaining nectar; the male upon her with his antennæ bent forward and gently tapping her with them on the front of her thorax. Her fore legs were folded, her wings lightly to the side and her abdomen somewhat elevated. Soon there was considerable buzzing. It could be seen that the two were in copula and after 15 seconds of intense buzzing, both flew away. The female soon returned to collect while the male flew again to his rock." Females and males were sometimes found resting in the corolla of *Pentstemon*, when the weather was cloudy or rainy or in the evening. In Colorado *P. vespoides* visited almost exclusively *Pentstemon acuminatus*, while in California the same species was found on *Pentstemon heterophyllus*.

These observations on *Pseudomasaris* confirm what I have written concerning the anthophilous habits of the Masaridinæ.

NOTES ON THE SYRPHIDAE COLLECTED AT JAFFREY AND MOUNT MONADNOCK, N. H., WITH A DESCRIPTION OF A NEW SPECIES

By Charles W. Johnson
Boston Society of Natural History

My first visits to Jaffrey and Mt. Monadnock, N. H., were made in February and March, 1917. Even with the deep snow covering the beautiful woodland and mountain, one could readily see that this would be an ideal place for collecting. June, 1917, was therefore selected for another two weeks visit. Arriving on the 15th, the flowers of the choke cherry were just opening and for four days I caught hundreds of syrphids and other insects on these blossoms. Later the flowers of a Cornus followed by those of a Viburnum attracted many other species. Among the specimens obtained were about seventy species of Syrphidæ. In 1920 another visit was made, this time covering a period from June 4th to 14th. In the depression back of the old red school house some timber had recently been cut and from the stumps of sugar maple and birch sap was still flowing freely, the fermented sap containing many larvæ from which were bred *Ferdinandea dives* and *Brachyopa perplexa.* The Cornus bushes were mostly dead, probably winter killed by the severe cold of January, 1918. My next visit was in 1923, staying from June 14th to the 23rd. A few rainy days had made the cherry blossoms poor collecting ground but this loss was somewhat made up by the flowers of the raspberry which had grown up on the clearing back of the old red school house, species of Criorhina and Xylota being especially common. My next visit covering a period from May 9th to 21st, 1925, was perhaps the most interesting. To see the various spring species appear one after the other was a very enjoyable experience. An old oak log along the brook near "The Ark" was visited daily from the 14th to the 21st to secure the two species of

Chalcomyia. The last of my June trips was in 1926 from the 5th to the 18th.

It is interesting to note how seasons and conditions change in different years in this fascinating place. I was not able to duplicate the great catch I made in June, 1917, on the flowers of the choke cherry, neither have I been able to find so much sap flowing from stumps as in 1920, nor another oak log frequented by the two species of Chalcomyia. The area covered in collecting extends from the Shattuck Inn to about 1700 feet on Mt. Monadnock and from Mead's Brook to Hadley Brook, an area of about two square miles. A few trips were made to the top of the mountain (3166 ft.) but no additional species were taken, all those on the bare rocks of the summit being probably derived from lower levels. With "The Ark", where I stayed, as a center, I doubt if there is a corresponding area that would produce as many Syrphidæ in the time mentioned. Of the 113 species recorded below, six were new to science. In addition to these a great many other insects were also collected.

LIST OF SPECIES

Microdon ocellaris Curr. June 20, 1923.
M. tristis Loew. June 14-21, 1923.
M. ruficrus Will. June 21, 1923.
Chrysotoxum fasciolatum DeGeer. June 18, 1917.
Chrysogaster nigripes Loew. June 15-25, 1917.
C. pulchella Will. June 18, 1917.
C. pictipennis Loew. June 18, 1917.
Pipiza femoralis Loew. June 18, 1917.
P. nigropilosa Will. May 14, '25, Junt 14, '23.
P. nigrotibiata Curr. *Allotype* June 17, 1917.
P. quadrimaculata Panz. May 12, '25, June 19, '17.
Heringia salax Loew. June 9, 1920.
Cnemodon pisticoides Will. May 16, '25, June 12, '26.
Paragus bicolor Fab. May 16, '25, June 15, '17.
Chilosia (*Chilosia*) *orillænsis* Curr. June 16-18, 1923.
C. (*Cartosyrphus*) *pallipes* Loew. June 8, 1920.
C. (*Cartosyrphus*) *sialia* Shan. May 18, '25, June 10, '26.
C. (*Cartosyrphus*) *slossonæ* Shan. May 16-18, 1925.
C. (*Cartosyrphus*) *tristis* Loew. June 14, 1920.

Chalcomyia ærea Loew. May 14-21, 1925.
C. cyanea Smith. May 16-19, 1925.
Cynorhinella longinasus Shan. Holotype June 4, 1920.
Myiolepta nigra Loew. June 11-18, 1917, 1926.
M. varipes Loew. June 18, 1917.
Ferdinandea dives O. S. Bred from larvae in sap oozing from the stumps of maple and birch. Adults emerged June 25 to July 6, 1920.
Baccha cognata Loew. June 19, 1917.
B. fascipennis Wied. June 28, 1917.
Pyrophaena rosarum Fab. June 16, 1923.
Platychirus chætopodus Will. June 7-10, 1920.
P. hyperboreus Stæg. June 15, 1917.
P. peltatus Meig. June 15, 1917.
Melanostoma confusum Curr. May 14, '25, June 11, '20.
M. mellinum Linn. May 18, '25, June 19, '17.
M. obscurum Say. May 9, '25, June 18, '17.
Didea fasciata var. *fuscipes* Loew. June 19, 1917.
Syrphus lapponicus Zett. (*arcuatus* auct.) June 12, 1926.
S. amalopis O. S. June 15-19, 1917.
S. johnsoni Curr. *Type* June 15, another June 18, 1917.
S. latifasciatus Macq. June 27, 1917.
S. laticaudus Curr. May 9-18, '25, June 4-10, '26.
S. nitens Zett. May 17, 1925.
S. perplexus Osburn. June 28, 1917.
S. rectus O. S. June 14-18, 1917-'20.
S. ribesii Linn. May 19- June 21, 1917.
S. ribesii var. *vitifrons* Shan. June 15-19, 1917.
S. torvus O. S. May 19, 1925.
S. venustus Meig. June 4-15, 1917-'20.
Epistrophe arcticus Zett. May 9, 1920.
E. diversipes Macq. June 9-21, 1917-'23.
E. fisheri Walt. June 18-27, 1917.
E. genualis Will. May 9, '20, '25, June 15, '17.
E. mentalis Will. May 12, 1925.
E. oronoensis Metc. May 17, 1925.
E. umbellatorum Fab. June 4, 1920.
E. xanthostomus Will. May 18 '25, June 18, '17.
E. xylotoides John. One male, June 18, 1917.
Doros æqualis Loew. June 14, 1920.

Toxomerus geminatus Say. June 21, 1923.
Sphærophoria menthastri Linn. May 16, '23, June 15, '17.
Spheina campanulata Robt. June 20, '23.
S. flavimana Mall. June 21, 1923.
S. infuscata Loew. June 17 and 18, 1917- '26.
S. keeniana Will. May 19, '25, June 10-18, '17-'26.
S. lobata Loew. June 14-19, 1923.
S. monticola Mall. June 11, 1926.
S. petiolata Coq. June 28, 1917.
S. rufiventris Loew. June 18-25, 1917.
Neoascia distincta Will. May 13-20, 1925.
N. globosa Walk. May 20, 1925.
Rhingia nasica Say. May 17, '23, June 15, '17.
Hammerschmidtia ferruginea Fall. June 25, 1917.
Brachyopa diversa John. *Holotype.* June 18, 1917.
B. flavescens Shan. June 23, 1917.
B. notata O. S. June 9-25, 1917-'25.
B. perplexa Curr. June 9-25, 1920-'23.
Condidea lata Coq. One, June 16, 1926.
Sericomyia chrysotoxoides Macq. June 15-21, 1917.
S. militaris Walk. June 18, 1917.
Eristalis compactus Walk. May 13, '25, June 15, '26.
E. bastardi Macq. May 12, '25, June 4-18, 1917-'26 .
E. dimidiatus Wied. May 20 '25, June 16, '23.
E. arbustorum Linn. May 14, '25, June 19, '17.
E. flavipes Walk. May 19, '25, June 18, '17.
E. saxorum Wied. June 16-21, 1917.
E. transversus Wied. June 8-18, 1917-'26.
E. tenax Linn. June 22-28, 1917.
Tropidia quadrata Say. June 28, 1917.
Helophilus fasciatus Walk. (*similis* auct.) June 15, 1917.
Parhelophilus lætus Loew. June 17, 1917.
P. obsoletus Loew. June 16, 1923.
Lejops lunulatus Meig. May 21, '25, June 18, '23.
L. stipatus Walk. (*conostomus* Will.) June 17, '26.
Mallota cimbiciformis Fall. June 15-25, 1917.
M. cimbiciformis var. *bautias* Walk. June 16-18, '17.
M. posticatus Fab. June 16-22, 1917.
Syritta pipiens Linn. May 19, '25, June 18, '17.
Xylota ejuncida Say. June 13-18, 1917-'26.

Xylota aristata n. sp.

Head bluish black, face shining, with a pollinose spot on each side and white hairs on the cheeks, front slightly roughened and pollinose, narrowly margined with brown above the antennæ, first and second joints of the antennæ dark brown, the third joint light brown, arista white, the base with a slight yellow tinge. Thorax black, slightly roughened and with short blackish pubescence, pleura shining, scutellum black, slightly rugose. Abdomen dark blue, shining, second and third segments margined posteriorly with an opaque black band that extends forward in the middle forming a broad triangle. Legs black with white hairs, posterior femora irregularly thickened with a cluster of spine-like bristles on the underside near the apex, posterior tibia strongly curved, with a prominent apical spur, under side of the tarsal joints with yellowish pubescence. Wings hyaline, base, stigma and veins dark brown, the cross-veins slightly clouded. Halteres light yellow. Length, 7 mm.

One male, Jaffrey, May 18, 1925. Type in the collection of the Boston Society of Natural History. The species is readily recognized by its white aristae.

Xylotomina chalybea Wied. June 16-28, 1917-‘23.
X. curvipes var. *satanica* Bigot. June 15, ’23.
X. pigra Fab. June 9, 1926.
X. plesia Curr. June 12-22, 1923.
X. vecors O. S. June 15-19, 1917.
Brachypalpus oarus Walk. (*frontosus* Loew). May 16 and 21, ’25, June 22, ’17.
Criorhina intermedia John. *Holotype.* June 15-18, 1917.
Cynorhina analis Macq. June 8-22, 1917-’23.
C. badia Walk. June 16, 1923.
C. confusa John. June 6-18, 1917-’20.
C. nigra Will. May 16, ’25, June 18, 1917.
Somula decora Macq. June 17-28, 1917.
Sphecomyia vittata Wied. June 8-21, 1917’26.
Temnostoma alternans Loew. June 15-21, 1917.
T. balyras Walk. June 16-23, 1917-’23.
T. bombylans Fab. June 21, 1917.

An autumn trip to Jaffrey (Oct. 2nd to 16th, 1929) yielded comparatively few insects. Among these, however, were twenty species of Syrphidæ of which the following are not in the above list: *Syrphus wiedemanni* John. *Epistrophe grossulariæ* Meig. and *Toxomerus marginatus* Say.

This region has entomologically speaking, an interesting history from the fact that the earliest collection of insects made in the state were found here. These were collected by the Rev. L. W. Leonard of Dublin, N. H., between 1828 and 1835. The specimens are now in the Harris collection, in the Boston Society of Natural History. In referring to Mr. Leonard's work Dr. T. W. Harris, in a letter to Hentz dated Milton, [Mass.] June 17, 1828, says: "My friend, Mr. Leonard has promised to send me a quantity of duplicates from his parish in Dublin, N. H. near the Grand Monodnoc Mountain. Many among those which I have already received from him are entirely new to me. Mr. Leonard is indefatigable in studying the habits of insects and very successful in raising them from the larvæ. Through him I have ascertained the larvæ of many species in my collection and particularly of the Lepidoptera."

In Hitchcock's Report on the Geology, Botany and Zölogy of Massachusetts, 1835, in the notes, page 601, Dr. Harris says: "I have included in the catalogue some insects which, though found beyond the boundaries of the State, may eventually be detected in Massachusetts. For these, and an immense number of duplicates, I am indebted to my friend the Rev. L. W. Leonard of Dublin, N. H., who has still more increased my obligations to him by his disinterested liberality in sending me even the rare and undescribed insects of which he possessed no duplicates."

In the material collected by Rev. L. W. Leonard are a number of interesting Syrphidæ including the type of *Temmostoma excentricum* Harr., and a specimen of *Criorhina intermedia* John., collected May 1832, which had been sent to Say by Harris in 1833 and given the manuscript name "*Milesia gnava.*" There are also specimens of *Chrysotoxum perplexum* John., *Sphærophoria cylindrica* Say., *Helophilu latifrons* Loew, *Criorhina verbosa* Walk., and *Spilomyia fusca* Loew.

THE PROPER USE OF THE TERMS PARAPSIDES AND PARAPSIDAL FURROWS.[1]

BY GEORGE S. TULLOCH

The terms parapsides and parapsidal furrows are very frequently misapplied by morphologists and systematists working with Hymenoptera. An examination of the literature reveals the fact that the term parapsidal furrows has been used to designate either of two pairs of longitudinal furrows that may be present on the mesonotum of certain Hymenoptera, viz., certain Xiphydriids, Ampulicids, Formicids (*pf* and *no* of Figs. 1, 2, 4, and 5). Likewise, the term parapsides has been used to designate the lateral regions delimited by either pair of the so-called parapsidal furrows (*pa* and *sc* of Figs. 1, 2, 4, and 5, II of Fig. 3). Since it is quite obvious that two distinct pairs of furrows or two distinct sets of regions cannot have the same terms applied to them, it may be of interest to persons working with Hymenoptera to have the correct application of the terms re-established as intended by their author. Moreover, as these characters are diagnostic and widely used in the classification of Hymenoptera, it is quite essential that the correct terms should be brought to the attention of present workers so that their usage may be stabilized and unnecessary confusion eliminated in future literature.

The term parapsides was first used by Macleay, 1830, (page 148, footnote 1) to designate certain lateral regions occurring on the mesonotum of *Polistes billardieri* Fabr.[2] Naturally the furrows delimiting these regions are the parapsidal furrows although Macleay does not specifically designate these furrows as such. Figure 3 of this paper is

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 323.

[2] Dalla Torre, 1904, considers *P. billardieri* Fabr. a variety of *P. crinitus* Felton.

a portion of the mesonotum of *P. billardieri* Fabr. bearing the parapsides and parapsidal furrows taken from Macleay's original figure and is enlarged to twice the size of his figure. In his explanation of the plate he designated the parapsides of the mesonotum with the Roman numeral II. Since it is perfectly clear from his figure as well as from his description (page 148, footnote 1) that he intended the term parapsides to be applied to the lateral regions of the mesonotum delimited by the longitudinal (parapsidal) furrows, it is logical that all homologous regions and furrows in other Hymenoptera should be similarly designated as it is one of the important principles of comparative morphology to apply the same term to the homologous anatomical parts in different groups.

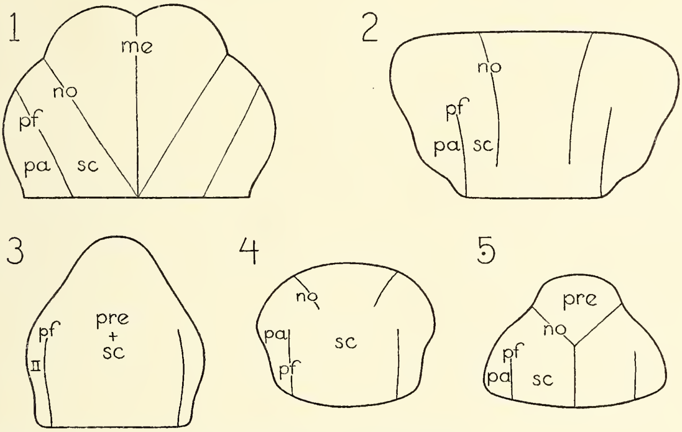

Fig. 1. Portion of the mesonotum of *Xiphydria.*
Fig. 2. Portion of the mesonotum of *Ampulex.*
Fig. 3. Portion of the mesonotum of *Polistes billardieri* Fabr.
Fig. 4. Portion of the mesonotum of *Myopopone castanea maculata* Roger.
Fig. 5. Portion of the mesonotum of *Paraponera clavata* F. Sm.

If all Hymenoptera had a mesonotal structure similar to that of *P. billardieri* Fabr. the matter would have been much simplified and no confusion would have resulted in the literature. However, in certain Hymenoptera (*Xiphydria, Ampulex, Paraponera,* Figs. 1, 2, and 5) another pair of longitudinal furrows appears extending backward from the anterior margin of the mesonotum and converging more or less in their course. It is these furrows that have been erroneously identified by some workers as parapsidal furrows for years; likewise, the lateral regions delimited by them and the true parapsidal furrows have been erroneously identified as parapsides. Since the correct term which should be applied to these furrows is little known, it may be of interest to review briefly the terms that have been applied to them, and, also to indicate the term which should have priority over the others as determined by its commonly accepted and correct usage in the literature.

Morphologically these furrows which extend backward from the anterior margin of the mesonotum a varying distance and at a varying angle of convergence have been considered to form the lateral limits of the prescutum when they converged sufficiently to fuse into a single median line. They have been correctly referred to as "prescutal sutures" by Crampton, 1926. In such cases as *Paraponera* (Fig. 5) they clearly limit the prescutum, but in many forms like *Ampulex* (Fig. 2) they open out and approximate parallel lines. It is obvious in such cases that the prescutum is not clearly delimited and that it fuses with the scutum to form the general region prescutum plus scutum.[1] Although, as just stated, the failure of these furrows to converge and fuse makes it impossible to determine the posterior lateral limits of the prescutum; their presence, if even of short length extending backward from the anterior margin of the mesonotum, indicates at once the lateral limits of the prescutum in the anterior region. In some forms such as *Polistes* these furrows are absent (Fig. 5) and in a similar case it has been assumed by a recent worker that the prescutum extends laterally to the parapsidal furrows. An examination of the immature pupal stages of *Polistes* reveals the presence of these prescutal sutures which gradually disappear as the chitin hardens before attaining the adult condition. In at least one species of *Polistes*

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[1] The writer is cognizant of the fact that when the furrows converge and fuse, Snodgrass, 1926, does not consider the region delimited by them as the prescutum but as a part of the scutum. The writer does not on the basis of the evidence presented accept this view.

the prescutal furrows are present in the adult. In *Pepsis,* a somewhat similar form, the mesonotum is, at first glance, composed of a large central area bounded laterally by the parapsidal furrows. A closer examination of the mesonotal surface reveals the presence of a pair of short indistinct furrows extending backward from the anterior margin. These are the remains of the prescutal furrows and delimit the anterior lateral borders of the prescutum. From the foregoing it is quite evident that the huge, apparently undifferentiated area present in *Polistes* and *Pepsis* is a combination of prescutum plus scutum and in no case does the prescutum extend laterally to the parapsidal furrows.

Mayr, 1861, was the first to mention these furrows which morphologically limit the prescutum in some forms and in his early writings applied to them the indifferent term "*convergirende Furchen.*" Later, 1878, he identified them erroneously with the furrows of Macleay calling them *Parapsidenfurchen.* Kokouyew, 1898, designated these furrows as *notauli.* Emery, 1900, noted the misinterpretation of Mayr and designated the central furrows as *Mayrian furrows.* Morley, 1903, used the term *notauli* in the same sense as Kokouyew. Schmeideknecht, 1907, uses the term *notauli* for the central furrows but gives it as a synonym of *Parapsidenfurchen* which is obviously incorrect. It may be seen from this brief sketch of the terms applied to these furrows that *convergirende Furchen, notauli,* and *Mayrian furrows* are synonymous. Since the term *notauli* has been used more widely than the other two terms and is perhaps the most appropriate of the three because, by derivation, it means "hollows on the back," present workers who have not already adopted this term to indicate the central furrows should do so and thus aid in avoiding any further confusion in the literature.

Some very clear distinctions between parapsidal furrows and notauli are evident upon an examination of different Hymenoptera. Both pairs of furrows are extremely variable in character, yet the following generalizations may be made. The parapsidal furrows may be present and the notauli absent, or vice versa, and occasionally in some forms both parapsidal furrows and notauli may be absent. In forms such as *Xiphydria* (Fig. 1) the parapsidal furrows extend from the transcutal suture of the mesoscutum to the anterior margin of the mesonotum. In forms like Paraponera (Fig. 5) they extend only halfway to the anterior margin of the mesonotum. Other gradations may be noted by simply examining other forms which always exhibit the tendency of the furrows to be lost in the anterior region and to be retained in the posterior region of the mesonotum. This would seem to indicate that the parapsidal furrows extend forward from the posterior region of the mesonotum or from the transcutal suture of the mesoscutum a varying distance in different forms. Another feature of the parapsidal furrows is that they usually extend forward parallel to each other (Figs. 4 and 5) or they diverge (Figs. 1 and 2) and rarely, if ever, have their terminal points at a position which is convergent from the assumed starting point at the transcutal suture. In the form of Polistes (Fig. 3) figured in this paper the parapsidal furrows appear to converge though their terminal points are at a position which is divergent from the points of intersection of the parapsidal furrows and the transcutal suture. The distinctive characteristics of notauli are to some degree the converse of the characteristics of parapsidal furrows. In forms like *Paraponera* (Fig. 5) and *Xiphydria* (Fig. 1) they converge backward from the anterior margin of the mesonotum, and fuse to form a median line. In forms like *Ampulex* they extend backward in a course closely approximating parallel lines but do not reach to the transcutal suture of the mesoscutum. In forms such as *Myopopone* (Fig. 4) they extend but a short distance backward and in *Polistes* (Fig. 3) they are absent. From the above facts the following generalizations may be made: notauli apparently extend backward from the anterior margin of the mesonotum a varying distance and at a varying angle of convergence, occasionally approximating parallel lines in their course but rarely, if ever, diverging from their assumed starting points at the anterior margin of the mesonotum.

Occasionally in some forms such as *Xiphydria* (Fig. 1) a median line (*me* of Fig. 1) is present extending longitudinally along the central region of the mesoscutum. The presence of this median line is of minor significance since it is used in the classification of only one group of Hymenoptera. However, its presence along with the notauli and parapsidal furrows illustrates the complete number of longitudinal lines of furrows that have been observed on the mesonotum of Hymenoptera.

Much of the confusion existing in the literature has resulted from the mistaken impression that the terms parapsidal furrows and notauli are synonymous. From the foregoing discussion it should be clear that this is not the case, since they are two distinct pairs of furrows, each pair so completely localized in position and possessing such distinct characteristics that misidentification should be impossible.

The terms discussed may be defined as follows:

1. Parapsidal furrows—longitudinal furrows extending anteriorly from the posterior region of the mesonotum or from the transcutal suture of the mesoscutum and varying in length and in their course from one approximating parallel lines to one which is strongly divergent but very rarely, if ever, converging from the original point in the posterior region of the mesonotum.

2. Parapsides—(sing. parapsis) lateral regions delimited by the parapsidal furrows and the tegulae.

3. Notauli—(sing. notaulus) longitudinal furrows extending posteriorly from the anterior margin of the mesonotum, varying in length and in angle of convergence, and occasionally approximating parallel lines but rarely, if ever, diverging in their course from the anterior margin of the mesonotum.

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ABBREVIATIONS

me.	median line.	pf.	parapsidal furrows.
no.	notauli.	pre.	prescutum.
pa.	parapsides.	sc.	scutum.
		ll.	parapsides (Macleay's original designation)

EXPLANATION OF TEXT FIGURE

Figure 1.	Portion of the mesonotum of *Xiphydria.*
Figure 2.	Portion of the mesonotum of *Ampulex.*
Figure 3.	Portion of the mesonotum of *Polistes billardieri* Fabr.
Figure 4.	Portion of the mesonotum of *Myopopone castanea maculata* Roger.
Figure 5.	Portion of the mesonotum of *Paraponera clavata* F. Sm.

NOTES ON THE HABITS OF AMPHIZOA

BY P. J. DARLINGTON, JR.

Amphizoa is such a curious beetle and is still so rare in collections that it was among my chief *desiderata* on a trip to the Northwest during the summer of 1927, when I was collecting "on shares" for Dr. J. G. Gehring. My introduction to the insect was performed by Dr. E. C. Van Dyke, whom I chanced to meet on Mount Hood, and with this auspicious start a total of about 350 specimens, including all the American species of the genus, was secured in the various localities visited. Horn (Proc. Ent. Soc. Philadelphia 6, 1867, p. 289) has compared the habits of these beetles to those of the Parnidæ, but this proved so misleading in my case that I think some further notes on their collecting are justified.

The three species have mutually similar habits. They occur chiefly in two sorts of places, either in gravel at water level along the banks of streams, or in masses of floating trash which have gathered against obstructions. In the first case they are nearly always at the side of an eddy or at a curve in the stream, or where for some reason the current is throwing up detritus. The collector soon learns to recognize likely spots by the presence of deposits of spruce needles or masses of foam. In favorable places the shores are often so undercut that the beetles must be sought in shallow caves or under overhanging rocks. Good collecting may be found in both swift and comparatively slow brooks, but in the latter the Amphizoa are usually in the rapid stretches.

A few examples of the right sort of place are, perhaps, worth giving. On Mount Hood Dr. Van Dyke and I found *Amphizoa insolens* in trash which had been caught against bushes in a small brook, just where the latter crossed a sand-filled beaver dam. Numerous *A. striata* Van Dyke were collected in similar rafts of trash which had gathered in a fallen sapling, partly damming a large brook near Duncan, Vicoria Island. In the Olympic Mountains *A. insolens* was common wherever a stream had deposited drift material. The species ranged from just below tree line on the north side of Mount Olympus to near Sol Duc Hot Springs. *A. insolens* and *A. striata* were taken beside eddying pools in a rapid stretch of Tokul Creek, near North Bend Washington, but were absent in the more gently flowing upper part of the same stream. A mass of floating logs and trash driven by the wind into the outlet of Lake Minnewanka, near Banff, Alberta, yielded a good series of *A. lecontei* and a few *A. insolens.*

From all this it will be seen that the species of Amphizoa live in cover where a brook or the current set up by a wind will bring them food, and it is a fair deduction that the insects are in some part scavengers, although I have never seem them feeding. I do not know whether they travel much, but I knocked down a single *lecontei* as it flew over the lake at Banff.

My specimens were all taken between July 4 and August 19, but adults undoubtedly occur through a much longer season. Freshly emerged *A. insolens* were secured near North Bend, Washington, July 30.

By day Amphizoa keeps out of sight, usually buried in gravel or clinging to a stick in a raft of floating trash. It is possible, however, that they are more active at night.

The beetles may be taken easily once their haunts have been discovered. Where they are among rocks or in gravel, the bank is dug out at water level, and raked a little at a time into the brook; where they are in floating material, the later is spread out on the water and beaten with a stick or the flat of the hand. The treatment in either case is to dislodge the beetles and separate them from the cover. When this is done, they swim slowly with their backs breaking the surface, for they cannot dive.

Specimens are frequently found in crevices in floating logs, especially when the latter are surrounded by masses of drift. A few individuals escape by crawling down rocks or log jams into deep water, and these do act like Parnidæ, but the behavior is for the most part much more like that of certain Hydrophilidæ. Indeed one hydrophilid, *Hydrobius scabrosus Horn,* is often found with Amphizoa, which it evidently imitates in its method of life. The Hydrobius is sometimes found along lake shores, however.

Amphizoa emits an odor which is rather pleasant, at least to the collector, and which Horn compares to that of decaying wood. The beetles also exude a thickish, yellow fluid from the joints, so that they leave a cigarette-like stain on the fingers.

Dr. Van Dyke's classification of our three American species (Pan-Pacific Entomologist 3, 1927, p. 197) is perfectly satisfactory. *D. striata* and *D. lecontei* hardly differ in color, however, as my large and variable series show, and the size difference is slight. The important difference is, of course, in the form of the elytra. It will be interesting to see whether the two species occur together, or whether intermediate forms occupy intermediate regions.

HABITS OF THE STAPHYLINID BEETLE *DIANOUS NITIDULUS*

By P. J. Darlington, Jr.

Dianous nitidulus Lec. is to be found in moss and similar cover along the swift, shady mountain brooks which drain the west side of Mount Moosilauke, near Warren, New Hampshire. All my specimens have been taken early in July. The species may be washed out like its relatives, but possesses a remarkable habit which is likely to take the collector by surprise.

On land the beetles are not particularly active, but they can skim so swiftly over running water that they disappear as if by magic in the changing shadows of the brook surface. I have had great difficulty in observing the "skimming," for I have never succeeded in getting a healthy Dianous into the laboratory, but the only possible explanation of the phenomenon is that the insects fly on the water partly supported by surface tension, as Donacia often does. This explains the fact that they bog down easily and cannot skim when bedraggled. They follow a straight or curving course, never zigzaging, and go several times faster than they can on land, so that their passage sets up a miniature, V-shaped swell. I have never seen a Dianous rise clear of the water as Donacia does, however.

The skimming habit is, of course, an admirable adaptation for a riparian beetle which lives along swift, fluctuating streams. It is shared by certain species of the related genus Stenus, particularly by some of the red-spotted forms which approximate Dianous in choice of habitat, but many Stenus are nearly helpless on a water film. The retiring habits and quick escape of *D. nitidulus* doubtless explain Major Casey's remark (Revision Stenini, page 9) that "When its localities are found, it seems to be numerous, but these are very seldom discovered."

It is barely possible that some habit of this sort, acquired by an adephagous beetle, may have started the evolution of the Gyrinidæ, which are almost certainly not derived from dytiscid stock and whose ancestors very likely never possessed true diving habits.

NEW BOOKS.

Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance, Part I, Medical. By W. S. Patton and A. M. Evans. X+786 pp., 40 pls., 373 figs., 8vo. Croydon, H. R. Grubb.

This large, well illustrated and finely printed volume includes a discussion of insects and other Arthropods in their relations to disease in man. The text is arranged in the form of lectures and laboratory exercises as presented to students in the Liverpool School of Tropical Medicine. The general arrangement of material is strictly adapted to this especial teaching purpose and a considerable amount of space is given up to laboratory directions and the descriptions of demonstration material. Nevertheless, there is a large amount of information which will be of great value to entomologists as well as to medical men, since as a whole the book forms a balanced compendium of medical entomology. The authors state that it is intended to supplant Patton and Cragg's Medical Entomology, published in 1904. C. T. B.

Ants, Bees and Wasps. Sir John Lubbock. Edited and Annotated by J. G. Myers, XIX+377 pp., Kegan Paul, Trench, Trubner & Co., London. E. P. Dutton & Co., New York, 10/6.

This latest edition of Sir John Lubbock's widely known classic is enlarged by a long series of annotations by Dr. Myers. These extend over more than 100 pages and serve to augment, qualify or refute, in the light of more recent knowledge, parts of the original presentation which appeared nearly fifty years ago. C. T. B.

Insect Singers, A Natural History of the Cicadas. By J. G. Myers. XIX+304 pp., 8 pls., and 116 figs. Geo. Routledge & Sons, London. 21/.

The external and internal structure, classification and life history, of the cicadas and their relation to other animals and plants from the major part of Dr. Myer's treatise, but there are also interesting chapters on cicadas in mythology, art and literature, on their psychology and behavior, and an account, with musical transcriptions, of the songs of a number of species. An extensive bibliography and index complete a most interestingly written and valuable account of these remarkable insects. C. T. B.

Insects, Their Structure and Life: A Primer of Entomology. By G. H. Carpenter. X+335 pp., 4 pls., 183 figs. E. P. Dutton & Co., New York, $3.75.

This is a short general account of insects intended as an introduction to entomology. In small compass it gives a very clear account of the anatomy, development, classification and varied habits of insects, viewed with such insight into biological principles that one may recommend it heartily to the amateur, beginning student of entomology or even to the layman who wishes to become familiar with this group of animals. A short, but well chosen list of references will serve to introduce the reader to entomological literature.

C. T. B.

ERRATA FOR VOL. 36.

p. 125, line 15, read *"Oribates castanea"*
p. 127, line 17, for form read "formed"
p. 128, line 14, read "it is not"
p. 125-126, for Michæl read "Michael"
p. 168, line 7, for *pallipes* read *"pilipes"*
p. 170, figure 8 is printed with the bottom at the left side of the page.
p. 172, line 35, read "in the insect world"

PSYCHE

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All new genera, new species and new names are printed in Small Capital Letters.

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THE FOOD OF INSECTS VIEWED FROM THE BIOLOGICAL AND HUMAN STANDPOINT[1]

BY CHARLES T. BRUES

Our present-day views concerning human food and nutrition are in such a state of active revolution, that it may seem futile to discuss the food of insects on the basis of the fragmentary knowledge we possess concerning these small animals. I have avoided the term nutrition, however, since food relates to actual materials and does not necessarily introduce chemical and physiological connotations. It is, therefore, clear that "entomological chop suey" might more adequately, if less elegantly, express the content of my subject matter, provided, of course, that we first separate and accurately identify all the disguised components of this delicacy. This separation, and identification of insect foodstuffs has, as a matter of fact, been rather thoroughly done by entomologists and affords the basis for an understanding of at least some of the principles that underlie the trophic behavior of insects.

That these peculiarities have determined to a great extent the evolution and differentiation of insects is very clear, and as I hope to indicate later we must also attribute to them a very important role among the many factors that have directed the course of organic evolution since the time when insects became a dominant figure in the living world.

The most striking feature of the diet of insects is the high degree of specificity which exists in the selection of

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[1] Presented by the retiring president at the annual meeting of the Entomological Society of America at Des Moines, Iowa, Dec. 28, 1929. Contribution from the Entomological Laboratory of the Bussey Institution, Harvard Uuiversity, No. 331.

food by a very large percentage of the species. This is paralleled almost nowhere else in the animal or plant kingdoms, with the notable exception of certain parasitic organisms. In the case of these parasitic types, such as pathogenic bacteria, fungi and worms, it has of course never been questioned that they are important factors in influencing the abundance, distribution and, finally, the evolution of their hosts and of competing organisms. The same is self-evident with respect to parasitic insects, including those that carry diseases, and the recognition of the role played by entomophagous parasites has led to the development of the method of biological control that we have applied with success to the reduction of noxious insects. Such facts are so generally appreciated that we must not allow them to draw our attention at the present time from the less patent relationships that I wish to discuss.

The conventional classification of food habits as first applied to vertebrate animals, and later extended to other less familiar groups may be readily applied to insects and we may thus more or less accurately group them in the following categories which are by no means either clearcut or mutually exclusive, since they may grade into one another or appear in combination in the diet of a single species of insect.

OMNIVOROUS = PANTOPHAGOUS
HERBIVOROUS = PHYTOPHAGOUS
PUTRIVOROUS = SAPROPHAGOUS
    minimivorous = microphagous
    fungivorous = mycetophagous
CARNIVOROUS = ZOOPHAGOUS
    predatory = harpactophagous
    parasitic = biophagous

So far as insects are concerned it is difficult to arrange these in any linear order and certainly no single arrangement could be made which would indicate the phylogenetic sequence of the different types in the several major groups where they occur. Every type except the parasitic one is to be found among the most generalized groups of insects. Thus, the omnivorous cockroach, the vegetarian walking stick, or the predatory dragonfly are to-day emulating their forebears who feasted likewise in the forests of carboniferous times.

It may seem idle to speculate concerning the most primitive type of food habits among the insects, although there seems good reason to believe that the earliest insects, like their somewhat problematical ancestors, may have subsisted upon dead or moribund animals in combination with miscellaneous plant material, or to speak more concisely, in terms of human dietetics, the balanced chop suey ration mentioned a few moments ago.

Such was undoubtedly the diet of the early multitudinous cockroaches that swarmed throughout those carboniferous forests. These very insects are today a prominent feature of the entomological fauna of tropical jungles, and, moreover, they have even invaded the overheated tenements of our great cities. The cockroaches, therefore, show three characteristic features: a mixed, more or less indiscriminate diet; great morphological stability over extended periods of time, and an adaptability to changing conditions and to intensive competition with other, more modern types of insects.

On the other hand, purely carnivorous habits are characteristic of several very primitive groups, notably of the earliest dragonflies. The predatory habits of these insects are very pronounced and predatism has attained a wonderful degree of perfection among the modern dragonflies. The imagines are admirably fitted for the capture of prey while on the wing, and the nymphs are even more marvelously adapted for the seizure of prey beneath the water in which they live. The mechanism peculiar to the nymph and unparalleled elsewhere is a unique, pincers-like, bristly organ, known as the mask formed by the highly modified labium. The form of this structure is so similar throughout the Odonata that there can be no doubt that it was characteristic of the earliest representatives of the order and perhaps of the ancestral Protodonata as well. So far then, as structural adaptation is concerned, the dragonflies must be rated very high. They have persisted over an extremely long period with little more tendency toward morphological change or speciation than the cockroaches. Even though the nymphal mouthparts are most exquisitely suited for the unfailing capture of prey, the diet of individual genera and species has not become highly specialized. We might almost say that the great efficacy of the mask has made unnecessary any great specialization in instinct; and, consequently, the diet of any species or individual varies greatly, depending upon circumstances. This statement is abundantly supported by observations made on the diet of dragonfly nymphs by several entomologists. These show that there is practically no selection since the imagines of a single species of dragonfly will devour a greatly diverse mixture of insects, while the nymphs consume also many small crustaceans, other invertebrates, and even some Protozoa.

Among the dragonflies, then, a long history with comparatively slow evolutionary change is associated with an indiscriminate diet during both the nymphal and reproductive stages.

If we now turn to certain predatory types among some of the more recent holometabolous insects we find a condition strikingly in contrast to that just described. In the Diptera, for example, there is a series of rather closely related families, that includes the robber-flies or Asilidæ, whose members are highly predaceous. Although only fragmentary data are available for these flies, some species are seen to have very strong predilections in the choice of prey. Thus, among the large flies of the genus Proctacanthus, one species captures almost entirely aculeate Hymenoptera, more than half of its prey consisting of honeybees and hornets, while the second greatly prefers small scarabæid beetles in combination with other miscellaneous insects. Other robber-flies are butterfly hunters, but many are more or less general feeders, and a tabulation shows that, although there is a consistent choice of food among species, there is not the close restriction that prevails among parasitic insects, nor among vegetarian types which we will discuss in a moment.

A very high specificity in the selection of prey obtains among the solitary wasps. With these insects the prey is stung and stored in the nest, where it forms the food of the developing larva. Thus, the choice of food rests with the mother wasp, while the larva obediently eats what is put before it, thriving to maturity thereon. Although a very wide range of prey, including spiders and the most diverse insects is utilized by these wasps, individual species commonly restrict their hunting to the capture of a series of related forms or even to a single species. One American Aphilanthops stores only queen ants and a related European wasp captures ants also. Our common American mud-dauber wasps collect small spiders of various kinds and certain crabronids capture flies of a single or of several species. The fixity and persistence of their instincts is shown by the tendency of genera or larger groups to restrict themselves to related types of prey, and this may extend to the members of a large family like the Psammocharidæ, where the spider-storing habit is so general that the vernacular name of "spider wasps" has been bestowed upon them by common consent. In another group, stages through which the change from a somewhat indiscriminate diet to a specific one has taken place are still preserved. Thus, in the genus Sphex (Chlorion) some species store a variety of Orthoptera in their nests, others only a few, and finally some only one. As we shall see in a moment this condition prevailing among the solitary wasps is wholly analagous to that which obtains among phytophagous insects.

The tendency among these diverse types of predatory insects is clearly toward a restriction of the dietary although we cannot consistently detect any orderly arrangement whereby a relationship of predators implies to any great extent a similarity of prey. Sufficient evidence has been presented, however, to show that we cannot make any broad generalizations. Thus predaceous insects do not exhibit the close correlations characteristic of parasites nor of vegetarian insects. At this point, we must emphasize the fact that many predatory insects have narrowed down their food relations to a point where their direct contacts with the environment are restricted to certain definite components of the fauna of which they themselves form an integral part. The significance of these facts may be best understood after we have examined the food relations of vegetarian insects.

Insects that feed on plants are far and away the most important series to illustrate the adherence of species or larger groups to restrict diet. On account of their complex relationships toward these plants directly, and indirectly through them to other animals, coupled with their great abundance and diversity, they are of extreme interest. Their ecological relations are far reaching for they extend, tentacle-like, into the innermost corners of every type of terrestrial, aerial, or fresh-water environment. From the general biological or evolutionary standpoint they are of peculiar interest for it is this vast horde of vegetarian species (for they include about half of the living kinds of insects) that have made their influence felt over the long lapse of geological time since these types became highly differentiated during the periods preceding the tertiary. The chronology of this process, at least with regard to specific food relations, is difficult to determine, but taxonomic groups similar to those of today were so well established in the eocene and oligocene that we can rest assured that their food relations were already equally complex at that time. Thus, the time during which the factors introduced by these insects have been active in affecting the evolution of other animals and plants is much more extended than that included in the period just mentioned. As I have shown previously, there is good reason to believe that the differentiation of feeding habits among phytophagous Coleoptera was well under way while that of the Lepidoptera was just beginning at the time when the modern types of trees appeared on the earth.

There is no need to attempt at the present time any detailed account of the specificity of food selection among the Lepidoptera as this is well known and I have already dealt extensively with it elsewhere. Briefly, we may say that the members of this order may be considered as forming two or three groups with respect to specificity of food. These are: first, those which utilize a very considerable and not necessarily related series of food plants, occasionally a hundred or more in number, like the cecropia moth or the leopard moth; second, those having a much more restricted dietary that includes a few, usually related, species; and finally, some that are confined to a single plant host or to several very closely related and genetically similar members of a single genus. Again, these categorical divisions are only relative; but experience shows them to be very convenient, and we may unquestionably regard them as successive phylogenetic stages. We may conveniently refer to the insects concerned as polyphagous, oligophagous and monophagous, respectively.

The labors of economic entomologists have gone far toward an elucidation of the interactions of these several types of food-habits as they determine the competition for food among insects and the devious ways in which they influence the biocœnotic relations of insect food plants. And, since no plants appear to be immune to insect attack this question is seen at once to involve the whole terrestrial flora.

Several factors concerned in these relationships between insects and plants may be considered separately. The effect of insect feeding on the flora is by no means the same in the case of polyphagous, oligophagous and monophagous species. With the former a long series of plants suffer to a more or less equal degree. Thus, with grasshopper outbreaks there is general injury to all kinds of vegetation; with the gypsy moth a considerable series of trees and also other plants suffer, but not to an equal extent. This means that there is a simultaneous reduction in the abundance of a number of different plants, and an opportunity is offered for many others to increase, at least temporarily, while many competing insects decline due to a lessened food supply. Thus, in brief, outbreaks or fluctuations among polyphagous species involve many other insects and plants to a major extent. We can also see how such feeding might actually cause the extinction of certain rare or poorly adapted plants.

The feeding of oligophagous insects results in the injury to a greatly restricted series of plants and has, of course, no direct effect upon any others. If dominant species of plants be affected there as a very considerable opportunity for many rarer forms to increase, while if a reverse condition prevails and the scarcer forms are affected, the influence upon the remainder of the competing flora is negligible. Incidentally we must notice that the extinction of certain plants might result from the feeding of oligophagous species, although the chances for such an occurrence are less than those noted above in the case of polyphagous insects since a great reduction in one of a few food plants will at once considerably reduce the food supply. This is then immediately reflected in a lesser abundance of the insect, and injury decreases. In general, therefore, the feeding of oligophagous insects does not involve simultaneous fluctuations in a considerable number of plants, especially if those concerned are not dominant forms, and likewise, a smaller number of species of insects is affected directly. The fluctuations that may occur among associated insects are to a greater extent in an inverse ratio rather than in a direct one.

Monophagous species present a very remarkable series of phenomena. Aside from any parasites they may support or predators that they may feed, their relations to the living environment are entirely restricted to contacts through the medium of the host plant. They can never become so abundant as to rise up and destroy it, since for obvious reasons their fluctuations in abundance trail very closely those of their host plants. Therefore, we may never attribute the extinction of any plant, even in a restricted region, exclusively to the activities of a monophagous insect. Other plants are affected to a varying extent, dependent mainly upon the rarity or abundance of the host plant. If it be a dominant species, its fluctuations increase or decrease the struggle for existence among competing plants; if it be a rare species, this influence upon a series of other plants is negligible. It also affects a number of associated insects which feed upon the same food plant. The number of these is, of course, extremely variable, but careful studies of plant faunæ indicate that dominant types of plants support surprisingly large numbers of vegetarian insects mounting into hundreds of species in the case of common types such as willows, figs, oaks and maize, although the average for plants in general falls far below this mark. Certain plants which produce poisons or violently irritating substances, (like our common American poison-ivy), enjoy comparative, but by no means complete immunity from injury by phytophagous insects.

In regard to their relations with the living environment, we may say that monophagous insects live a life apart. Their association with plants is such that the vicissitudes of life for both members of the pair are greatly reduced on account of the lesser number of variable factors that affect each. So far as abundance of fluctuation in numbers they are mutually adaptive. The instincts determining food selection are firmly fixed in the germ-plasm and the insect is doomed to feed to the end of its days on beans, cabbage, yeast or what-not, unless some fortunate shift or mutation of instinct may add pork to the beans, or perchance combine hops and malt with the yeast ration. Such persistence over long periods during which whole groups of insects and plants have evolved in mutual adaptation seem only to be explained on the basis of instinctive behavior. This view which I have upheld in the past has been recently questioned by some, who would place the matter upon a purely physiological basis, but I cannot see that there is convincing evidence to support this conclusion or to controvert my own contentions that we are dealing with persistent instincts rather than with digestive necessities.

With the foregoing considerations on phytophagous insects as a basis it is possible to draw certain conclusions of a general nature which indicate some of the ways in which the development of oligophagy and monophagy has influenced the evolution of the higher plants as well as that of the insects themselves. Due to its tendency to reduce the chances of extinction of plant species whose existence might be jeopardized by an abundance of polyphagous insects we can see that it has tended to increase the diversity of the flora. The development of many mutual adaptations of plants with both monophagous and oligophagous insects are dependent upon the specific food habits of the insects concerned and it is thus clear that we must attribute to the development of these instincts many of the remarkable morphological modifications seen in both plants and insects. In the present state of our knowledge, at least, there is no other causal explanation for their existence. Since speciation and the rapidity of evolutionary change in general are highly correlated with adaptive modifications, we must attribute to the phenomena of restricted food a highly important role in determining the trend of these evolutionary processes.

A relationship similar to the one just given was early noticed by Darwin in connection with anthophilous insects and entomophilous flowers and his interpretation of the mutual modifications of insects and flowers has long since become solidly entrenched among the unassailable biological doctrines, after having further engaged the attention of a score of later naturalists. I mention it here not for discussion, but only to show the similarity to to views just expressed concerning phytophagous insects and their food-plants.

Really no time remains for the discussion of the other types of food habits among insects which I had hoped to mention in connection with their biological interest. They would serve to clarify the statements already made, but since they might also cloud the issue somewhat and since they show how thoroughly the insects have exploited the world's food supply they are more appropriately dealt with in connection with my concluding remarks on insect food as viewed from the human standpoint.

From a purely human standpoint, we must regard everything as either beneficial or harmful, unless it appear to be utterly unimportant or indifferent and the scientific mind will not admit the third possiblity. As entomologists are prone to look upon insects in this light we may view them thus at the moment.

INJURIOUS INSECTS

harmful to man directly
harmful to useful plants
harmful to useful animals
    a. harmful to useful insects

BENEFICIAL INSECTS

destroyers of injurious insects
destroyers of undesirable plants
destroyers of obnoxious substances
producers of useful substances.

I think this classification reflects the usual attitude toward the economic relations of insects, and it serves well to emphasize the fact that the importance of every species is gauged by what it harms, injures or destroys, with the sole exception of the small handful of "producers" like the honey bee, silkworm, etc. This can only mean that, practically, the activities of insects that appear to be of greatest human interest, are those which serve to destroy other things. As the ultimate purpose of the human species is to destroy and make over the face of nature, quite naturally insects and man are at once both in accord and conflict, and our most competent practical entomologists predict a battle to the death between insects and man. Unfortunately for ourselves, man has proceeded to change the face of nature as rapidly and completely as possible. In so doing, he has found his progress seriously impeded by an unforseen increase in the numbers of insects that feed upon agricultural, horticultural and forest crops, combined with an equally unexpected migration or spread of many phytophagous species into regions where they did not previously occur. There is no need to press this point for we all realize that this is a serious situation that confronts agriculture, horticulture and forestry today. It is equally clear that this distressing condition has been brought about mainly by two factors inherent in our prevailing mode and philosophy of life. One is the growing tendency throughout the world, and particularly in America, to devote more and more extensive areas to the propagation of easily managed crops that give promise of large pecuniary returns. This matter then goes deep into the fabric of our commercial life. The other factor concerned is the unprecedented increase in the bulk and variety of vegetables, fruits and food-stuffs of all kinds that are shipped here and there in all directions, aften to the uttermost corners of the earth wherever they may be disposed of at a profit. If, as generally occurs, there is great local over-production of certain foods, the urge for wider distributional opportunities is so powerful that it must needs invoke the aid of advertising propaganda and every other known method that may be put to the tune of modern jazz. No one has ever suggested the curtailment of such shipping on economic grounds. This matter is, of course, likewise not a suitable subject for unbiased discussion except in purely academic circles, since it is too deeply concerned with the business of transportation, with advertising, with the love of luxury and with other matters of vast and immediate pecuniary importance.

Having thus bared a very pessimistic attitude and exposed to view what you have doubtless recognized as the clear, clinical picture of an inferiority complex, let us return to some purely entomological phases of the matter. How do the several types of food-habits among vegetarian insects affect their pracitical importance in relation to the human food supply? It is generally conceded that monophagous and oligophagous types are the ones most destructive to cultivated crops. We can at once recall a long series of such species, the potato-beetle, the codling moth, the oriental peach moth, and many others whose importance is due to the fact that they unerringly pick out valuable and widely cultivated agricultural plants. On the other hand, many with a considerable range of food-plants, the bollworm, the corn-borer, the Mediterranean fruit fly, the melon aphid, the red scale and the like are very destructive, but quite generally less so on the whole, in spite of the much greater variety which may feed upon a particular species of plant. General feeders like the various types of locusts, army worms, etc., although very conspicuously destructive in some regions and on certain occasions, are in the long run less generally dreaded by agriculturists. To return then to our earlier discussion of monophagy and oligophagy, we must admit, without further ado, that our present civilization could well dispense with this interesting evolutionary phenomenon, since it is a gift of Nature that serves to increase injury to cultivated plants, at least under modern agricultural conditions. We might return the gift with thanks, but so far, science has been unable to write a sufficiently polite or forceful note to accompany the transfer.

There is just one more matter relating to these destructive insects which I hesitate to mention as it is so familiar to all of us. It was one of the first choice bits of information we acquired as students and we have religiously passed it on to our students ever since. The most destructive insect pests are those that have spread from their original habitat into some other faunal region. The reasons for this are usually said to be well understood on the basis of predatory and parasitic control, but there is much to suggest that other factors remain still to be elucidated.

Since human behavior is conventionally regulated by prohibitions, punishments and legislative action of endless variety, it is quite natural that the immigration of insects should have come to the attention of law-makers as a fit subject for similarly paternal consideration. The protection of the human population from communicable diseases by restricting the movements of diseased persons has been so satisfactorily effected by quarantine measures that excludatory regulations have been instituted to protect countries from invasion by insects from other regions, without a clear statement that the two situations are neither identical nor essentially similar. Thus, such regulations have been based upon the inspection of host plants or other materials. The success of these has not been all that might have been hoped and there is a wide divergence of opinion as to whether the results attained are in any sense commensurate with the great expense and hardships entailed. It is quite clear that the absolute exclusion of insects is a much more difficult undertaking than the interception of cases of human disease. Human beings are dealt with legally and otherwise as individuals and besides, the success of public health measures does not depend upon absolute exclusion for all time. There is no question that such measures must aid somewhat to delay the introduction of insect pests where some natural geographical barrier to animal or plant migration exists. As time goes on, as transportation increases and speeds up and as movement becomes our main interest, the poor old oceans, mountains and deserts are rapidly losing their importance as separating faunas and floras. In our own country during the past few years there has also been an increasing movement to prevent the spread of particular species of insects between states or other artificially limited areas where absolutely no natural barriers exist. This in itself is a most commendable endeavor when it can be carried on unostentatiously and at reasonable expenditure, since it serves to delay the otherwise extremely rapid naturalization of insects over contiguous areas. In some instances it is obvious that such quarantines may become oppressive and entail expenditures and economic consequences to communities that are not at all warranted by any advantages that might reasonably be expected to accrue from them. This is well illustrated by the supreme efforts made to curb the spread of the Mediterranean fruit fly following the recent discovery of its establishment in Florida. Many persons were even led to believe that the extermination of this pest in the United States was a foregone conclusion instead of a hoped-for miracle. Certainly long experience in connection with the establishment of exotic insect pests of cultivated plants holds out little prospect of their eradication. Another unfortunate circumstance in this connection is the great menace of repeated introductions of the same insect. I do not wish to pose as a critic of the legislative activities of entomologists but feel that it is our duty to view such matters in an unbiased attitude and to shy clear of the idea that all evils may be remedied by the enactment of laws and the expenditure of money. The use of the quarantine has increased at such a rapid rate that we should be sure of our ground before allowing it to usurp the foreground of entomological practice. Another grave danger lies in the fact that perfectly sane scientific pronouncements may be easily perverted by legislative enactment and subsequent enforcement by persons far less expert than the entomological authorities who formulated them.

Certainly the importance of these problems and the threat which they hold over our future comfort and welfare demand that we as entomologists approach them in an altruistic spirit.

A REVIEW OF OUR PRESENT KNOWLEDGE OF THE GEOLOGICAL HISTORY OF THE INSECTS.[1]

By F. M. Carpenter.

During the past ten years, subsequent to the publication of Handlirsch's general account of fossil insects in Schröder's "Handbuch der Entomologie" in 1920, many important and unexpected specimens have been discovered. So profound an effect have these new fossils had upon insect paleontology that I venture to invite your attention this evening to a review of our present knowledge of the geological history of the insects, and to a discussion of the main problems which await solution.

First, let us consider what important discoveries the past decade has witnessed.[2] The Carboniferous rocks, unfortunately, have not made a very large or an unusual contribution. The British coal measure insects, comprising sixty species, have been monographed by Bolton in a work which has added a great deal to our knowledge of certain extinct orders. Pruvost has described a splendid series of new fossils collected at the famous Commentry beds in the central plateau of France, and Bolton has published on a smaller assemblage of insects from the same locality and now contained in the British Museum. In this country, Cockerell has written a comprehensive account of the Carboniferous insects of Maryland. But interesting as all these coal measure insects are, they seem to be quite typical of those which have previously been found in this horizon,

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[1] Annual address of the retiring president of the Cambridge Entomological Club, Jan. 14, 1930. Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 330.

[2] Although Handlirsch's account of fossil insects in the "Handbuch" was published in 1920, it did not include the results of several important works which appeared a few years earlier. For this reason, the latter (as Tillyard's "Mesozoic Insects of Queensland") are mentioned here.

including such groups as the Paleodictyoptera, the Blattaria, the Megasecoptera, etc. In marked contrast to this, the Permian has unexpectedly furnished us with a remarkable series of specimens, representing groups which have not previously been reported from this horizon. In 1920 Handlirsch listed from the Permian 97 species of insects, aside from cockroaches; now there over 250, also exclusive of cockroaches, and many additional species are contained in unworked collections recently obtained from Permian deposits. For the most part, these new fossils have been secured at three widely separated localities, in Australia, North Russia, and Kansas. The Australian and Kansan specimens have almost exclusively been studied by Tillyard, while the Russian material has been investigated by Martynov. Of course such fossils have thrown much light on the geological ranges and the phylogenetic origin of our existing groups of insects. We now know that many recent orders had a much longer geological history than had been supposed; for the first time the Mecoptera, Neuroptera, Coleoptera, Diptera, Odonata, Homoptera, Psocoptera, and Orthoptera[3] have been found in the Paleozoic.

The Mesozoic has likewise contributed much to our collections during the past decade. The Triassic, which had previously been nearly a blank as far as insects were concerned, is now represented by about 120 species, described by Tillyard from Queensland. Martynov has published on another remarkable series from the Jurassic of Turkestan, and his studies are by no means complete. Mention should also be made of Tillyard's monograph of the Liassic dragonflies of England, and Ping's study of the Cretaceous insects of China. The latter work is particularly interesting since it has brought to light the only promising insect deposit of the Cretaceous which has yet been found.

The Tertiary, of course, has played a large part in the recent advances of insect paleontology. The Baltic amber insects have received much attention at the hands of several specialists; certain groups, as the Thysanura, Colembola, and Paussidae, have been completely revised. Cockerell has continued his description of the Florissant and Green River

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[3] Undescribed.

insects, as well as those of the Tertiary of England and others contained in the Burmese amber. Very recently Martynov has described the insect fauna of a newly discovered Tertiary bed in Russia, and Pongraz has written several papers on the fossil insects of Hungary, redescribing many obscure insects which Heer first studied seventy years ago. A few Tertiary insects have been collected at new localities in this hemisphere,—in Tennessee, Washington, Nevada, and Argentina, all of which give much promise of providing us with a more complete series of fossils in the future.

If we take the conventional bird's-eye view of the geological history of the insects, we are at once struck by the antiquity, not only of their natural groups, such as the orders, families, and genera, but of their habits and ethology. As far back as the Oligocene, about 50 million years ago, the social Hymenoptera had already differentiated into several castes, and the ants, at least, had accomplished this by the Middle Eocene. The Baltic amber ants, as demonstrated by Wheeler, show definite polymorphism and even the higher stages of development such as ergatoid and pseudogynic females, and ergatomorphic males. Some of these Oligocene ants had also "learned to attend" plant-lice, just as many of the modern species do. Whether or not some of the amber insects belong to species which are still existing on earth, is an open question. In the case of the ants, there are eight species which are morphologically identical with certain living ones. If these species actually are identical —and there is no evidence to the contrary—then they have existed without apparent structural change for some 50 million years[4]. Aside from the probability of the specific identity of some of our fossil and recent insects, it is certain that most of the genera of the Tertiary are still surviving. Of course many of the genera which used to be more or less cosmopolitan, these many millions of years ago, are now restricted to much smaller areas,—as the dipterous genus, *Glossina* or the formicid, *Oecophylla*. As we become more and more acquainted with the tropical insect

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[4] I have used the time estimates advanced by Dr. A. Holmes, in his "Age of the Earth" (London, 1927).

faunas, we even find genera which were first known to us only as fossils and supposed to have been extinct. Such a genus is *Archipsocus,* described by Hagen for an amber Psocid, but subsequently found to be existing in the tropics of both the New and the Old World. Another instance is the ant *Gesomyrmex,* which was originally described by Mayr from the amber, and which was found many years later in the region of Borneo.

Now if we go back another hundred million years on the geological calendar, to the Middle Mesozoic, we are unable to recognize definitely any existing genera, but we do find many families quite familiar to us at the present time. Of course, as one would naturally expect, there is a marked difference in the development of the several orders. All the Mesozoic Trichoptera, for example, belong to extinct families, but many of the Orthoptera and Diptera can be included within modern families. When we reach the Permian, another 50 million years away, we observe that our recent families no longer make their appearance, but we are still able to recognize several existing orders, as the Mecoptera, Neuroptera, Odonata, Diptera, etc., including types with complete metamorphosis. However, receding another 50 million years—making a total of about 250 million—we come to the Upper Carboniferous, in which our earliest winged insects have been found. Here we find an assemblage quite unlike that of any other period, including such primitive forms as the Paleodictyoptera, and a few more highly specialized groups as the Protodonata and Megasecoptera. Only one recent order, Blattaria, has been recognized without question in the Upper Carboniferous[5]. Tillyard has described from even older rocks, the Devonian of Scotland, the remains of some arthropods which he considers to be true Collembola, but I do not believe that entomologists in general have accepted his conclusions. The absence of winged insects from strata below the Upper Carboniferous is particularly disconcerting, for, primitive as these coal measure insects may be, they are nevertheless

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[5] Tillyard maintains that the obscure *Metropator pusilus* Handl., from the Pottsville series of the Upper Carboniferous, is a true Mecopteran, but this is very dubious. See G. C. Crampton's discussion, Psyche, 37, 1930; p. 93.

perfectly respectable insects and so far along the line of the Insecta that they show no definite relationship with other Arthropods.

With this general survey of insect paleontology in mind, I suggest that we now examine more carefully the geological ranges of the larger and more prominent insect orders. Of the extinct ones certainly the most interesting, phylogenetically, is the Paleodictyoptera. These generalized creatures, which are usually regarded as the ancestors of all the other winged groups, were developed into many diversified families before the end of the Carboniferous; but for some reason their glory was brought to an abrupt end, for only one species is known to have persisted into the Permian. Another interesting Carboniferous order was the Megasecoptera, the members of which were unique among the other known species of the period in that they possessed petiolate wings, not very much unlike those of the damselflies. These insects appear to have completely died out before the Permian, but some recent groups are supposed to be their direct descendants,—as the Odonata and Mecoptera. The order Protodonata, another assemblage which has never been found living, is especially famous because of the large size attained by some of its members, *Meganeura* of the Commentry of France having a wing-expanse of about 29 inches. This order, in contrast to the foregoing, persisted through the Permian, but apparently became extinct during the Triassic. All the rest of the Carboniferous insects, excluding a few very small orders with obscure affinities, seem to fall into what we may call the Blattoid, or cockroach, complex. Handlirsch and others have attempted to divide them into separate orders, such as the Protorthoptera and Protoblattaria, but these groups overlap in many respects. This complex, in my opinion, represents the converging branches which later lead to several distinct orders of insects; it represents, in other words, the trunk of the conventional phylogenetic tree, where the several branches had joined—or were in the act of joining—into one. I suspect that as more and more Upper Carboniferous insects are found this complex will become even more jumbled; and I also believe that when Lower Carboniferous insects are discovered, as they eventually must, we shall find the Paleo-

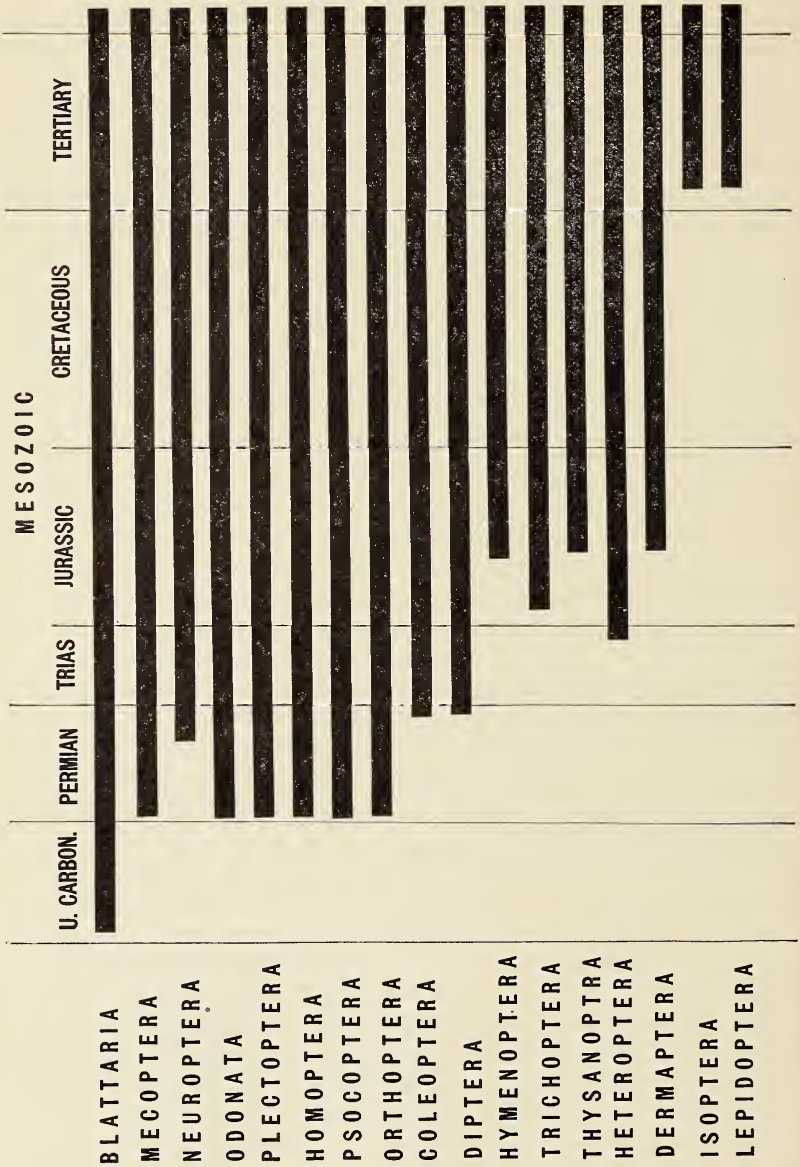

Plate 1.

Table 1. Geological Ranges of the Larger Insect Orders.

dictyoptera, Megasecoptera, and the other extinct orders of the Upper Carboniferous, joining with this complex.

If we examine a diagram showing the geological ranges of the larger existing orders of insects, we are at once impressed by the fact that ten of them have been found in the Permian; of these, seven have been recognized in the Lower Permian, and one, the Blattids, in the Upper Carboniferous. These ten Permian orders are a rather diversified lot, including the Mecoptera, Neuroptera, Odonata, Homoptera, Psocoptera, Coleoptera, Diptera, Plectoptera, Blattaria, and Orthoptera. Since their occurrence in the Permian marks the earliest record of all these insects, except the cockroaches, let us see if these ancient representatives are as primitive as we might expect.

The presence of Mecoptera in the Lower Permian is particularly striking, inasmuch as our recent members of this order develop with complete metamorphosis. Of course since no larval or pupal forms of the Permian Mecoptera have been found, we have no direct evidence that they, too, were holometabolous; but, as Tillyard has pointed out, they are so close to our existing types in other respects that no one would deny that they also possessed holometabolism. There are many features of these ancient scorpion-flies that are most unusual. Those from the Lower Permian of Kansas, with which we are best acquainted, are very minute, having an expanse of about 10 mm.,—less than that of any existing species. Some of the Permian forms had short beaks, like those of the Australian Choristidae; the antennae were shortened and possessed fewer segments than those of any known Mecopteran except the highly specialized Bittacidae; the males of some genera had a genital structure essentially like that of the Bittacidae, also. Finally, some of the Lower Permian species had a wing venation more highly specialized than that of any recent types. The Neuroptera have not yet been taken in the Lower Permian, but those of the Upper Permian were actually more specialized in their venation than their existing relatives. Both the Planipennia and Megaloptera were already differentiated and as highly developed along their own lines as the Mecoptera were along theirs. Although Tillyard maintains that the absence of Neuroptera in the Lower Permian collections is sufficient to show that the order was a later development than the Mecoptera, I believe that the Upper Permian specimens demonstrate that the Neuroptera are at least as old a group as the Mecoptera. The finding of true Odonata in the Lower Permian was one of the surprising discoveries of the decade; previously no Odonata had been known from the Paleozoic, but subsequent to the finding of the Lower Permian fossils, an Upper Permian species has also been located. All these described Permian forms possessed petiolate wings, more narrow and elongate than any recent types. As in the case of the Mecoptera, the Permian Odonata were very small, some having a wing-expanse of about 4.0 cm. The absence of Odonata with broad wings basally from the Permian has lead Tillyard to the conclusion that the Anisoptera and the Anisozygoptera were derived from the petiolate Zygoptera during the Triassic. For my own part, I do not accept this inference, but consider that both the anisopterous and zygopterous lines were already developed during the close of the Upper Carboniferous. The occurrence of true Homoptera in the Lower Permian is of much significance, especially since we are forced to admit that they appear to be the most highly specialized of all the insects of this horizon. Numerous Homoptera, even more highly developed, have been taken in the Upper Permian of Australia and Russia. The finding of Psocids in the Lower Permian was perhaps the most surprising discovery made in the field of fossil insects for many years. At the time when these fossils were collected, the earliest record of the order was in the Baltic amber, of Tertiary age, some 200 million years later, but subsequent to the finding of the Permian specimens, Martynov has taken others in the Jurassic of Turkestan. The Permian Psocids were very similar in venation to the Homoptera, and were nearly as highly specialized. The Plectoptera or Ephemerida have long been recognized as very primitive insects, so their presence in Lower Permian beds is not at all surprising. The Permian species, although more primitive than any recent forms, were nevertheless well developed along certain lines and show that the order originated far in the past. The other Permian orders, the Diptera, Orthoptera, and Coleoptera, are too sparsely represented in our collections just now to enable us to form any definite idea as to how far they had developed along their particular lines of evolution. But I believe that it is already evident from our discussion of the preceding groups that the Permian orders were far more highly specialized than they should be in the strata where they first make their appearance. Some of them, in fact, such as the Mecoptera, Neuroptera, Odonata, Homoptera, and Psocoptera, were so highly developed that they must have extended as distinct orders well back into the Carboniferous. Now if this is the case, one might wonder why these insects have not been found in the Upper Carboniferous. The explanation, I believe, lies in the coarse nature of the Carboniferous strata in which the insects are preserved. The Lower Permian representatives of the Mecoptera, Odonata, Homoptera, and Psocoptera are very small, those of the first two orders being much smaller than the average existing species of these groups; and all the Neuroptera of the Russian Permian and most of those of the Australian Permian (which is almost Triassic) are also small, their averaging wing-expanse being about two centimeters. The majority of the Carboniferous insect beds are composed of coarse material, and even the finest of them would hardly be capable of preserving such minute insects as those which we have just considered from the Permian. The average wing-expanse of the Carboniferous insects was approximately 10 cm., not including the cockroaches. The wings of the latter were much smaller, but they also possessed the coriaceous texture of the recent species, and were consequently able to be preserved regardless of their smaller dimensions. This selective nature of the Carboniferous strata has given rise to the notion that all the Carboniferous insects were "giants"; but I do not believe this to be the fact, and predict that when some enterprising geologist discovers for us a Carboniferous insect bed with as perfect a preservation as the Wellington shales of Kansas, we shall find some very small insects belonging to the several recent orders which are so highly developed in the Permian.

Let us now consider the orders of insects which make their first appearance in the Mesozoic. There are five of these: the Trichoptera, Heteroptera, Dermaptera, Hymenoptera, and Thysanoptera. Only one, the Heteroptera, has been found in the Triassic; the others are not known earlier than the Jurassic. These oldest Heteroptera were so well developed along the lines of the recent species that it seems almost certain that the order must have existed in the Permian. The Trichoptera of the Jurassic, on the other hand, are essentially more primitive than the extant species, many of them possessing a venation so similar to that of their contemporary Mecoptera that it is frequently difficult to distinguish the members of these two orders. Consequently, it is very doubtful if the caddis-flies will ever be found lower than the Triassic. The Hymenoptera are first represented in the Jurassic, by such forms as Siricoids, Oryssoids, and Ichneumonoids. This diversity of the Jurassic Hymenoptera makes it rather obvious that the order had been some time in existence before that period, probably at least as far back at the lower Triassic. The only known Mesozoic Dermaptera and Thysanoptera have been taken in the Turkestan beds, but they are both represented by characteristic types, not very much unlike certain recent species.

We are now left with the two orders whose first record is in the Tertiary rocks,—the Lepidoptera and Isoptera. Only very few Lepidoptera have been found as fossils in this horizon, but these are absolutely modern in every respect, and there can be no doubt that the group arose some time in the Mesozoic. The Isoptera are quite common in the Tertiary beds and are differentiated into many recent families, most of which, however, are now limited to much smaller geographical areas. There is every indication that the termites will some day turn up in Jurassic and perhaps even Triassic strata.

From the foregoing discussion of the geological ranges of the larger insect orders, it is obvious that by far most of the orders have had a longer history than one would assume from the mere geological occurrence of the oldest species. In every case where we have enough fossils to utilize, we see that the earliest representatives of each order are relatively highly specialized along the lines of the recent types; and this is particularly true of the Permian record. In order to have our diagram represent the probable true range of these orders, we must make several changes: The Mecoptera, Neuroptera, Odonata, Homoptera, Psocoptera, Plectoptera, and of course the Blattids, would extend back to the Upper Carboniferous; the Hemiptera would recede to the Permian, and the Trichoptera, Dermaptera, and

Thysanoptera to the Triassic, while the Lepidoptera and Isoptera would be shown as far back as the Jurassic only. Whether these estimations are substantiated or not will of course depend entirely upon the future discoveries in insect paleontology.

There is one other aspect of insect paleontology which I wish to discuss: the relative development of each order in the several geological periods. Those of you who have never considered this aspect of entomology will probably be more or less surprised at some of the facts. The average entomologist, if there be such a freak, is so accustomed to thinking of the insect orders in their present relative standings that he never stops to reflect that there must have been some period in the earth's history when the more predominant of the recent orders were actually struggling for a footing; when some of our smaller groups, now nearly extinct, were the predominant ones. Or perhaps the entomologist is, let us say, a hymenopterist, and so fond of his pets that he cannot imagine any period in the earth's history when they were not disconcertingly abundant. But a moment's reflection on the geological history of the other groups of animals will show that such a change in the relative status of the orders is only to be expected. Taking the fishes for an example, we note that the Lung Fishes, which are now represented by a very few species, were one of the most predominant groups during the Devonian and Carboniferous; in a similar manner the Lobe Fishes and the sharks were very abundant during the latter half of the Paleozoic, although both of these types are now greatly outnumbered by more recently evolved forms. Innumerable examples may also be found in the higher vertebrate classes. Among the Reptilia, the Order Crocodilia was represented in the middle Mesozoic by a great number of species, which are now reduced to a small fraction. An even more striking illustration is furnished by the Rhyncocephalia, which were well developed in the number of species during the Triassic, but are now known from a single living species, *Sphenodon punctata,* of New Zealand. It is only logical, therefore, that we should find that our insect orders have passed thru similar modifications.

I take it that no one will deny that the number of species in an order is an index to the "health" of that group. At least it is obvious that such an aggregation as the Coleoptera, with close to 200,000 existing species, is in less danger of becoming extinct within the next thousand years than, say, the Mecoptera, of which less than 200 species have been found in all regions of the earth. Consequently, an accurate idea of the "species strength" of the orders can be obtained by determining the percentage of species which each order contributes to the entire insect fauna. The present percentages for some of the existing orders are shown in the right-hand column of figure 2. Here we see that the Mecoptera, Neuroptera, Odonata, Psocoptera, Plectoptera, and Blattaria each make up less than 1% of the known species. The Orthoptera and Homoptera are but little better, with about 3% and 3.5% respectively. The Coleoptera lead with the striking figure of 41%.

TABLE NO. 2.

RELATIVE ABUNDANCE OF SPECIES IN EACH ORDER AT DIFFERENT PERIODS

(Figures in Percentages)

	Permian	Mesozoic	Tertiary	Recent
Mecoptera	9.0	3.7	.16	.035
Neuroptera	3.0	4.8	.50	.42
Odonata	.80	6.6	1.6	.56
Homoptera	12.5	9.0	4.0	3.4
Psocoptera	6.0	.25	.45	.12
Coleoptera	1.0	37.0	37.0	41.5
Plectoptera	3.5	2.0	.30	.095
Diptera	.30	5.0	27.0	10.8
Orthoptera	.30	9.0	1.2	2.9
Blattaria	34.0	7.0	.90	.42

Even a casual examination of the geological history of the insects will indicate that quite different conditions have prevailed. In the case of the Mecoptera, for instance: 10 species of these insects have been secured in the Lower Permian of Kansas, 4 species in the Russian Permian, and 15 in the Australian Permian, making a total of 29 species from these three deposits. Yet in the Tertiary, which has produced more than twenty times as many species of fossil insects as the Permian, we have found only a total of 12

Mecoptera in all deposits! When we put this on a percentage basis, the results are even more striking (table 2). We find that the Mecoptera make up about 9% of the Permian insect fauna, less than 4% of the Mesozoic, and not even .2% of the Tertiary; and as I have mentioned above, the Mecoptera contribute less than .04% to the recent species. The Neuroptera comprise about 3% of the Permian insects, nearly 5% of the Mesozoic, but less than 1% of the Tertiary and Recent. The Odonata are only represented in the Permian by less than 1%; but in the Mesozoic we find that almost 7% of the species belong here, while in the Tertiary the figures drop below 2%, and at the present time the Odonata make up about one-half of one per cent. The Homoptera, as I have stated above, are very common in the Permian beds, making up a total of about 12.5; in the Mesozoic this changes to 9%, in the Tertiary and Recent to a little less than 4%. The Psocoptera are also common in the Permian, making up 6% of the fauna; but less than .3% of the Mesozoic, .4% of the Tertiary and about .1% of the Recent. The Coleoptera are rare in the Permian, only about 1% of the species of this horizon belonging here; but in the Mesozoic, Tertiary and Recent about 40% of the species fall within this order. The Plectoptera make about 4% of the Permian insects, but this figure drops off gradually from the Mesozoic reaching about .1% at present. Approximately .3% of the Permian insects are Diptera, and this increases to 5% in the Mesozoic and 27% in the Tertiary, only to drop again in recent times to about 10%. The Orthoptera are as scarce in the Permian as the Diptera but increase to 9% in the Mesozoic, then fall off to about 2%. The Blattaria furnish us with an astonishing decline: in the Upper Carboniferous they composed about 57% of the entire insect world, as we know it; in the Permian, this figure became 34%; in the Mesozoic, 7%; and in the Tertiary and Recent, less than 1%.

I have presented these figures without any implications as to their significance, or without trying to interpret them. It is an undisputable fact that the Mecoptera include 9% of the known species of Permian insects, 4% of the Mesozoic, and .2% of the Tertiary. We now have to determine whether this variation is due merely to chance or to actual variation in the specific standing of the groups during the several geological periods. Have the Mecoptera, for example, really been on the wane since the Lower Permian, or are the figures which indicate this without significance? To answer this question one might consider the correlation between the occurrence of the orders in the deposits of each horizon; if the percentages of each order even approximately agreed, we should have positive evidence of the value of our percentages. But this would be a long and tedious recital, so we must find another way of accomplishing similar results. Fortunately Handlirsch in 1908 included in his volume on fossil insects a list of the percentages of the orders, similar to the one which we have considered above. At that time there were 7651 species of fossil insects described. In 1920 Handlirsch again listed the percentages in a similar way for the fossils known at that time, a total of 9302 species. Now there are approximately 10,400 species of fossil insects recognized. That is to say, between the years 1908 and 1920, 1651 species of insects were described; and between 1920 and 1930, a total of 1100 more. These additional species represent the fossils that have been taken in new deposits, as well as those contained in new collections from previously known beds. A comparison, therefore, between the percentages obtained in 1908, 1910, and 1930, furnishes us with a means of determining how closely fossils in new localities, new deposits, and additional collections agree with older records, and consequently a means of determining whether or not our figures have any significance. In table 3 these percentages are listed in parallel columns. We observe at once, of course, the blankness of the Permian record before the 1930 column. This, as I have explained above, is due to the fact that practically no Permian collections had been worked before 1920. We have since found three widely separated Permian beds, each with a diversified fauna, and each sufficiently fossiliferous so that our total of Permian specimens is well over 7000. We cannot therefore check these Permian figures with earlier ones, to any extent. In 1908 Handlirsch placed the Permian blattids at about 80%. This was because Sellards had described only the cockroaches of the Kansan Permian at that time; in the 1920 column this percentage dropped to 57%, for Sellards had by then described the Plectoptera, and a few other groups. Now that all the Permian orders have been studied, we find the figure at 34%, which is probably very close to the correct magnitude. Although we have no previous records to check with those of the 1930 columns, it is interesting that the insect faunas of the several Permian beds compare very closely, although neither the Kansan nor Australian Permian beds have been entirely worked out. We are therefore obliged to regard the Permian record as more or less temporary and probably subject to slight changes when additional material has been found. Just how great these changes are we cannot say at present.

TABLE 3.

RELATIVE ABUNDANCE OF SPECIES IN EACH ORDER AT DIFFERENT PERIODS, AS DETERMINED IN 1908, 1920, 1930

(Figures in Percentages)

	—Permian—			—Mesozoic—			—Tertiary—		
	1908	1920	1930	1908	1920	1930	1908	1920	1930
Mecoptera			9.0	2.0	3.3	3.7	.11	.13	.16
Neuroptera			3.0	4.0	4.1	4.8	.60	.62	.50
Odonata			.80	6.8	6.2	6.6	1.5	1.3	1.6
Homoptera			12.5	4.0	8.0	9.0	4.0	3.6	4.0
Pscoptera			6.0	.15	.15	.25	.40	.40	.45
Coleoptera			1.0	35.0	30.0	37.0	40.0	37.0	37.0
Plectoptera ...	2.8	7.5	3.5	1.8	1.8	2.0	.30	.20	.30
Diptera			.30	3.5	5.0	5.0	26.0	25.0	27.0
Orthoptera			.30	8.0	10.0	9.0	1.2	1.2	1.2
Blattaria	80.0	57.0	34.0	8.0	7.0	7.0	.70	1.0	.90

Leaving the Paleozoic and passing to the later formations, we note that at the present reckoning the Mecoptera make up about 3.7% of the Mesozoic insects. Although this is nearly twice the percentage obtained from the 1908 records, it is still vastly lower than the 9% of the Permian, and equally greater than the Tertiary percentage, which is quite constant in all of the columns. It seems very probable therefore that while the relative number of species of fossil Mecoptera may vary somewhat as additional beds are discovered, these variations will not be sufficient to upset the present trend in the figures, and we are quite safe—

as safe as any paleontologists—in concluding that the Mecoptera had reached their maximum during the Permian. The Neuroptera show a much more consistent series of figures during the Mesozoic and Tertiary, and it is doubtful in my mind that these percentages will change radically in the future. In this case, however, we see that the Neuroptera appear to make up a higher percentage of the Mesozoic fauna than the Permian one; but the difference is very slight, only a little over 1%, and since the Permian Neuroptera are quite as highly specialized as the Mecoptera of that period, it is very probable that a much larger number of Neuroptera will turn up in new beds. The Odonata in both Mesozoic and Tertiary have been regular in their occurrence, so that there has been hardly any variation in their percentages during the past twenty years. Here the maximum seems to be in the Mesozoic, and the difference between the Permian on the one hand, and the Tertiary on the other is so great (even more so than in the Mecoptera) that it is extremely doubtful that this trend will ever be disturbed. The next order, the Psocoptera, has apparently had a history similar to that of the Mecoptera. While the percentages of these insects in the Mesozoic and Tertiary have varied somewhat, due to the early neglect of these small insects, they are so abundant in the Permian that there are no grounds for supposing that they will ever turn up in the Mesozoic and Tertiary to a similar extent. The Homoptera are the same. It should be noted that there was a great increase in the percentage of the Mesozoic Homoptera between 1908 and 1920, again, as in the case of the Psocids, because these minute insects were not observed in the deposits until after the publication of Handlirsch's "Fossilen Insekten". At the present time, although the percentage of Mesozoic Homoptera is about 9% of the whole insect fauna of the period, it is very doubtful if this will ever increase to overtake the Permian ratio, where it is 12.5%. When we come to the Coleoptera, we see that the percentage of these in the Mesozoic and Tertiary has been quite stable in collections obtained during the past 20 years. The striking fact, of course, is the evenness of their relative abundance as fossil from the Mesozoic to the present, especially in contrast to the small percentage known in the

Permian. It is obvious, I think, that the jump from 1% in the Permian to 37% in the Mesozoic, is so great as to arouse one's suspicions as to the accuracy of the geological records of these insects. For my own part, I suspect that the fault lies with the Permian, not with the Mesozoic, and that a relatively larger number will be found in the Permian than we know at present; but it seems unlikely that the Permian ratio will ever approach that of the Mesozoic. The Diptera have likewise been constant in their occurrence in insect beds. It certainly does not seem logical that the Tertiary proportions, somewhere around 25% will ever be exceeded by those of the Mesozoic, which have not gone over 5%. Whether the Diptera were actually twice as abundant relatively in the Tertiary as they are at present, as our figures would indicate, is perhaps open to more question; there is certainly no reason why this order should not have attained its maximum during the Tertiary. When we pass to the Plectoptera or Ephemerids, we again find in the Mesozoic and Tertiary a stable list of percentages. The Tertiary figures are much lower than those of the Mesozoic, and would, in fact, require an increase of 600% to bring them to the same magnitude. The Permian percentage in the 1930 column are not quite twice those of the Mesozoic, so that it is perfectly possible that sometime we may have sufficient records to show that the may-flies were relatively more abundant in the Mesozoic than in the Permian. From the standpoint of comparative morphology, however, this is unlikely, for these insects are generally recognized as being the most primitive of any insects now existing. The Mesozoic and Tertiary records of the Blattids are also very constant, and since that of the Mesozoic is far ahead of the one in the Tertiary, we certainly cannot look for a reversal of the present ratios. The figures of all the geological periods point definitely to the conclusion that the cockroaches reached their highest development in the number of species during the Upper Carboniferous, and have been decreasing right down to the present time. Of all our records that of the cockroaches is the least open to radical change. The last order on our list, the Orthoptera, has turned up rather regularly in the various geological formations, and the percentage of the Mesozoic species is so far ahead of either the Permian or the Tertiary that we are justified in concluding that the order reached its maximum development during the Mesozoic.

For my own part, therefore, I believe that the above percentages, indicating the relative abundance of the species in each order during the several geological periods, is approximately correct for all the orders mentioned, except probably the Neuroptera and Coleoptera. On that basis, at any rate, we may separate the orders into several groups, based upon the time of the maximum development of the order. The Mecoptera, Homoptera, Psocoptera, Plectoptera, and Blattaria are alike in that they had reached their maximum by the Permian. This result is not at all surprising when we reflect that this is precisely what we should expect from the morphology of these insects. For a comparative study of their structure has demonstrated that every one of the orders mentioned is very primitive. It is probable, as I have noted above, that the Neuroptera belong to this series. The next group of orders, those which reached their highest development in the number of species during the Mesozoic, includes the Odonata and the Orthoptera. Here again we find this situation perfectly consistent with the results of comparative morphologists, for these two orders, while primitive in many respects, are a little more highly specialized than those which we have just considered. There remains, then, only a single order, the Diptera, which at present seems to have attained its peak during the Tertiary. And once more we are consistent in our conclusions with those of morphological studies, for the flies are more highly specialized than any of the orders included in the foregoing groups. In this discussion of the development of the insect orders, I have omitted any mention of the Perlaria or stone-flies, because just at present the geological record of these insects is much confused owing to difficulties in interpreting the venation. I have also omitted reference to certain other groups, such as the Heteroptera, Trichoptera, Lepidoptera, Isoptera, and Hymenoptera, none of which has been found in rocks older than the Mesozoic. All these appear to be younger groups, with a shorter and perhaps less completely known geological history than the ones which we have considered. Most of them seem to have increased in the number of species right up to the present time.

As I bring to a close this discussion of insect paleontology, I cannot resist a feeling of curiosity as to just what discoveries will take place during the next few years, and just how much our present conception of the geological history of the insects will have to be modified by the end of this next decade. I have already ventured to predict above that certain existing orders will some time be found in Carboniferous rocks, and have demonstrated that we must eventually find winged insects in the Lower Carboniferous and probably also in the Devonian. Just how soon this discovery will be made depends upon the coöperation which the entomologists receive from the geologists. For the student of fossil insects is, on the whole, utterly dependent upon the geologists not only to discover but also to collect his specimens. It is impossible to predict whether or not fossil insects will be found in any one deposit; consequently, their discovery can only be made by someone who is already occupied with the study of that particular formation from some geological aspect. And even when a formation is known to contain insects, these fossils are so scarce that usually it is not practical to work the beds for insects alone. Of course there are a few insect-bearing strata, such as the Wellington Shales of Kansas and the Florissant Shales of Colorado, which contain a sufficiently high percentage of insects so that an expedition of that nature is worth while. But these beds are exceptions. It is upon the geologist who is investigating some other aspect of the strata that we must depend for our fossils. For this reason it is particularly deplorable—and I make this statement with all due apologies to the few exceptions—that geologists have not favored us in late years with their needed coöperation. While recently visiting one of the larger eastern universities, I was much astonished to find in the possession of the geological department a splendid wing of a Paleodictyopteran, complete from the apex to the base, and showing every vein with gratifying clearness. The specimen was without locality label, and no one appeared to know just where it was collected; for several years the specimen had been used in the elementary geology class as an example of a fossil insect, and has passed thru so many inexperienced hands that all its brightness and freshness had gone! Let us therefore hope that the geologist, the paleobotanist, and other paleontologists, will be on the alert for fossil insects, and that once having found them, will place them in the hands of one who can give the fossils the necessary attention. Perhaps this is too much to expect in these days, when the vision of the average geologist is so obscured by petroleum; but by this means alone will we ever locate a Devonian or Mississippian winged insect,—a find which would contribute more to our knowledge of the origin of the class Insecta than any other single discovery.

A SECOND NOTE ON GESOMYRMEX

By William Morton Wheeler[1]

On his recent return from a sojurn of several years in the Philippines, Dr. James W. Chapman generously gave me a considerable portion of a colony of Gesomyrmex which he had had under observation at his camp (alt. 1500 ft.) near Dumaguete. The specimens are of unusual interest because they comprise not only a complete series of the various worker forms and therefore confirm the conclusions recorded in my former paper[2] on the identity of the genera Gesomyrmex and Dimorphomyrmex, but also the mother queen of the colony and an adult male. In the paper cited I endeavored to ascertain the characters of this sex from a young pupa of the Javan G. *kalshoveni* Wheeler, but examination of the specimen from the Philippines proves that my inferences from pupal structure were inadequate. Comparison of Dr. Chapman's queen with the female of G. *luzonensis* Wheeler shows that whereas both belong to the same species, the former represents an undescribed variety. Since the Luzon form is known only from a female specimen I shall have to compare the workers of the new variety with those of the closely allied *kalshoveni*.

Gesomyrmex luzonensis var. **chapmani** var. nov.

Worker maxima.—Length 6.5-7 mm.

Distinctly larger and more robust than the maxima of G. *kalshoveni* and of a deeper, more reddish yellow color, with a large spot on the ocellar region and the discal, or

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 332.

[2] The Identity of the Ant Genera Gesomyrmex Mayr and Dimorphomyrmex, Ernest Andre'. Psyche 36, 1929, pp. 1-12, 1 fig.

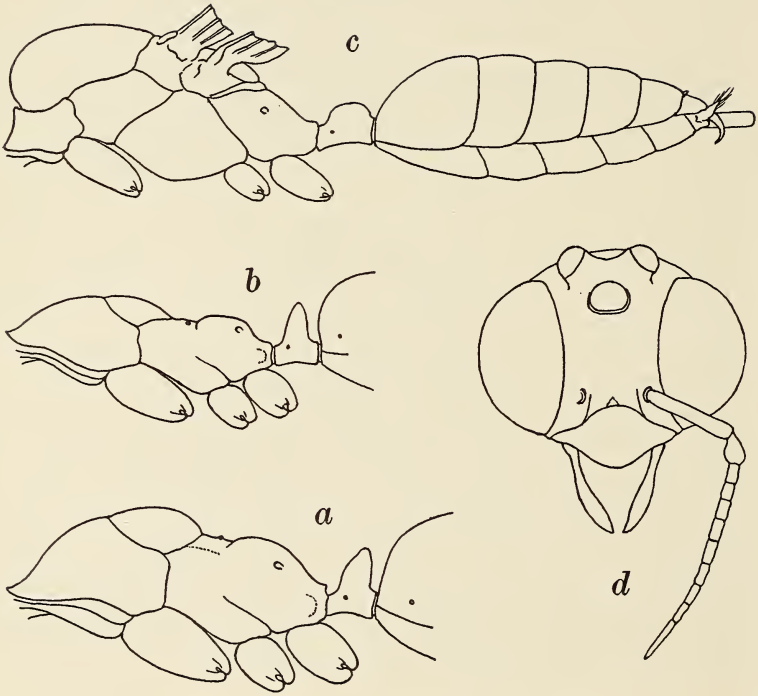

Fig. 1. *Gesomyrmex luzonensis* Wheeler, var. *chapmani,* var. nov. *a,* thorax and petiole of worker maxima in profile; *b,* same of worker minima; *c,* thorax and abdomen of male; *d,* head of male, dorsal view.

central portion, of the pronotum dark brown. In some specimens the pleuræ and epinotum are reddish brown. Basal portions of the several gastric segments distinctly brownish. Mesonotum broader than long and much more convex than in *kalshoveni*. Petiole thicker above and less distinctly cuneate.

Worker media.—Length 4.5-6 mm.

The larger specimens are as large as the maximæ of *kalshoveni* and differ from them only in their deeper yellow coloration, in having the spot on the vertex and the disc of the pronotum brown, though paler than in the maxima, and in the thicker and blunter petiolar node. In the smaller specimens the brown on the vertex and pronotum becomes fainter or disappears altogether.

Worker minima.—Length 2.5-3.5 mm.

Without dark markings and very similar to the minima of *kalshoveni*, but with the petiolar node distinctly thicker, less compressed above and therefore less cuneate in profile. The general yellow color of the body seems to be somewhat darker.

Female (deälated).—Length nearly 9 mm.

Closely resembling the female of *luzonensis* in structure, pilosity and sculpture but differing in coloration. Paler and more ivory yellow, with a large rhomboidal spot on the middle of the head, covering more than the ocellar region, the wing insertions and the discal portions of the pronotum and epinotum dark castaneous brown. Dorsal surface of the same color, with the borders of the segments and a transverse band at the base of the first segment yellow.

Male.—Length 3.6 mm.

Head small, including the large, convex eyes somewhat broader than long, broadly rounded behind, with extremely short cheeks. Ocelli large and prominent. Clypeus somewhat broader than long, convex in the middle, anteriorly produced as an entire, rounded lobe. Mandibles small, slender, edentate, subspatulate. Frontal area very small, triangular; antennæ short and slender, 11-jointed; scapes cylindrical, nearly as long as the four basal funicular joints together; first funicular joint swollen, ellipsoidal, one and one-half times as long as broad, remainder of funiculus tapering, joints 2-9 subequal, about one and one-half times as long as broad, terminal joint narrower, as long as the two penultimate joints together. Palpi long, maxillary pair 6-jointed, labial pair 4-jointed. Thorax broad and robust anteriorly, gradually narrowed behind, the pronotum short, with raised posterior border; mesonotum broader than long, broader than the head, strongly convex in front and somewhat overhanging the pronotum. Scutellum large, but not very convex. Epinotum small, narrower behind than in front, with rather flat, sloping dorsal surface, without differentiated base and declivity. Petiole resembling that of the female, nearly as long as broad, subrectangular from above, in profile with a thick, broadly and evenly rounded node, and feebly concave ventral surface. Gaster small, slender and elongate; cerci present; genital appendages exserted, the stipites small, spreading, subtriangular, acutely pointed and pilose, the volsellæ slender, falcate and deflected; sagittæ much larger, longer than broad, parallel-sided, with truncated tips. Legs slender; hind femora slightly bowed; tarsal claws large.

Smooth and shining, very indistinctly and finely shagreened.

Pilosity white, delicate, almost absent on the head and thorax; erect and more abundant on the petiole and gaster, especially on the former; appendages with sparse, appressed pubescence; funiculi with short oblique hairs.

Sordid or brownish yellow; head dark brown; mesonotum and scutellum pale brown. Wings yellowish hyaline, with pale yellow veins and pale brown pterostigma.

Described from a series of 43 workers, a single female and single male, all from the same colony, captured by Dr. J. W. Chapman at Dumaguete, Negros Oriental, P. I.

A study of the male of this ant has led me to reverse my opinion in regard to the specimen which Mayr regarded as the male of his *G. hoernesi* from the Baltic Amber. Apart from its much greater size and its smaller mandibles, petiole and genital appendages, his specimen would, after all, seem to be a true male Gesomyrmex. The head, antennæ, thorax and wings are very much like the corresponding parts of the above-described male of *chapmani*, and the discrepancies in the other parts are perhaps attributable to defects in Mayr's figure. It is not so easy to make an accurate drawing of an insect embedded in a block of fossil resin as it is of one carded or pinned.

The specimens of the new variety were accompanied by Dr. Chapman's notes which are worth quoting, because they contain the first observations on the habits of Gesomyrmex.[1]

"May 11, 1924, at 8 A. M., while sitting on our azoteo, I noticed on the balustrade a honey-colored ant which arrested my attention by its peculiar jerky, zigzag gait and unusually large dark eyes. On capturing it I found it to be a small worker of Gesomyrmex! Then a few others were seen running about in the same place. I smeared some ripe banana in their path on the railing and found that they at once proceeded to gorge themselves with the juices. They eventually moved away and I followed them down a banister and along the sill to one of the large posts which serve as supports of the house. From this post they passed to a pole, which I had placed diagonally between two of the posts, to serve as a brace. They descended this for a foot or more and together entered a hole in its surface. There were other workers within the entrance but they could not be induced to come out. During the day several workers were seen to visit and feed on the banana. The last one retired to the nest at 5 P. M., apparently for the night.

"The pole containing the nest was about eight feet long and was two and one-half inches in diameter where the nest was situated. The entrance consisted of four small, slit-like holes, close together and resembling the orifices of beetle burrows. The pole had been cut about two weeks previously on the mountain side behind the house from a particular

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[1] Dr. Chapman also sent me a series of drawings of the various worker castes of *G. chapmani* to illustrate the identity of Gesomyrmex and Dimorphomyrmex. I have not reproduced these drawings because they are so much like those in my paper on *G. kalshoveni*.

tree, which was selected because it is known to be very resistant to the attacks of termites.

"May 12 and 13 the workers continued to visit the ripe banana in small numbers. I failed to excite the colony or to bring out any of the workers by pushing a straw into their nest entrances, by pounding on the pole or blowing into the cavity. On the evening of May 13 I decided to open the nest and therefore placed the pole on a large collecting canvas, filled the entrances with alcohol and carefully split the wood. The four entrances were seen to unite to form a single funnel-like passage, which grew narrower towards the end of the pole and opened into the middle of the main nest-cavity. This was about five inches long and one and a quarter inches from the surface. The two ends of the cavity were rounded out and the wood around the excavated pithy center had been gnawed away to form several irregular galleries. The colony had evidently been nesting in these cavities for some time. The wood was green and solid. There were about 150 adult workers, their queen, male and a number of eggs and larvæ."

These observations antedate and add materially to those of Dr. Kalshoven on *G. kalshoveni* cited in my first note.[1]

We may conclude from them that the colonies of Gesomyrmex are monometrotic, or possess a single mother queen, that they are not very populous and nest in sound wood. Like other lignicolous ants they probably take possession of the abandoned burrows of other insects and enlarge them by tunnelling in the wood as the colony grows. Dr. Chapman's observations show that the smaller and more numerous workers do most of the foraging, have a peculiar, jerky, zigzag gait and are very timid. He has not observed the guarding of the nest-entrances by the largest workers, though he seems to have seen workers stationed just within the entrance gallery.

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[1] Note on Gesomyrmex. Psyche, 36, 1929, pp. 91, 92.

TWO NEW GENERA OF ANTS FROM AUSTRALIA AND THE PHILIPPINES

By William Morton Wheeler[1]

Chapmanella gen. nov.

Worker: Integument rather thin, smooth and hairy. Head elongate, high in the frontal region, depressed and narrowed behind, without posterior corners. Eyes very small but distinct, placed well up on the dorsal surface near the middle of the sides. Ocelli absent. Mandibles narrow, decussating, with oblique, dentate apical borders. Clypeus rather large, not extending back between the frontal carinæ, which are very short, poorly developed and not very far apart. Frontal area and groove absent. Palpi short, the labial pair 4-jointed, the maxillary pair apparently 6-jointed, with the terminal joint much shorter than either of the two subequal preceding joints. Antennæ very long and slender, 12-jointed, inserted near the posterior corners of the clypeus; funiculus filiform, scarcely thickened apically. Antennal and clypeal foveæ not confluent. Thorax long and slender, with distinct promesonotal and mesoëpinotal sutures. Anterior portion of mesonotum narrow and subcylindrical; mesosterna convex and somewhat swollen anteriorly. Metanotal spiracles prominent, closely approximated, on the dorsal surface just anterior to the base of the epinotum, which is small, short and unarmed, with its spiracles situated on each side at the angle between the base and declivity. Petiole small and elongate, with a low, erect node at its anterior end. Gaster moderately large, with short first segment, which is convex anteriorly but does not overlie the petiole. Legs

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 333.

very long and slender; middle and hind tibiæ without spurs; tarsal claws slender and simple.

Genotype: *Chapmanella negrosensis* sp. nov.

Chapmanella negrosensis sp. nov.

Worker.—Length 4 mm.

Head longer than broad, subelliptical, broadest through the middle where the small eyes, consisting of only about 16 ommatidia, are situated, the occipital border concave. Antennal scapes straight, extending more than half their length beyond the occipital border; all the joints of the funiculus except the last, subequal, nearly three times as long as broad, the last joint somewhat pointed, as long as the two penultimate joints together. Mandibles 6-toothed, the terminal tooth long and curved, the remaining teeth

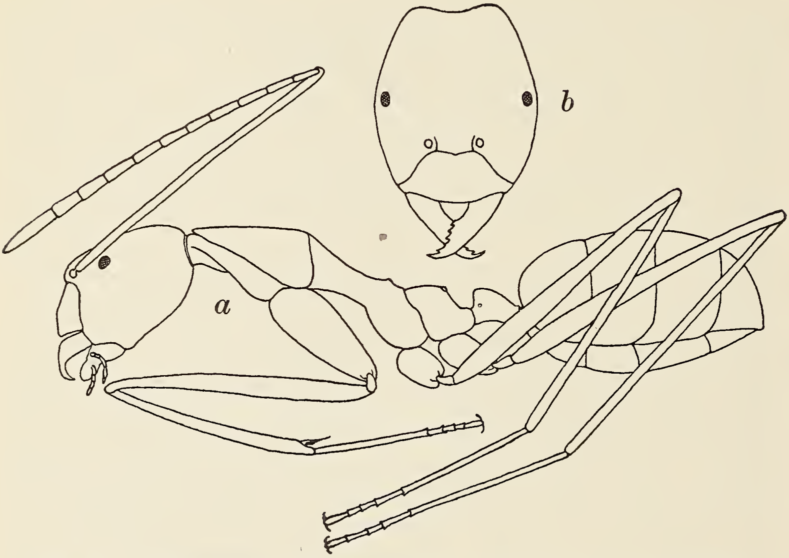

Fig. 1. *Chapmanella negrosensis* gen. et sp. nov. *a,* Worker, in profile; *b,* head of same, dorsal view.

oblique, subequal, except the third from the apex, which is distinctly smaller. Clypeus convex, bluntly subcarinate in the middle, its anterior border broadly rounded and entire. Pronotum from above elliptical, one and one-half times as long as broad, with evenly rounded sides, its dorsal outline in profile nearly straight and horizontal. Mesonotum as long as the pronotum, its subcylindrical anterior portion long, slightly concave laterally, dorsally and ventrally, descending to the posterior portion which embraces the sides of the epinotum. The projecting metanotal spiracles interrupt the dorsal outline near its posterior end. Mesoëpinotal constriction short and feeble. Epinotum broader than long, in profile with straight base and declivity, meeting at an obtuse angle. Petiole longer than broad, broader in front than behind, the node in profile perpendicularly truncated anteriorly, rounded above, with its posterior surface gradually descending with even convexity to the posterior end of the segment. Legs very long and slender.

Smooth and shining; body, scapes and legs very delicately and indistinctly shagreened, with sparse piligerous punctures; mandibles less shining, very finely punctate-striate.

Pilosity yellowish, bristly, of uneven length, erect and moderately abundant, long on the body, shorter and more oblique but coarse also on the scapes and legs. Pubescence undeveloped.

Yellow, the legs and antennæ scarcely paler; mandibles more reddish with black teeth.

Described from a single specimen taken by Dr. J. W. Chapman, April 7, 1927, at Dumaguete Negros Oriental, Philippine Islands. This specimen, which superficially resembles an *Anoplolepis longipes* Jerdon, formed a portion of the prey captured by an army of *Ænictus læviceps* F. Smith. The remainder of the prey comprised a worker of *Ischnomyrmex longipes* F. Smith, and two workers and several larvæ of *Polyrhachis (Myrma) mayri* Roger. The head of the Chapmanella had been crushed and the tip of its gaster bitten off by its captors, so that the conformation of these regions may be inaccurately represented in the figure.

The genus Chapmanella appears to be most closely related to Prenolepis and Paratrechina, as redefined by Emery, but is peculiar in the vary small size of the eyes, the short palpi, the unmodified base of the gaster, the shape of the petiole, the extremely long appendages and the absence of spurs on the middle and hind tibiæ. The pale color, small eyes, very long appendages and long pilosity of this ant indicate that it must be hypogaeic in habit. This might explain why it has not been taken heretofore and why the *Ænicti,* which forage more or less subterraneously, were able to reveal its existence.

The following is another undescribed genus belonging to the same tribe (Lasiini) of the subfamily Formicinæ.

Aphantolepis gen. nov.

Worker: Resembling Prenolepis in the structure of the head, thorax and gaster, but with somewhat harder integument. Eyes of moderate size; ocelli absent. Mandibles small, triangular, decussating, with finely dentate apical borders. Clypeus short, not extending back between the frontal carinæ, which are distinct, subparallel and as far apart as their distance from the lateral borders of the head. Frontal area and groove obsolete. Antennæ rather stout, 12-jointed, the funiculi but slightly enlarged towards their tips. Antennal and clypeal foveæ confluent. Palpi long, maxillary pair 6-jointed, with thickened basal and elongate terminal joint; labial pair 4-jointed. Thorax with deep mesoëpinotal constriction, dorsally approximated and protruding spiracles and prominent, highly placed epinotal spiracles. Petiole flattened above, without a node. Gaster rather large, its first segment truncated anteriorly and in life evidently overlying the petiole. Middle and hind tibiæ with well-developed spurs; tarsal claws simple.

Genotype: *Aphantolepis quadricolor* sp. nov.

Aphantolepis quadricolor sp. nov.

Worker—Length 2.7 mm.

Head slightly longer than broad, distinctly narrowed anteriorly, with broadly rounded posterior corners and entire posterior border. Eyes moderately large and convex, placed a little in front of the middle of the sides of the head. Surface of clypeus rather flat, slightly projecting but scarcely subcarinate in the middle, the anterior border transverse, feebly sinuate on each side. Mandibles with nearly straight external and somewhat oblique apical borders, the latter with seven small, acute teeth, which are somewhat crowded and subequal, except the basal and third tooth from the apex, which are smaller. Antennal scapes extending nearly one-third their length beyond the posterior border of the head; first funicular joint twice as long as broad, nearly as long as the two succeeding joints together; joints 2-10 only slightly longer than broad, the terminal joint as long as the two penultimate joints together. Pro-

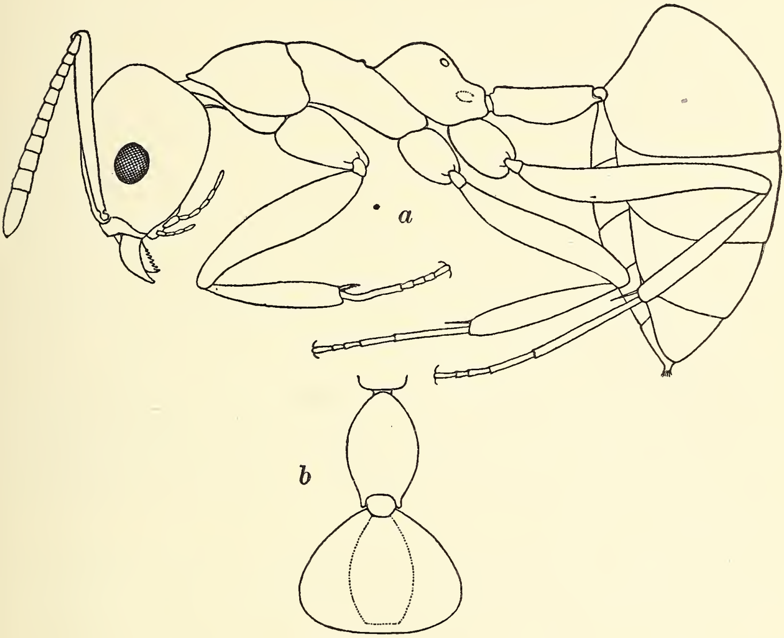

Fig. 2. *Aphantolepis quadricolor* gen. et sp. nov. *a,* Worker, in profile; *b,* petiole and anterior portion of first gastric segment, dorsal view.

notum from above trapezoidal, broader than long, broader anteriorly than posteriorly, in profile feebly convex above. Mesonotum much narrower than the pronotum, slightly longer than broad, as broad in front as behind, with subparallel, slightly concave sides, in profile rounded and sloping backward to the pronounced mesoëpinotal constriction. Epinotum broader than long, subrectangular from above, slightly broader behind through the prominent spiracles than in front; in profile with very convex, rounded base passing without an angle into the shorter, concave declivity. Petiole small, nearly twice as long as broad, from above regularly elliptical, except at the posterior border where it is excised for the articulation of the gaster. A very feeble trace of the absent node is represented by the narrowly rounded anterior end of the flat dorsal surface; the ventral surface is distinctly convex. Gaster broad anteriorly, rapidly tapering and pointed posteriorly, the anterior truncated surface of the first segment longitudinally impressed in the middle for the accommodation of the petiole. Legs rather stout.

Smooth and shining, especially the dorsal surface of the head, the pronotum and the gaster, meso- and epinotum more subopaque, very finely and densely punctate or reticulate. Mandibles smooth, with a few scattered piligerous punctures.

Erect hairs brownish, pointed, few in number, of unequal length, arranged as pairs of macrochætæ on the head, pro- and mesonotum as in some species of Paratrechina (subgen. Nylanderia). Gaster both dorsally and ventrally with similar but shorter hairs, and the head and gaster also with more numerous short, suberect hairs or coarse pubescence. Antennal scapes and legs with pale, long, oblique, rather abundant pubescence.

Head and thorax yellowish red, the former a little darker, with a fuscous cloud on the vertex. Manibles, petiole, legs, scapes and first funicular joint clear yellow; remaining funicular joints dark brown; mandibular teeth and gaster black; terminal tarsal joints reddish.

Described from a single specimen taken by Mr. A. M. Lea in the Cairns District, Queensland, Australia, "among fallen leaves."

This beautiful little ant may be readily recognized by its very peculiar nodeless petiole, which is unlike that of any known Formicid. In other respects it very closely resembles certain species of Prenolepis and Paratrechina (of the subgen. Euprenolepis). Until the female and male have been discovered it will be difficult to decide whether Aphantolepis is to be regarded as an independent genus or as a subgenus of Paratrechina.

TWO MERMITHERGATES OF ECTATOMMA

By William Morton Wheeler[1]

Since the publication in 1928 of my review of the modifications induced by Mermis parasites in various species of ants, two additional cases have been reported, one by Strelnikov (1928) in a Ponerine ant, *Pachycondyla striata,* from Paraguay, and one by myself (1929) in a Formicine ant, *Camponotus (Tanæmyrmex) punctatus* from Argentina. Two other interesting mermithergates have just come to light among some ants collected by Mr. Nathan Banks and Mr. P. J. Darlington. One of these belongs to the typical *Ectatomma tuberculatum* Olivier, the other to its variety *punctigerum* Emery. As long ago as 1890, Emery (1890 *a*) mentioned a peculiar worker of the typical *E. tuberculatum,* which we now know must have been a mermithergate, but he merely cites it as "analogous" to a similar specimen of *Neoponera villosa* with small head and voluminous abdomen.

The mermithized specimen of the typical *E. tuberculatum* was taken by Mr. Banks on July 15, 1924, near the tropical laboratory on Barro Colorado Island, Panama. It measures nearly 16 mm. and is of the same brownish ferruginous color as normal workers from the same locality, but with the gaster distinctly darker. The head is smaller and narrower, with scarcely an indication of the posterior angles and with very slightly larger and more convex eyes. Ocelli lacking. Antennal scapes extending half their length beyond the posterior corners of the head and the mandibles slightly narrower. Thorax shaped as in the normal worker but slightly less robust, with distinct, blunt teeth on the epinotum. Petiolar node more strongly compressed anteroposteriorly. Postpetiolar and gastric segments, especially

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 334.

the first, enlarged and distended with Mermis. Legs decidedly longer than in the normal worker.

Head sculpture peculiar in that the longitudinal rugæ are finer, closer together and decidedly more numerous on the front than in the normal worker. The reticulate rugæ on the sides of the vertex in the latter are also replaced by such longitudinal rugæ. Thoracic sculpture as in the normal worker. Petiolar node transversely rugulose and not irregularly rugose above. Postpetiole and gaster more opaque throughout, finely and densely striate, with a satiny lustre; the striæ transverse and converging behind on the postpetiole, longitudinal on the gastric segments. Venter more shining but very finely and transversely, though more superficially striate throughout. The sculpture of the abdomen therefore resembles that of the normal worker *tuberculatum.* The pilosity of the mermithergate is quite normal.

Although the typical form of *E. tuberculatum* is a common ant over a large portion of the Neotropical Region from Southern Mexico to Southern Brazil, its two varieties, *acrista* Forel and *punctigerum* Emery have a much more restricted distribution. The var. *acrista* is known only from Paraguay; Emery (1890 *b*) described *punctigerum* from a couple of workers taken by Simon at San Esteban, Venezuela. It is certainly the common, if not the only form of the species in Trinidad, where it has been taken by Prof. R. Thaxter and myself, and Dr. George Salt and Mr. Darlington brought me specimens of it from Northern Colombia. The worker differs from that of the typical *tuberculatum* in coloration, being decidedly darker and more brownish, and in the sculpture of the postpetiole and first gastric segment, the coarse, sparse punctures on which are larger, more impressed and interrupt the striated sculpture. Moreover, the striation on the first gastric segment is much feebler than in the typical *tuberculatum* and becomes obsolete on the sides, so that the whole segment is decidedly smoother and more shining. The female *punctigerum* (undescribed) is scarcely paler than the worker, with very similar abdominal sculpture though in some specimens the striation on the first gastric segment is even

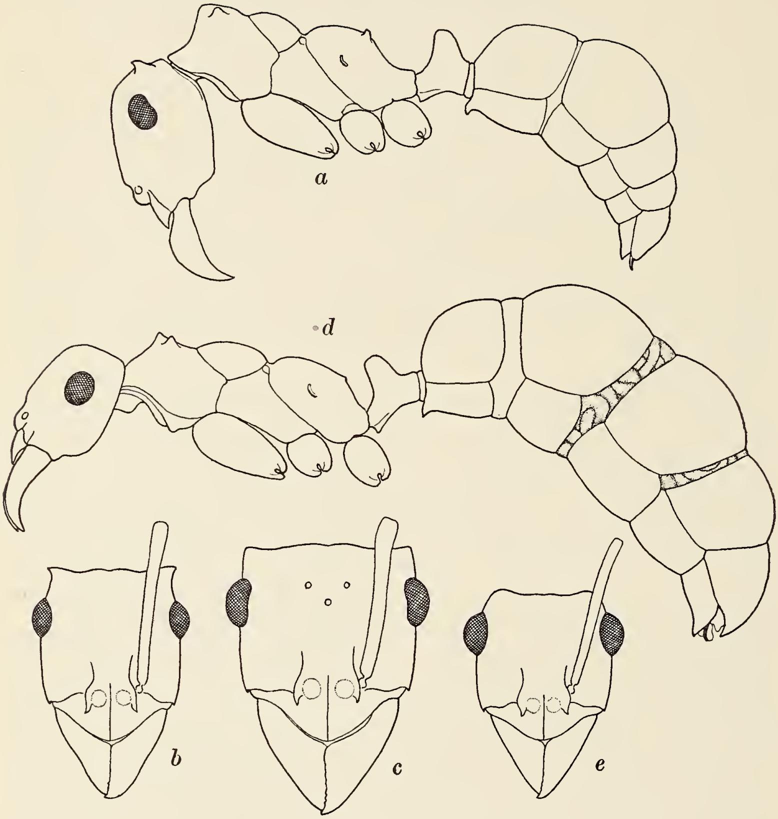

Fig. 1. *Ectatomma tuberculatum* Olivier var. *punctigerum* Emery. *a,* normal worker in profile; *b,* head of same, dorsal view; *c,* head of normal female; *d,* mermithergate in profile; *e,* head of same.

feebler and the surface, therefore, even smoother and more shining.

The *punctigerum* mermithergate (Fig. 1d,e) was captured by Mr. Darlington on April 20, 1920 at St. Augustine, Trinidad, together with three normal workers of the variety. Were it not for this association the specific identity of the parasitized specimen might be doubtful, though its cephalic and thoracic sculpture is clearly of the *E. tuberculatum* type. The specimen measures 16.6 mm. in length and is longer than the average normal worker which measures only about 10-12.5 mm., but the proportions of the head, thorax and abdomen are very different. In the mermithergate the head measures only 3.2 mm. in length, including the mandibles, the thorax 4 mm., the abdomen 9.4 mm. The corresponding measurements of the normal large worker are: head 3.5 mm., thorax 4.5 mm., abdomen 4.5 mm. Though the head and thorax resemble those of the normal worker they are therefore decidedly smaller and more slender. The head, excluding the mandibles, is nearly square, very slightly longer than broad, with very feebly rounded sides and the posterior angles merely rounded-rectangular and not sharply rectangular or even distinctly cornuate as in the normal worker. Eyes larger, more protuberant, nearly hemispherical. There are no traces of ocelli. Antennal scapes extending nearly half their length beyond the posterior corners of the head (only two-fifths in the normal worker), mandibles somewhat narrower. Besides its smaller and more slender dimensions the thorax differs from that of the normal worker in having the lateral tubercles of the pronotum more acute and less auriculate, the median tubercle or projection narrower and more sharply defined. The base and declivity of the epinotum form a less distinct obtuse angle and the epinotal teeth are reduced to mere denticles. Petiole very similar to that of the normal worker but the node slightly more compressed anteroposteriorly. Postpetiole and gaster much larger and more voluminous, owing to their containing a large Mermis, the compact coils of which are visible through the distended intersegmental membranes. The hypertrophy affects not only the postpetiole and first gastric segment but also the deflected second, third and fourth gastric segments, which in the normal worker and even in the female are much shorter and telescoped into one another. Anteroventral projection of the postpetiole less developed than in the normal worker and female; legs as long as those of the former.

Sculpture peculiar; the longitudinal rugæ on the front and vertex decidedly less coarse, denser and more numerous than in the normal worker, with the reticulate rugæ between the front and eyes also much finer; rugules on the median portion of the clypeus more numerous; striæ on the mandibles somewhat coarser. On the thorax the rugæ are distinctly finer and more definitely transverse; those on the posterior portion of the pronotum also transverse, not coarse and irregular as in the normal worker. The rugæ on the petiolar node are finer and symmetrical. On the postpetiole and gaster the sculpture is quite unlike that of *E. tuberculatum* and much like that of *E. quadridens* Fabr., the tergites of all the segments being finely and regularly striate, so that the surface is subopaque, with a faint satiny lustre. The striæ on the postpetiole are arcuate anteriorly, longitudinal in the middle and transverse posteriorly; on the first gastric segment longitudinal anteriorly and transverse behind; on the second and third gastric segments transverse and more oblique on the sides. The fourth segment is more shining, with finer and less distinct striæ. The coarse punctures on the postpetiole and first gastric segment are small, inconspicuous and scattered, as in *E. quadridens* and therefore very different from those of *punctigerum* or the typical *tuberculatum*.

Pilosity as in the normal *punctigerum* worker, but less abundant, especially on the abdomen.

Coloration decidedly darker; dark brown, almost blackish, with brownish yellow clypeus and mandibles, the former streaked with fuscous in the middle, the latter fuscous externally. Femora, terminal tarsal joints, tips of scapes, apical halves of antennal funiculi and borders of gastric segments reddish brown; a spot on the middorsal region of the postpetiole and one on the corresponding region of the first gastric-segment more yellowish.

The specimens described in the preceding paragraphs are obviously modified workers, without any perceptible female (queen) characters. Even the enlargement of the abdomen is quite unlike that of the normal Ectatomma female, since in this caste the gaster is shaped like that of the worker, though more voluminous, especially in the region of the postpetiole and first gastric segment. The mermithergates are interesting for two reasons, first, because they so clearly illustrate the compensatory decrease in the size of the head and, in Darlington's specimen, also of the thorax as a result of the hypertrophy of the abdomen, which harbors the Mermis, and second, on account of their close resemblance in coloration, abdominal sculpture, and, I may add, also in the shape of the posterior portion of the head, to another species of the same genus, *E. quadridens.* This singular resemblance may, I believe, be most readily explained on the supposition that the specific characters of *quadridens* are probably more nearly those of the ancestral species of Ectatomma and that in the mermithized specimens these characters have been activated as a result of metabolic disturbances set up during metamorphosis by the parasite. To have produced such a pronounced effect on the characters of the adult ant, the young nematode must have entered its body cavity during the larval stage. Recently Vandel (1927) has maintained that in *Pheidole pallidula* infection of the prepupa by the Mermis is sufficient to produce a mermithergate, but his evidence for this contention is very meager. I have called attention to the fact (1928) that the larvæ of the Ponerinæ and Formicinæ (Lasius) spin cocoons before the prepupal stage and that it is therefore very improbable that the young nematode would wait to bore through a tough envelope when it could so easily and directly enter the unprotected, thin-skinned larva. That this is actually what happens, has been shown by Dr. N. A. Cobb, our well-known authority on the nematodes, who writes me that he has found the larva of *Allomermis myrmecophila* Bayliss—"in the body cavity of a queen grub of the dark-colored Lasius from Falmouth, *Lasius niger neoniger.*" Falmouth, Massachusetts, is the locality in which Dr. A. H. Sturtevant found the many mermithized queens (mermithogynes) of Lasius described in my paper of 1928.

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A NEW PARASITIC CREMATOGASTER FROM INDIANA

By William Morton Wheeler [1]

For many years I have suspected that some of the species of the huge, cosmopolitan ant-genus Crematogaster might prove to be social parasites. My grounds for this suspicion were the fact that one common Neotropical form, *C.* (*Orthocrema*) *limata* F. Smith subsp. *parabiotica* Forel commonly lives in parabiosis with *Camponotus* (*Myrmothrix*) *femoratus* Fabr. and *Dolichoderus* (*Monacis*) *parabioticus* Forel, and the fact that the females of certain subgenera, notably those of Crematogaster *sens. str.* (as shown in the type of the genus, *C. acuta* Fabr.), Nematocrema and Atopogyne, have small subtriangular gasters like those of the workers and unlike the voluminous, suboblong gasters of the females in other subgenera. This small size and worker-like aspect of the female gaster is, of course, a sign of underdevelopment of the ovaries and an indication that the female may be parasitic, or in other words, adapted to invading and securing adoption in a flourishing colony of some allied species in order to provide for the maturation of her ovarian eggs and the rearing of her offspring.

That a parasitic Crematogaster has probably been found at last, not in the tropics but in our own country, is suggested by a study of some specimens sent me for identification by Professor C. H. Kennedy. They comprise 43 workers and 7 black winged females which undoubtedly belong to a form of our common acrobat ant, *Crematogaster* (*Acrocoelia*) *lineolata* Say (near var. *cerasi* Fitch, but darker), together with 14 females and six males of a distinctly different species. The females of the latter are very small and have the head, thorax and pedicel red as in the

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 335.

subsp. *laeviuscula* Mayr (with the vars. *clara* Mayr and *californica* Emery) common in the Gulf States and California. The six males seem to be cospecific with the small females, since their wings are of the same color and also like those of *laeviuscula.* All the forms cited above were taken Sept. 22, 1929 in Robinson Park, Fort Wayne, Indiana, by Professor Kennedy from the same nest, which, he says (*in litt.*) "was large and under the loose bark of a cottonwood log. It contained workers, males, large brownish-black queens and *many smaller shining red and black queens.* These latter queens were a shining cherry red and a pitch black in life and acted differently from the ordinary queens. My memory is that they were more active. They were so different that I cannot believe they are the same species."

The specimens and Professor Kennedy's notes suggest the following reflections:

1. The colony might be said to represent a distinct and hitherto unknown variety of *C. lineolata,* characterized by having dimorphic, or A— and B— females, like *Lasius (Acanthomyops) latipes* Walsh of North America and *L.* (*Dendrolasius*) *spathepus* of Japan. This is very improbable, if, as I believe, the males belong to the small red and black females.

2. It is much more probable that these females and the males represent a distinct species parasitic in a flourishing *C. lineolata* colony, but this again suggests the question as to whether the parasite possesses a worker caste or is workerless like such ants as *Anergates, Anergatides, Epoecus* and *Wheeleriella.*

3. The absence of any workers other than those of the common *lineolata* in the material examined strongly indicates that the parasitic species is represented only by females and males, as in the genera just mentioned.

4. If this interpretation is adopted we must suppose that the parasitic Crematogaster is phylogenetically a comparatively recent off-shoot of the host species, *lineolata,* because its morphological modifications are so feeble. In this respect it resembles such perma-

nent social parasites as *Vespa austriaca* and *arctica* among wasps, the species of the genus Psithyrus among bumble bees and those of the genera Wheeleriella and Epoecus among ants, rather than Anergates and Anergatides, in which the modifications due to parasitism are so considerable.

5. There is only one consideration that would seem to cast doubt on the interpretion of the small red and black females and their males as workerless parasites and that is the presence of perfectly developed virgin *lineolata* females in the same nest, because we should expect the mother queen of the host colony to have been eliminated just after the intrusion of the parasite and hence to have been incapable of leaving either female or worker offspring. It is conceivable, however, either that the mother queen of the new Crematogaster may manage to secure her own adoption and the rearing of her offspring in the *lineolata* colony without supplanting its mother queen, or that the suppression of the latter may be greatly delayed and the rearing to maturity of her female offspring be permitted by the worker personnel.

6. That the small red and black females are parasites and are fertilized in the nest (as in *Anergates atratulus,* though this form has wingless, pupa-like males, so that a marriage flight is out of the question) is indicated by the fact that the 14 specimens are in part winged and in part wholly or partially deälated, whereas the seven females of *lineolata* show no indications of losing their wings. And though Miss A. M. Fielde found that mating may take place in the nest in our common *lineolata,* the conditions in Professor Kennedy's colony suggest that the red and black females are more precocious than the winged females of their host. The differences in the behavior of the two kinds of females, noticed by Professor Kennedy, are also very suggestive in this connection.

As shown in the following description, the female of the new Crematogaster may be readily distinguished from the female of *lineolata* or of any of its various subspecies and varieties, but the male has departed so little from that of its host, that its characters are rather elusive. This is not surprising since the male is the conservative sex among the Formicidæ.

Crematogaster (Acrocoelia) kennedyi sp. nov.

Female.—Length 5-6 mm.; forewing 5 mm.

Decidedly smaller than the females of *lineolata,* its subspecies *laeviuscula* Mayr, *coarctata* Mayr, *etc.*, which measure 8-9 mm., with the anterior wings 7-7.5 mm. Head less narrowed anteriorly and more rectangular, owing to the sides being straight and the posterior corners less rounded. Antennæ longer, the scapes extending a distance equal to their greatest diameter beyond the posterior corners (not reaching the posterior corners in *lineolata*). Thorax shorter and stouter, the mesonotum being nearly as broad as long (decidedly longer than broad in *lineolata*), the epinotal spines more acute and acuminate, and the base of the epinotum external to the spines conspicuously swollen. Dorsal surface of petiole more convex, with straight instead of concave anterior border, its sides less converging posteriorly; postpetiole more broadly grooved or impressed in the middle behind. Gaster much shorter in proportion to its width, less parallel-sided, more subtriangular and therefore more like that of the worker *lineolata.* Legs rather short.

Even smoother and more shining than the subsp. *laeviuscula.* Mandibles coarsely striato-punctate. Head very finely striated anteriorly, rather sparsely and finely punctate behind; thorax and gaster with similar but even sparser punctures; mesopleuræ and sides of epinotum less shining than the mesonotum, scutellum, postpetiole and gaster, longitudinally rugulose; petiole subopaque, very finely granular. Antennal scapes and legs distinctly punctate.

Hairs glistening, yellowish, erect or suberect, much more abundant, much shorter and of much more even length on the head, thorax and gaster than in *lineolata,* and conspicuously long and abundant on the petiole and postpetiole.

Hairs on the scapes and legs slightly longer and less appressed than in *lineolata.*

Head, thorax, pedicel, coxæ and femora and more or less of the venter of the first gastric segment bright yellowish red, more vivid than in the female of the var. *clara* Mayr of the subsp. *laeviuscula.* Gaster scutellum, metanotum and three large elongate spots on the metanotum, one anteromedian, the others parapsidal, jet black; mandibles, antennæ, tibiæ, knees and tarsi darker and more brownish red; bases and sometimes the whole of the scapes, the tips of the funicular clubs, the ventral portions of the mesosterna, the inner border of each ocellus and the posterior corners of the head, more or less blackened or infuscated. Wings whitish hyaline, the pterostigma and anterior veins of the forewings very faintly yellowish, the remaining veins colorless.

Male.—Length 4 mm.

Very similar to the male of *lineolata* but somewhat more slender; gaster, especially, much narrower and more elongate. Mandibles more linear and narrower, furnished with three more distinctly equal denticles. Funicular joints apparently a little more cylindrical and less monillate. Pronotum distinctly less convex anteriorly and less overarching the pronotum. Epinotum more rounded with less distinct base and declivity and no indications of teeth, except in one of the six specimens.

Somewhat smoother and more shining than the male of *lineolata* and more like that of *laeviuscula.* Mesonotum very finely and rather indistinctly striated and sparsely punctate.

Hairs whitish, almost lacking on the head, thorax and gaster, where they are present, though sparse, in *lineolata;* gaster and legs merely with short, sparse, appressed pubescence; antennæ and genital appendages with short, erect or suberect, very dense white pubescence.

Jet black; mandibles, gaster, antennæ, legs and alar insertions dark brown. Wings whitish hyaline with the pterostigma and anterior veins of forewings even more feebly tinged with yellowish than in the female; remaining veins colorless.

In conclusion I would suggest that those who encounter flourishing colonies of our common *C. lineolata,* especially during the late summer, scrutinize their various castes with great care and, in the event of again finding the small red and black females of *C. kennedyi,* keep them in artificial nests and observe their adoptive behavior in uninfested colonies of *lineolata* with and without their mother queens.

AN UNUSUAL NEST OF POGONOMYRMEX[1]

By George S. Tulloch

During 1919 Professor Harlow Shapley, while collecting in the vicinity of Pasadena, California, discovered a nest of *Pogonomyrmex californicus* Buckley in which a large number of the worker-like forms possessed vestiges of wings. Professor Shapley noted this unusual occurrence of workers possessing vestigial wings (1920, 1921) and considered them to be pterergates following the term suggested by Dr. Wheeler (1903). Of 1737 worker-like forms taken from this nest during 1919 and 1920, 740 were found to possess vestigial anterior wings or the stubs of broken fore wings. Four ants were noted which possessed vestiges of both fore and hind wings—"a phenomenon not heretofore recorded, as only anterior wings are represented in all other pterergates." There appeared to be no obvious reason why this particular nest should present such an anomalous condition as the intermittent war with the Argentine ant (*Iridomyrmex humilis Mayr*) which has been introduced there, was no more severe for these ants than those of neighboring colonies of the same species. It was noted, however, that this nest had little access to wild barley and similar grasses which is a common food of the species, yet it was well provisioned with mixed grains from a nearby feed store whenever the Argentine ants permitted the nest to be opened for normal harvesting activities. An examination of several thousand individuals from fifty colonies within a radius of two miles yielded only one pterergate.

While engaged in a study of the Formicoid thorax, Dr. Wheeler suggested that the writer communicate with Professor Shapley and ask permission to examine specimens

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 328.

from this interesting nest. Professor Shapley kindly gave the writer specimens of the different forms and in conversation described the region in which the nest was found. The writer wishes to thank Professor Shapley for these abnormal specimens and for numerous facts concerning these ants in the locality of Pasadena, California. To Dr. Wheeler the writer wishes to express his thanks for his opinions concerning the specimens.

According to Creighton (1928) abnormalities in ants appear to fall into three fairly well defined categories:

1. Sex mosaics and intersexes.[2]
2. Aberrant forms produced through altered food supply.
3. Freaks and atavistic forms.

The first group includes the various lateral mosaics as well as the rarer antero-posterior type. The second group includes a large number of peculiar forms which arise from pronounced nutritional irregularities. Lack of food may produce dwarf individuals, while loss of food due to the presence of parasites gives rise to pseudogynes. In the event of an overabundance of food, unusually large males and females, egg-laying workers and, more rarely, repletes may result. In the third group may be included those individuals which show duplication, loss or malformation of parts and atavistic forms.

The method by which aberrant forms, particularly pseudogynes, may be produced through altered food supply has been studied by Wasman for more than thirty years. He has suggested the following hypotheses.

1. Ants of colonies, having their larval broods devoured by the *Lomechusa* larvæ try to transmute into workers some larvæ which have already developed somewhat along the path terminating in the queen phase. These efforts result in the production of forms that belong to neither caste.

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[2] Intersexes should probably fall in the second category, as recent works indicate that they are produced through a change in the rate of metabolism.

2. Pseudogynes may arise without any effort at transmutation but from female larvæ that have been merely neglected and left unfed after they have passed the stage at which such treatment would lead to the formation of workers. "That the pseudogynes are not the result of pathogenic conditions in the egg or mother queen has been proved experimentally by Viehmeyer (1904) who removed an aged *sanguinea* queen from a colony that for years had been producing pseudogynes, owing to the presence of *Lomechusa* larvæ and caused her to be adopted by a new set of unusually healthy workers from an uninfested colony. Under the changed conditions her eggs developed into larvæ that gave rise to perfectly normal workers" (Wheeler, 1910). It would appear, therefore, that pseudogynes result from an upset in the nutritional balance due to the presence of parasites, although it is impossible to state positively whether they are transmuted females or over-developed workers.

The pterergate falls into the third group of abnormal ants, i. e. freaks and atavistic forms. As there are only a few cases of such forms on record (nine prior to 1920) their sporadic appearance would indicate that they are extremely unusual and thus may be classified in the third category. Dewitz (1878) has shown that in *Formica* the embryonic vestiges of wings are retained until the larval and pupal stages, and it is not surprising, therefore, that we should occasionally find some workers which retain them until the adult stage. No doubt this phenomenon occurs more often than has been suspected, and the minute vestiges are broken off during emergence from the pupal case, or during the mutual stroking of their bodies with their antennæ, to which the ants devote so much of their time. Since the retention of a character that usually disappears among the normal forms is in the broad sense of the term a freak, pterergates or workers possessing vestiges of wings, though in other characteristics exactly like the true worker, fall readily into the third group of abnormal ants suggested by Creighton.

The difference between pseudogynes and workers is very distinct when a large series of forms is available for study, and many comparisons may be made between them. The pseudogyne is characterized by an enlarged mesonotum and oftentimes by the presence of vestigial wings. It is more robust than the worker, and in the case of some forms retains the median ocellus which entirely disappears in the worker. However, a very complete series of intergrades may be noted, and in some cases a pseudogyne so nearly approximates a worker in size and in shape that a careful examination is necessary to differentiate between them. Pterergates and pseudogynes are easily distinguishable. In the case of a wingless pseudogyne and a pterergate, the distinction is obvious. In the case of a winged pseudogyne and a pterergate, the difference is one of size and structure of the thorax. Usually in winged pseudogynes the lower intergrades tend to lose their wings as they become reduced in size, so that the less developed individuals differ only in size from the worker and from the pterergates both in size and the absence of wings.

From the foregoing discussion of the polymorphic forms of the female ant, it may be noted that the distinctions between the forms are based mainly upon thoracic characters. The thorax of the female ants is as specialized as any that may be found among the winged insects, while the thorax of the worker ants is the most highly specialized, and at the same time as simplified as may be found among all insects. Adlerz has stated in his Myrmecologiska Studier that "we know that those characteristics that distinguish the typical worker from the queen are partly of a retrogressive nature; for example, the reduction of the receptaculum seminis, ovaries, eyes, wings, together with their muscles and muscular attachments, and partly progressive, for example, the increased size of mandibles and their muscles." The adoption of a terrestrial habit and the subsequent disappearance of wings has resulted in a fusion of sclerites in the thoracic region which makes a homological study almost impossible. Usually the dimorphic forms, the winged sexual forms and the wingless workers, are the only forms available for study, the intermediate forms having disappeared during phylogeny. Occasionally intermediate forms appear, giving convenient graduations from the winged to the wingless state, showing how the fusion of the sclerites and the simplification of the thorax may have taken place. In the material received from Professor Shapley a very interesting series of pseudogynes was noted.[3] Since this series may be of significance in tracing the evolution of the wingless worker from the winged form, this description is offered.

The typical female of *P. californicus* Buckley is rather a large form (Fig. 1, A) about 8-9 mm. in length. It is much larger than the workers and pseudogynes, the difference in size being most noticeable in the thorax and gaster. The thorax is of the typical Myrmicine type, being characterized by the presence of a large parascutellar region on either side of the mesonotum and by the absence of a distinct metathoracic spiracle. In the mesonotum the prescutum is fused with the scutum. The notauli are absent and the parapsidal furrows extend but a short distance forward from the transcutual suture. The lateral and sternal sclerites of the mesothorax are fused and modified so as to make their identification rather difficult. In the mesopleuron the epimeron persists as a narrow region bordering the postero-dorsal margin of the episternum. The episternum is secondly divided into an upper (anepisternum) and lower (katepisternum) plate. The metanotum is reduced to a transverse plate and the metapleuron is almost indistinguishably fused with the propodeum.

The modifications noted in the series selected for study are as follows. Fig. B is a lateral view of one of the larger winged pseudogynes. In this form fusion of the sclerites in the notal region has taken place although the mesonotal region is still enlarged, while the mesopleural region is practically unchanged except for a reduction in size. Vestigial wings and poorly developed tegulæ are present. The metanotum persists as a transverse plate almost indistinguishably fused with the mesonotum and propodeum. In the form next to the true worker (Fig. C) fusion of the pleural region as well as the notal region has taken place, yet the pronotum is still separated from the enlarged mesonotum, the promesontal suture persisting in its entirety. In pseudogynes similar to this one vestigial

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[3] Shapley considered these forms to be pterergates, but a comparison of a large number with the typical worker shows them to be pseudogynes.

wings were noted (textfigure). The thorax of the true worker (Fig. C) is one of the most specialized found among the ants. The mesonotum is reduced in size and the sclerites have fused together, except the lateral region of the pronotum with the mesopleuron.

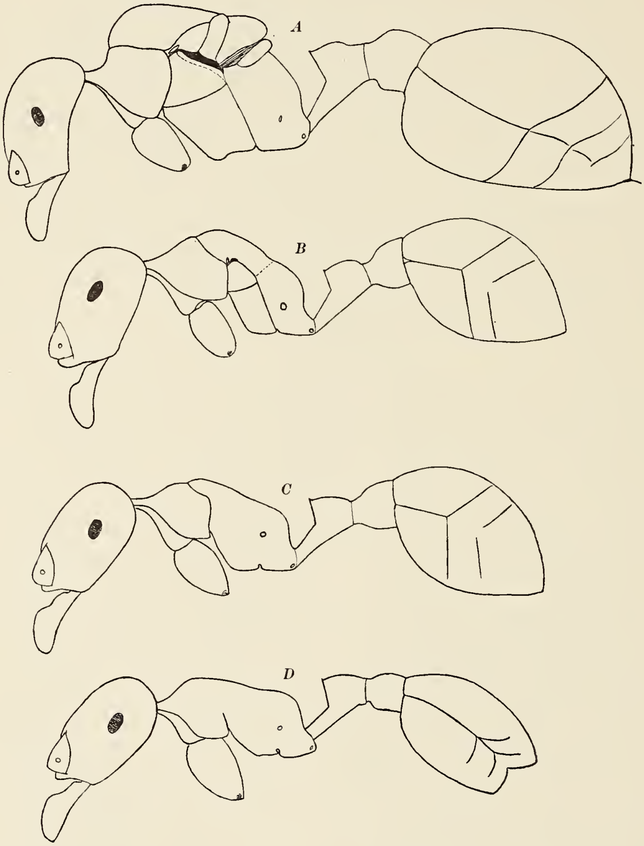

Fig. 1. *A,* Queen of *P. californicus* with wings removed; *B* and *C,* pseudogynes of *P. californicus; D,* worker of *P. californicus.*

In order to comprehend the significance of this series, it is necessary to consider the manner in which a wing bearing segment may have been evolved from a wingless segment. Snodgrass (1926) has suggested that the insect's ancestor may have been a soft-bodied, segmented animal, resembling in its segmentation the soft-bodied larvæ of some modern insects. Modern adult arthropods, unlike their hypothetical ancestors, have the thorax modified as the locomotor region of the body, and are in general hard-shelled forms, having developed an external skeleton formed of calcareous or chitinous matter, and the hardening of the body wall has had a profound influence on the structure of the segments and on the general mechanism of the animal. The skeletal deposits have taken the form of segmental plates, of which the principal is a dorsal, or tergum and a ventral, or sternum. These two plates are separated on the sides of the segment by a membranous pleural area. The condition found in a wingless thoracic segment is fundamentally of this structure, except that a chitinous pleural plate is present and connected to the tergum and sternum by membranous regions. In the winged thoracic segment these plates have become modified to strengthen the thorax in order to provide solid attachment points for the muscles of the wings. This has come about by the formation of chitinous antecoxal and postcoxal bridges connecting the pleuron and sternum, as well as prealar and postalar bridges connecting the pleuron and tergum. The tergum has become secondarily divided to provide muscle attachment points. Thus the transition from the wingless thoracic segment to the winged segment has been one of strengthening the thorax to accommodate the muscle stresses concomitant with the acquisition of wings.

The embryonic history of insects substantiates the fact that the thorax was first differentiated as the locomotor region of the body by a specialization of three pairs of segmented appendages as the principal organs of progression, this being accomplished by the modification of the gnathal appendages to feeding organs and by the suppression of most of the abdominal appendages. Flight being a comparatively recent development as a further mode of progression, the development of wings and the perfection of the mechanism meant a further and much greater alternation in the structure of the wing-bearing segment than that which was evolved to accommodate the legs. With a return to a terrestrial environment it is natural to expect that the character most recently acquired should be the first to disappear. In the series of intermediate forms of *Pogonomyrmex* from queen to worker this is precisely what has happened. The appearance of functionless wings, the reduction in the size of the thorax due to the reduction in size of the wing muscles, and the simplification of the mesonotal region presents a stage in the evolution of the apterous forms from the winged forms. This progressive reduction in size of the thorax and wings, and the simplification of the pleural as well as the notal regions represents a recessive stage in the evolutionary series. The loss of vestigial wings and a progressive reduction in size represents a further step, and the true worker type marks the culmination of a long series of evolutionary stages from the winged to the apterous condition. Usually the intermediate forms have disappeared, and only the first and final stages are present, but occasionally abnormal forms such as these persist and give us a convenient series of connecting forms. Moreover, one is not compelled to formulate any hypotheses or construct any hypothetical figures as has been done in the case of the evolutionary stages from the wingless ancestors to the winged insects; here we have living examples of the connecting stages, a condition which is not usually met with in evolutionary study. The writer is very fortunate in having at his disposal these connecting links in most of the subfamilies of the ants. These series will be considered in a later and more comprehensive paper.

The wings of the queen and winged pseudogynes are illustrated in the textfigure. The wing of the queen is about 6 mm. in length and is much reduced in the distal region (Fig. a). The venation of the wing of the first pseudogyne is much reduced, especially in the anal and cubital region. The vestiges in forms similar to Fig. C consist of a small veinless wing sac. The grouping of the winged intermediate forms roughly in order of the development of vestiges by Shapley follows:

With minute veinless wing-sacs, or with stubs of broken wings—385.

With sacs from 0.5 to 1.0 long and indistinct veining—219.

With transparent, clearly veined winglets from 0.8-1.5—132.

He further states that "the gradation of wing vestiges is, however, perfectly continuous, from small protuberances (without appendages) on the mesothoracic segment to the most developed winglets, with venation approaching that of the wing (6 mm. in length) of the mature queen." Brues (1903) distinguishes three types of vestigial wings:

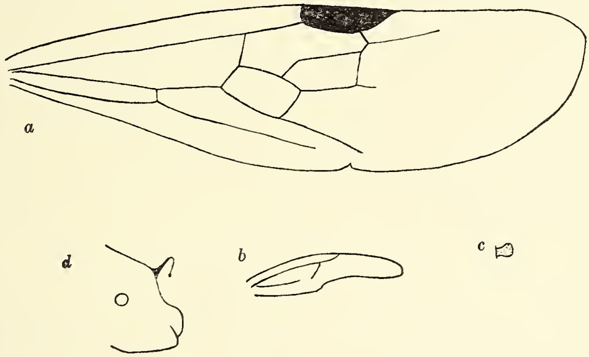

Fig. 2. *a,* wing of queen of *Pogonomyrmex californicus,* Buckley; *b,* wing of pseudogyne shown in Fig. 1, B; *c,* wing of pseudogyne shown in Fig. 1, C; *d,* propodeum of pseudogyne.

1. Wings having essentially a pupal character, viz, developing as normal wings up to the pupal stage, but failing to expand.

2. Wings essentially normal except for their similar size and less complex venation.

3. Wings consisting of little more than a hollow bag and giving no clue from their appearance as to the probable wing structure of their ancestors.

The vestigial wing (Fig. b) from the first pseudogyne of the series would fall into the second category, while the sac-like vestige (Fig. c) of a wing from forms similar to Fig. c would fall into the third group. The third group apparently represents the stage just preceding total aptery and is, therefore, phylogenetically, the most recent condition.

In addition to the pseudogynes found in this nest another interesting group of four specimens was noted. These were supposedly workers possessing vestiges of both fore and hind wings. On examining a specimen of this form the writer finds it to be a deälated female, the stubs of wings giving the impression of vestigial wings. However, this particular specimen is extremely interesting from another point of view, as it possesses a propodeal spine on the right side of the body and none on the left. (Fig. d) Since spines do not occur on this particular species this specimen may be classified as a freak, since it is probably an atavistic form.

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NOTES ON *EUPONERA GILVA* (ROGER) (HYMENOPTERA, FORMICIDAE)

By Wm. S. Creighton and George S. Tulloch[1]

In a collection of ants made by the senior author in Alabama during the months of May and June, 1929, there are many specimens of *E. gilva* (Roger). These are of interest both because of the presence of sexual forms, which have not been previously described, and also because of their bearing on the subspecies *harnedi,* recently described by M. R. Smith. The total number of specimens secured was about three hundred. Most of these came from one unusually large nest found at Point Clear, Baldwin County. Others were taken at Spring Hill (Mobile), and a very interesting nest containing five deälated females was discovered near Florence. It would appear that *gilva* is by no means as rare as was formerly supposed. Its scarcity in collections may be ascribed to the combination of a restricted type of nesting site and a southern range which has kept it out of the hands of collectors. It prefers to nest under the bark of fallen pine trees, selecting trees which are lying in such a position that the trunk is clear of the ground for at least a part of its length. The nests are made in the thin and rather spongy layer between the bark and the wood and always on the under side of the trunk. This insures an abundant supply of moisture, which is apparently indispensable to these insects. With the single exception noted above, all the colonies found were small. Many males, a single winged and somewhat callow female and much well-developed brood came from the Point Clear colony which was taken June 20.

E. gilva was originally described by Roger in 1863. Emery in 1895 corrected and amplified the description and

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 329.

figured the thorax. Wheeler and Gaige in 1920 redescribed the insect from specimens taken at Camden, Tennessee. Unfortunately the figure which was to accompany the description was omitted in publication. In 1929 M. R. Smith erected a new subspecies which he called *harnedi*. The types of this insect were found at Columbus, Mississippi. The paper containing the account of this subspecies was received while the present work was in preparation. From certain remarks made by Dr. Smith in his introduction, it was apparent that some mistake had been made in regard to the cotypes of *harnedi*. These were supposed to have been examined by Dr. Wheeler, but upon inquiry the single specimen from the type series present in his collection proved to be a female. Under such conditions it was manifestly impossible that any opinion of the status of the worker could have come from Dr. Wheeler. Furthermore this female of *harnedi* was so similar to those of the typical *gilva* taken by the senior author that the validity of *harnedi* seemed very questionable. To clear up the matter cotypes of *harnedi* were secured through the coöperation of Dr. Smith. The authors are glad to take this opportunity to thank him for the gift of these specimens and also for his consideration in laying aside his own description of the sexual forms, which was in course of preparation at the time when he learned of this paper.

A comparison of the cotypes of *harnedi* with specimens which we regard as the typical *gilva* has convinced us that the former must be regarded as a synonym. The two insects are identical as to the width of the head, the length of the antennal scapes and the size of the eyes. The specimens of *harnedi* are as robust as those of *gilva* and their size is well within the range shown by the latter. In coloration Dr. Smith's specimens are identical with the darker specimens taken in the Point Clear colony, the thorax being practically as dark as the head, and the appendages a rather dingy brownish yellow. This condition is apparently shown by the older individuals in the colony, since there are many specimens from the same nest in which the thorax is somewhat lighter than the head and the appendages are of a clear brownish yellow. We were unable to detect any significant difference in the sculpture of the two, although the pronotum and mesonotum of *harnedi* appeared a trifle more glabrous than that of some of the specimens of the typical *gilva.* The abdominal pilosity of *harnedi* also seemed slightly longer and more abundant, but here again it was impossible to make a satisfactory distinction because of the variability of the typical form. We are of the opinion that the minor differences shown by *harnedi* are those which have been used to distinguish the so-called nest variety. To establish varietal status on this basis necessitates the frequent splitting of a series from a single colony, a procedure which we consider taxonomically unsound. The authors feel sure that Dr. Smith will agree that synonymy is preferable to the use of such minute distinctions.

It may be of interest to note here that the name *gilva* appears to have been a misnomer. As ordinarily used *gilva* refers to the light yellow color more often characterized by the term *flavus* or *flava.* The name *gilva,* therefore, seems scarcely applicable to the ferrugineous specimens which have been found to represent this form, and one is justified in questioning that our present material is of the same color as Roger's types. That the latter were also ferrugineous is indicated by Emery's statement in his description of '95. Emery had for study two workers from the Berlin Museum. Although these do not seem to have been cotypes, they were, in all probability, compared with Roger's original specimens. Emery notes that their color is much darker than that of the European *ochracea.* There are two specimens of *ochracea,* taken by Emery, in the collection of Dr. Wheeler. The color of these is a clear, golden yellow, notably lighter than that of any specimen of *gilva* which we have seen. We may consequently conclude that the color of Emery's specimens of *gilva,* and presumably Roger's also, was the same as that of our present material.

Descriptions of the sexual forms of *E. gilva* and figures of all three casts are presented below:

Euponera (Trachymesopus) gilva (Roger)

Ponera gilva,
Roger, Berl. Ent. Zeitschr., Vol. 5, p. 170, (1863).
Mayr, Verh. Zool-bot. Ges. Wien, Vol. 36, p. 438, (1886)

Dalla Torre, Cat. Hymenop., Vol. 7, p. 39, (1893).
Emery, Zool. Jahrb. Abth. Syst., Vol. 8, p. 266, pl. 8, fig. 10, (1895).
Wheeler, Ants, etc., p. 561, (1919).

Pachycondyla, (Pseudoponera) gilva, Emery, Ann. Soc. Ent. Belg., Vol. 45, p. 46, (1901).

Euponera (*Trachymesopus*) *gilva,* Emery, Genera Insect., Ponerinae, p. 86. Wheeler and Gaige, Psyche, Vol. 27, p. 69, (1920).

Euponera (Trachymesopus) gilva subsp. *harnedi,* Smith, Ann. Soc. Ent. Amer., Vol. 22, p. 534, (1929).

It is not necessary to repeat here the description of the worker of *gilva* since a very satisfactory account of this caste has already been given by Wheeler and Gaige ('20). It may be well, however, to mention in passing certain features which were not noted in their description. The greatest width of the head, which occurs approximately at the posterior third, is to the length as 3.7 : 4. The eyes consist of eight or nine poorly defined ommatidia which are partially obscured by overlying pubescence. The penultimate and antepenultimate joints of the funiculus are very slightly longer than broad and not, as has been stated, broader than long. Their true proportions are obscured in dry specimens by the erect hairs which they bear, but become apparent when the specimen is examined in a liquid mount. The ventral surface of the node of the petiole bears a rounded anterior lamella and a somewhat more flattened posterior lobe.

Female.—Length 4.7-5.2 mm.

Head relatively broader than in the worker, its greatest width approximately equal to the length, the sides less evenly convex than in the worker, much narrower in the anterior half than in the posterior, the occipital angles well-marked, the occiput straight or at most very feebly concave. Mandibles large, their external border almost straight, except at the apical third, where it is feebly convex. Apex of the mandible with a long, stout, sharp tooth, which is longer than any of the other teeth on the masticatory margin, the first three of these large and rather blunt, the innermost three smaller and set very close together. Clypeus with a well-marked, steeply declivious and acutely triangular median lobe, the apex of which lies between the anterior ends of the frontal lobes. Anterior border of the clypeus feebly convex with sinuate lateral terminations. Eyes oval, moderately large, their anterior border separated from the insertion of the mandible by a distance less than the thickness of the antennal scape at its apex. Ocelli of moderate size, equidistant from each other. Frontal lobes flattened, together forming a subcordiform plate which is divided by a longitudinal impression that is continuous with the frontal groove, the latter extending back to the median ocellus. Antennæ twelve-jointed, the funiculus twice as long as the scape. The scape in repose fails to reach the occipital border by a distance one and one-half times its greatest thickness. First funicular joint somewhat longer than the following two together; joints two to seven all broader than long; joint eight as broad as long; joints nine and ten slightly longer than broad; terminal joint slightly longer than the two preceding joints together.

Thorax narrow, its maximum width one-half its length. The dorsum of the thorax in profile feebly convex. Pronotum with a short and very declivious anterior face descending to the neck. Seen from above the humeral angles are much rounded, which with the strongly concave posterior border, gives the pronotum a crescentric appearance. Scutum sub-trapezoidal, one-sixth broader than long, the anterior border strongly convex. Notauli (Mayrian furrows) absent, parapsidal furrows present, extending two-thirds of the distance to the anterior margin of the scutum. Scutellum small, suboval in outline, scarcely half as wide as the greatest width of the thorax. Metanotum very narrow, arcuate in shape. Epinotum seen from above rectangular, the dorsum one-fourth wider than long. In profile the basal face is considerably shorter than the declivious, which it meets at a sharp angle. Petiole very similar to that of the worker, the anterior face steeply sloping, the anterior face virtually perpendicular, the summit

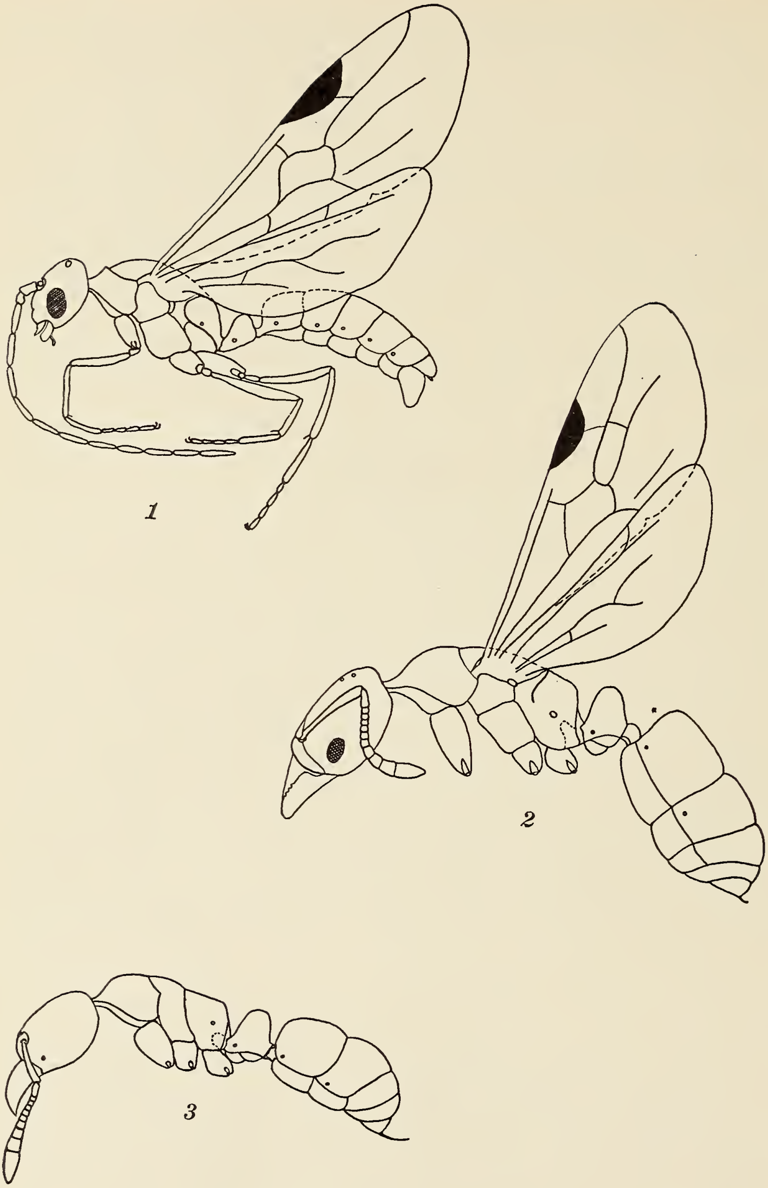

Fig. 1. *Euponera (Trachymesopus) gilva.* 1, male; 2, female; 3, worker.

very thick and obtusely rounded. The ventral surface of the node bears posteriorly a swollen lobe and anteriorly a thin, evenly convex lamella. Seen from above the node is transverse, the apex, which is broader than the more ventral portions, is approximately twice as wide as thick. Gaster elliptical, the constriction between the first and second segments rather feeble.

Color ferrugineous, the head and mandibles somewhat darker, the thorax marked with irregular areas of yellow, particularly on the pronotum and scutum; petiole and abdomen of a somewhat clearer tint, the posterior borders of the gastric segments with broad piceous bands. Antennæ and legs brownish yellow. Cephalic punctures so closely approximated that the head appears to be covered with minute coriaceous rugulae, giving it an opaque texture which shows a dull sheen in certain lights. Thorax more shining, the punctures not so closely approximated, the epinotum somewhat more shining than the rest of the thorax. Petiole and abdomen strongly shining, the punctures about as numerous as those on the epinotum but very small. Mandibles highly glabrous, the punctures very sparse and minute. Head covered with moderately abundant, appressed pubescence, which becomes much longer and coarser on the frontal lobes. Pubescence on the thorax and petiole somewhat finer and sparser. Abdominal pubescence very abundant, longer, coarser and more erect than elsewhere. Erect hairs on the head sparse and short with the exception of one or two very long ones which are inserted at either side of the medium lobe of the clypeus. Those on the thorax longer and more abundant. Erect hairs on the gaster numerous, particularly at the edges of the posterior segments. Tarsi and funicular joints with numerous, short, stout, erect hairs. Wings grizzled, the veins and stigma yellow, the entire wing covered with numerous, fine, short, suberect hairs.

Male.—Length 3.9 mm.

Head subtrapezoidal, much narrowed behind, its greatest width (measured through the eyes) slightly greater than its length, occiput narrow, scarcely wider than the distance between the lateral ocelli, sides moderately convex. Eyes large, convex, suboval in outline, their margin bounded by a narrow and shallow groove, the posterior border lies at the middle of the side of the head, the anterior border separated from the insertion of the mandible by a distance equal to the thickness of the first funicular joint. Ocelli large and prominent, the two lateral ocelli separated from each other by a distance almost twice as great as that which separates each from the median ocellus. Clypeus subtrapezoidal, the median portion somewhat elevated, the anterior edge feebly sinuate. Mandibles small, rather broad at the base which bears a curious, oval impression, but with a narrow though rounded apex, entirely without teeth, Antennæ filiform, of thirteen joints. First joint cylindrical, about one and one-half times as long as thick; second joint thinner, more rounded, about as broad as long; the remaining joints all much more slender, five times as long as thick.

Thorax seen in profile with a feebly convex dorsum, the pronotum steeply declivious throughout, the small anterior portion forming the neck not well differentiated from the rest; seen from above the pronotum is cresentric in outline and separated from the scutum by a very pronounced suture. Scutum subtrapezoidal, the anterior face evenly convex, its greatest width five-sixths of its length. Notauli (Mayrian furrows) absent, parapsidal furrows extending forward two-thirds of the distance to the anterior margin of the scutum. Scutellum small, rather convex, its dorsum triangular in outline but spreading ventrally to form a quadrate outline. Metanotum thicker and less arcuate than in the female. Epinotum seen from above tapering towards the rear, without sharp definition between the basal and declivious faces. Seen from the side the two faces appear as a continuous curve. Node of the petiole low and thick, the anterior face steeply declivious, the posterior face perpendicular, the summit thick and evenly convex, the ventral surface without lobe or lamella. Gaster very elongate, its greatest width three-eighths of its length, a feeble constriction between the first and second segments.

Color dirty blackish brown, the thorax more or less marked with dirty yellow. The posterior gastric segments with a narrow band of sordid yellow at the base. Occiput and frontal area piceous. Antennæ and legs dirty yellow. Punctures throughout less numerous than in the female, not sufficiently abundant on the head to produce the opaque appearance characteristic of the female and worker, the head feebly shining. Thorax, except for the epinotum, with the same punctuation as the head. Epinotum, petiole and gaster strongly shining, the punctures very fine and much less abundant. Pubescence on the occiput and front short, fine and appressed; longer, coarser and suberect on the clypeus, thorax and petiole; very long, sparse and suberect on the gaster where it grades into upright hairs at the edges of the segments. Occiput and clypeus with a few long erect hairs. Antennal joints with numerous, short, erect hairs; those of the tarsi, longer, sparser and less erect. Wings grizzled with yellow veins and stigma, the entire wing covered with numerous, short, suberect hairs. In certain lights the wings are iridescent.

THE TYPE FETISH

By J. R. de la Torre-Bueno
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Professor Embrik Strand writes in Psyche, for September, 1929, an extremely thought-provoking article under the title "Down with the Type Cult"[1], which I translate as in my heading. Whether our personal opinions run with his or not, we must admit he discusses what is becoming an extremely serious matter in entomology. We have types ranging from dipteran ovaries to fragmentary parts of insects, microscopic mounts, and, of course, the whole insect. These are scattered to the four quarters of the globe, in museums and in private collections. In many instances, internal evidence may point to certain specimens or to a series of specimens with which the author worked, but nothing on the specimens themselves shows that these were the ones from which the description is drawn up. Again, we face the condition that a type label may have been carelessly lost or put on a wrong specimen; or even removed or changed of set purpose.

Dr. Strand's idea of doing away with type specimens is not novel. Over twenty years ago, Dr. Verrill, the English dipterist, advocated the destruction of all types and the rejection of all descriptions unintelligible without the type. I have always maintained that paper and ink are far more lasting than specimens; and while we today may have the use of the type material of our contemporaries, it does not follow that our successors will. And even where types are extant, it is difficult to have access to them: Institutions are justly averse to lending types, particularly when these types have far to travel to the borrower. The vicissitudes of a type start when it is taken out of its case and continue

[1] Vol. XXXVI, pp. 228-231.

until it is safely back, perhaps not so entire as when it started, in spite of all the care exercised by both lender and borrower. Who has not at some time received a small box with one or more pins careering madly about in a debris of insect fragments? The policy of institutions is becoming more and more crystallized against the lending of types; and it is necessary now in many instances to inspect types in the parent collection itself, and to have to travel long distances in order to do so.

Another consequence flowing from the type cult is that certain describers content themselves with a one- or two-line, so-called, description; and blandly refer other students to the extant type or types. This saves the describer great labor: *vice-versa* the student.

Of course, these conditions present a full field to the synonym-hounds, who are thus enabled to cast what they please into the discard; or to erect new species on insufficient grounds.

Yet, in view of the extreme parsimony of words of many of the older descriptions and of their authors, what could we do without their types (if extant)?

Figures are sometimes advocated to take the place of types, or to make reference to them unnecessary. But who is to guarantee the accuracy of any figure? If an author makes the drawing, he may not be adept enough to bring out the particular features of the insect which form its basic characteristics (and many of these are impossible to depict in words or in drawing, because they are a part of the habitus or facies of the insect, elusive and difficult to seize upon). Two men may have straight noses, yet each has some fleeting characteristic which differentiates them. Every artist gives these characteristics a personal and probably subjective bent as he protrays them. Uncle Sam as portrayed by an American has an entirely different cast of countenance from the same portrayal by a Japanese, or by a German, or by a Russian, or even by an Englishman. And this is the personal equation of the artist! But when it comes to some other person, no matter how capable, imperceptible (and sometimes obvious) differences creep in. This has happened time and again; and any entomologist may cite numerous instances of these subtle differences, culled from his own experience. Photography is also suggested as a solution. But photography requires great expertness to attain results. And even here, the very direction of the light may obscure the most important characteristics. The reproduction of the most careful and accurate photograph is also fraught with hazard. Not long since, an entomologist friend of mine had a plate made from a photograph of the venation of an odonate wing. Here is an object all in the same plane, all in lines, possible to photograph exactly, and not depending on light and shade for its accuracy. Yet, the engraver *perfected* the photograph by adding a line where he thought it was needed, thus creating not only a new species, but a new genus as well! And after this come the hazards of proper printing.

All these considerations lead inescapably to the description as the residual *sine qua non,* Dr. Strand's fundamental position as I understand it.

When we arrive at this point, we arrive at the crux of all modern insect taxonomy. The only solution is an adequate description to stand or fall alone, without benefit of types. But what form shall such a description take? Is it to be a taxonomic description, restricted only to selected critical characters? Or is it to be a morphological description taking in each and every structure, internal as well as external? A taxonomic description of *Homo sapiens,* var *entomologus,* might occupy a printed page, but volumes would be required for a complete morphological description. And what are we to do about those who make genitalia the be-all and end-all of specific description?

A modern description, to be acceptable must be in such form as to stand alone independent of a type or of any other description. And by its form it should not only apply to the species described exclusively, but it should also cut all other cognate forms. This eliminates all ambiguity and makes it impossible for one neighbor to be mistaken for another.

When this is done, the type fetish will be automatically abolished, thus attaining the very laudable desire of Dr. Strand.

Et quis custodiet ipsos custodes?

THE WINGS OF THE REMARKABLE ARCHAIC MECOPTERON *NOTIOTHAUMA REEDI* McLACHLAN WITH REMARKS ON THEIR PROTOBLATTOID AFFINITIES

By G. C. Crampton, Ph. D.

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Through the great generosity of Dr. Edwyn P. Reed, the distinguished Chilean surgeon, I have had the privilege of making an anatomical study of the remarkable archaic Mecopteron *Notiothauma reedi,* McLachlan. In presenting me with the only known specimen of the hitherto undescribed male of *Notiothauma* for dissection and description, Dr. Reed has placed me deeply in his debt, and I would use this opportunity of thanking Dr. Reed for the rare privilege of studying this unique specimen.

The male of *Notiothauma* conforms to the general description of the female in having a castaneous body, but the wings of the male, and those from a specimen which had been damaged by pests (presumably a female, though the sex could not be determined from the remaining fragments) are ochreous, shot through with brown, giving a "brindled" appearance to the incumbent wings.

The male has a remarkable median dorsal process on what appears to be the fourth abdominal tergite (the specimen has not yet been softened for study) and on the next tergite is a pair of rather small lateral tergal processes, while the tergite behind this bears a pair of longer lateral tergal processes, which give a remarkable appearance to the flattened abdomen. The abdomen does not taper like that of a typical Panorpid, and is somewhat suggestive of the abdomen of the Mecopteron Merope, which is rather closely allied to *Notiothauma.*

The genitalia are rather "bulbous" and the basistyles or basal segments of the claspers of the male are rather short and stout; and the dististyles or distal segments of the claspers, unlike those of *Merope* (which has long slender dististyles) are shorter and stouter, and are somewhat furcate, with the exterior terminal branch curving outward (laterad) to some extent, apparently for the purpose of lying on either side of the median dorsal process (described above) when the genitalia are held forward in repose.

I would designate this hitherto undescribed male as the allotype of *Notiothauma reedi,* McLachlan, and a detailed description of it will be presented in a later paper dealing with the morphology of this remarkable Mecopteron, which is the only scorpionfly with flat incumbent wings (see Plate 2).

There is no fundamental difference between the wings of the male and those of the damaged specimen (presumably a female), so that the accompanying description of the wings of the supposed female will serve to illustrate the later description of the venation of the male, in describing the alar ossicles and other features of the basal region of the wing, in discussing the morphology of the male insect.

The measurements of the wings are as follows: Length of fore wing, 23.5 mm.; greatest width of fore wing, 10 mm.; length of hind wing, 22 mm.; greatest width of hind wing, 9 mm. The fore wings are more deeply pigmented and are ochreous, while the hind wings are more hyaline, and have a yellow tinge. The fore wings are like delicate tegmina, apparently derived from Protoblattoid (Protoblattid-like) or Protorthopteroid (Protorthoptera-like) prototypes, but the hind wings have lost the anal fan characteristic of the Protoblattids, etc., as likewise have the Isoptera (except Mastotermes), for that matter, which are the direct descendants of Protoblattoid forbears. The fore wings are somewhat broader in the distal half of the wing, and are broadly rounded apically, resembling in these respects the fore wings of the Protoblattids *Asyncritus, Adiphlebia,* etc., figured by Handlirsch, 1925 (Schroeder's "Handbuch," Band 3), or the Protorthopteroid insect *Metropator,* figured by Handlirsch, 1909 (Die Fossile Insekten). These are Protoblattoid features pointing to a

Protoblattoid ancestry for the Mecoptera, instead of indicating an ancestry for the Mecoptera in forms like the Megasecoptera or even the Palæodictyoptera.

The Megasecoptera and Palæodictyoptera are Archipterygota, or insects incapable of folding the wings along the abdomen in repose, while the Protoblattids and Protorthoptera are Neopterygota, or insects capable of laying the wings along·the abdomen in repose, and the Protoblattids and Blattids typically hold the wings in the recumbent position in repose (i. e., the wings laid flat, one on top of the other, on the top of the abdomen) and it is a very significant fact that Notiothauma holds its wings in the incumbent position in repose, so that this archaic Mecopteron must have been descended from Neopterygotan ancestors rather than from Archipterygotan ancestors such as the Megasecoptera, etc., regarded by Handlirsch and Tillyard as the ancestors of the Mecoptera. (See Plate 3)

The basal arch (*ba* of Figs. 1 and 7) of the first anal vein, forming a typical "basoplica," together with the fold-like depression, like that described by Crampton, 1927 (Psyche, 34, p. 59) and 1928 (Bull. Brooklyn Ent. Soc., 23, p. 113) in the Blattids, Isoptera, Orthoptera, Cicadas, Trichoptera, etc., which have developed these structures in connection with laying the wings along the abdomen in repose, likewise indicates a Neopterygotan ancestry for the Mecoptera.

The formation of cellules in the wings of the Protoblattids *Asyncritus, Adiphlebia,* etc., suggests the beginnings of a tendency to form cellules in the fore wings—a tendency which has been carried to an extreme in *Notiothauma.* It should be noted that it is not necessary for all of the Protoblattids or for all of the Mecoptera to exhibit this tendency in order to derive the Mecoptera from a Protoblattoid ancestory, since, according to the adumbration theory, some members of an ancestral group may exhibit tendencies which later reappear in some members of a derived group without these features being exhibited by all, or most, of the members of either group, as has been discussed elsewhere. It is therefore illogical to demand that all of the Protoblattoids shall exhibit a tendency toward the formation of numerous cellules, in order to derive such a

Mecopteron as *Notiothauma* (with its many cellules) from Protoblattoid ancestors.

In both the fore and hind wings of *Notiothauma,* there is a postero-basal lobe, or jugalula, labelled *a* in Figs. 1 and 2, which is called the alula in Coleoptera, etc., but the term alula was long ago used by Osten-Sacken, 1896 (Berlin Ent. Zeit., 41, p. 285) to designate an entirely different structure, namely the anal lobe of the Dipterous wing (i. e., the lobe distal to the calypteres); and it is preferable to refer to the jugalular lobe as the jugalula, since it is homologous with the jugalula of the roach. Esben-Petersen, 1921 (Mecoptera in Coll. Zool. Selys Longchamps) calls these jugalulæ the "clavi" in *Notiothauma,* but the clavus is an entirely different region, homologous with the anal region presently to be described, and there is no excuse for applying the term clavus to any structure other than the region homologous with the clavus of the Hemiptera. The jugalula *a* is bordered by a fringe of hairs labelled *af* in Figs. 1 and 2, and when the jugalula *a* of the fore wing (Fig. 1) is folded forward under the fore wing, it engages the bristles labelled *bsc* in Fig. 2 of the hind wing, thus serving as a primitive type of jugum. In my specimens, the jugalula was folded forward, and it was very difficult to make out its structure in the mounted wings.

The basicostal bristles *bcs* of Figs. 1 and 2, are borne on a thickened, antero-basal, marginal structure in both wings; and these bristles in the hind wing are apparently the forerunners of the frenulum of higher insects, although they can hardly be called a frenulum on the fore wing. These bristles are unusually stout and long, and belong to the type of bristle which may be called dinotrichia, or powerful bristles, such as those occurring on the veins, etc., at the base of the fore wings (Fig. 7) or on the thorax, etc., Macrotrichia occur on the costal margin of the wings in the neighborhood of the humeral veinlet *h* of Figs. 1 and 2, and gradually become smaller toward the middle of the wing, (they are not drawn in this region of the wing in Figs. 1 and 2). The "dinotrichia" occurring on some of the veins in the basal region of the fore wing are shown in Fig. 7, and the sockets or pits, which are left when such bristles are broken off, are shown in the figure. Macrotrichia occur on the ventral surface of the basicostal structure labelled *bc* in Fig. 4, and on the ventral surface of the humeral veinlet *h* of Fig. 4; and a row of macrotrichia occurs on the ventral surface of the subcostal vein shown in Fig. 4. This row of macrotrichia may aid in holding the wings in place in repose.

Forbes, 1924 (Ent. News, 35, p. 232) in describing the nygmata of Holometabolous insects, states that in "*Merope* and apparently *Notiothauma* nygmata are absent," but I find in the basal costal cell, for example, what appears to be the homologue of a nygma, similarly located to that of *Panorpodes* (see *n* of Fig. 7), and nygmata are thus apparently present in the fore wings of *Notiothauma*, although I have not examined Merope to determine if they are present in this insect also.

The venation of the hind wings is quite easily homologized, but the tangle of cellules in the distal portion of the fore wings makes it extremely difficult to trace the course of the veins in this region of the fore wings, so that the course of the distal portions of such veins as the second, third and fourth branches of Media is merely suggested, although the basal portions of these veins are quite easily homologized.

The fore wing has preserved a suggestion of a humeral lobe in the curved contour of the basal portion of the wing just anterior to the label *h* in Fig. 1 (which is a Protoblattoid or Protorthopteroid feature) and the costal vein has become interrupted just basad of the humeral veinlet *h* of Fig. 1. The detached basal portion of the vein becomes broadened (to accommodate the large bristles *bsc*) and forms a structure homologous with the sclerite called the basicosta in the roach, Mantids, Trichoptera, Cicadas, etc. (Psyche, 34, p. 59, and Bull. Brooklyn Ent. Soc., 23, p. 113). The occurrence of such a basicostal sclerite in *Notiothauma* indicates that its fore wing was derived from a Blattoid or Protoblattoid prototype rather than from a wing of the type occurring in the Archipterygotan insects (which have no such sclerite). I find a trace of the basicostal sclerite even in the hind wing of such a highly specialized insect as the monarch butterfly *Danaus archippus* ("Anosia plexippus") in which the costal vein fades out and the humeral veinlet is retained to support the weakened humeral lobe. In the hind wing of *Malacosoma* and other Lasiocampids there are two veinlets called the humeral cross veins by Comstock, 1924 (An Introduction to Entomology) but I think it preferable to restrict the term humeral veinlet to the first veinlet *h* of Figs. 1 and 7, and to refer to the one distad of it as the posthumeral veinlet (i. e., *ph.* of Fig. 7). These structures are referred to as veinlets rather than as cross-veins, since they are homologous with the veinlets of the Neuroptera, etc. The humeral veinlet *h* of Figs. 1 and 7, is much stouter than the other veinlets; and the weaker posthumeral veinlet *ph* is more pronouncedly curved.

The veinlets in the broad costal area of the fore wing have branched or are connected by cross veins in an irregular fashion causing a distortion of the veinlets and producing numerous cellules, which are irregularly pentagonal or hexagonal in the basal region and are more elongated and subquadrate in the distal region of the costal area. The broad costal area apparently represents a condition inherited from Protoblattoid ancestors resembling *Asyncritus* in some respects, and the curve in the costal margin of the fore wing may also represent the retention of a tendency more markedly developed in the Protoblattoid insects, instead of these features representing a type of specialization peculiar to *Notiothauma.*

As is true of Mecoptera in general, the subcostal vein *Sc* of the fore wing (Figs. 1 and 7) is a concave vein, and a minus sign (-) has been placed above it in Figs. 1 and 7, to indicate this fact. The base of *Sc* dips below the base of the radius R, as is indicated in Fig. 7. After paralleling R for some distance, *Sc* ends at the pterostigma *pst* of Fig. 1, although some of the branches of *Sc* appear to penetrate the pterostigma for a short distance. The wide separation of *Sc* from the costal margin, and its paralleling R for such a considerable distance are Protoblattoid features apparently inherited from a Protoblattoid ancestry.

The radial vein R is higher than the concave vein Sc, and appears to have much the same character as that of R_1 which is a convex vein, so that R may be regarded as a convex vein, although its sector R_s seems to be a concave vein. R fuses with M basally, and is contiguous with M until it forks—or rather, the space between R and M is sclerotized giving the appearance of a union between the two veins, although the veins themselves are not as closely contiguous as this pigmentation or sclerotization of the intervening membrane would suggest (See Fig. 7). R_s is given off in the basal fifth of the wing, and is richly branched, being somewhat like the radial sector of the Protoblattid *Stenoneura* in this respect, though it is of course much more like the venation of such primitive fossil Mecoptera as "*Protomerope,*" or the primitive fossil Neuropteron *Permorapisma* (particularly the latter) than it is like the Protoblattids, since the Mecoptera and Neuroptera are naturally more closely related to *Notiothauma* than the Protoblattids are. The convex vein R_1 is apparently unbranched and extends distally below the pterostigma *pst* almost to the margin of the wing, although a short backward extension of the pterostigma in this region intervenes between the margin of the wing and the tip of R_1. The concave radial sector R_s is given off in the basal fifth of the wing, and is richly branched with numerous cellules between the distal portions of its branches, and the cellules tend to become elongated and more quadrilateral than the cellules of the costal or cubital regions. It is quite easy to trace the branching of the radial sector, and the branching of its forks into R_2 and R_3 or into R_4 and R_5, in the basal portion of the wing, but the tracing of the courses of these branches in the distal portion of the wing is not as easy a matter as it is in such forms as *Merope* or even *Permorapisma,* due to the fact that the course of these branches is obscured by the tangle of cellules in *Notiothauma,* and on this account the interpretation of the branches of radius in the figure of the fore wing is purely tentative, although in the hind wing of *Notiothauma* the course of these branches can be followed with ease.

M seems to be a concave vein, although it fuses with *R* basally and is contiguous with *R* in the basal region of the wing. The branches of *M* are also concave veins, so that it should be an easy matter to distinguish the course of these veins from that of Cu_1 which is a convex vein, but the course of the median veins is so extremely aberrant, that I am the least confident of my interpretations in this region of the fore wing, although of course it is an easy matter to interpret the median veins of the hind wing. I have figured the median veins of the wings of *Notiothauma* from all available sources, using the original photograph (which is much clearer than the published figure) from which the illustration of Dr. C. E. Porter's note on *Notiothauma* was made (Revista Chileana Hist. Nat., 1929, XXXIII, p. 288),—Dr. Porter having very kindly sent me the original photograph—and I have also used Esben-Petersen's figure of the wings of *Notiothauma,* but even with these figures to aid me, in addition to examining the wings of two specimens of *Notiothauma,* I am not very sure of the course of the branches of M in the fore wing! In his review of Imms' book, Tillyard, 1926 (N. Z. Jour. of Science and Technology, 8, p. 127) states that the "thyridium is a hyaline area on M just before it forks" in Trichopterous wings, and there is a clear spot at the forking of M in Nannochorista, Sisyra, etc. Since there is a hyaline area (resembling the so-called bullæ) labelled *b* in Figs 1, 3, 4, 5 and 6 at the base of what Esben-Petersen (1. c.) considers as the first fork of *M* in the fore wing of *Notiothauma,* I feel almost certain that the forking of M is at the point labelled *b* in these figures. This interpretation, however, would leave a whole vein unaccounted for (can this be M_5?) but lying between the concave anterior branch of M and the convex anterior branch of Cu (i. e., Cu_1, whose course is indicated by a + sign in Fig 1) in these figures. Unlike the typically short M_5 of most insects (although M_5 is longer in some Psychopsidæ), the vein in question is of considerable extent, and joins the rest of the branches of M instead of extending across to Cu_1 as the vein M_5 usually does, and as is done by the vein labelled M_5 in Fig. 1, etc. I am therefore inclined, purely provisionally, to interpret as the first forking of M, the fork which is located just distad of the dotted line running up from the label M in Fig. 1. This fork occurs in all of the wings, and figures of wings, which I have seen; so it can hardly be an added cross vein that has taken on the appearance of a fork in one specimen: furthermore, it is continued in the vein labelled M_3 in Fig. 1—although it may possibly continue on down and fuse with Cu_1 instead, but the latter view is not very probable (although it should be considered as a possibility), because it would leave the vein labelled M_3 unaccounted for. I am therefore inclined purely provisionally to interpret the fork of M just distad of the dotted line running up from the label M in Fig. 1 as the forking of M into M_{1+2} and M_{3+4} as is indicated by the labelling. The fork at the hyaline spot labelled *b* in Figs. 1, 3, 4, 5 and 6, would then be the forking of M_{1+2} into M_1 and M_2. Where the forking of M_{3+4} into M_3 and M_4 is, I do not know, although I am inclined to think that it may be just basad of the dotted line running up from the label M_3 in Fig. 1. If this be correct, M_3 would be the vein so labelled in the Figure, while M_4 would be the short vein extending to and fusing with Cu_1 in Fig. 1. On the other hand, this short vein may be merely a cross vein between vein M_{3+4} and Cu_1, in which case the vein labelled M_3 in Fig. 1 would in reality be vein M_{3+4}. I have provisionally followed the former view and have labelled the median veins as though M_4 had fused with Cu_1 in Fig. 1. There is such a disconcerting tangle of cellules (which are more elongate and quadrangular in the medial region than in the cubital region) in the medial region, however, that I would not insist on the interpretation of the courses of the branches of *M* indicated by the labelling, and the final interpretation of these veins must await the study of the pupal tracheation, or the comparison with some less complicated venation in the fore wing of some as yet unknown Mecopteron. *Merope* and *"Protomerope,"* however (both of which are related to *Notiothauma*) are primitive Mecoptera with a less complicated venation which shows no indication of a fusion of M_4 with Cu_1, and this fact makes me suspect that the vein labelled M_3 in Fig. 1 is in reality vein M_{3+4} and the forking of this vein into M_3 and M_4 occurs further out toward the distal half of the wing, and the labels should therefore be shifted accordingly in Fig. 1. The development of the medial field is much greater in *Notiothauma* than in most Protoblattids, but some of the Protoblattids, such as *Eucaenus,* have a four branched media such as the ancestors of the Mecoptera must have had.

The cubital field of *Notiothauma* is filled with broader irregular pentagonal or hexagonal cellules and the cubital field is remarkably like that of such Protoblattids as *Asyncrytus*. The extremely short basal portion of Cu (i. e., before it forks) is another feature strongly suggestive of these Protoblattids, and is an added feature pointing to a Protoblattoid ancestry for *Notiothauma* (and hence for the Holometabola in general). As was mentioned above, Cu_1 is a convex vein (as is indicated by a + sign in Fig. 1) and Cu_2 is a concave vein (indicated by a — sign in Fig. 1), and this seems to be characteristic of all Mecoptera. As occurs in the wings of some fossil, but no other Mecoptera, Cu_1 branches into Cu_1 a and Cu_1 b judging from the condition exhibited by the hind wing, but I am not certain where this occurs in the fore wing unless it be at or just beyond the point where the dotted line running up from the label M_1 in Fig. 1 crosses Cu_1. As is also true of the Mecopteron *Panorpodes*, a nygma or wing spot, occurs in the basal cubital cell, as is shown in Fig. 7, where the nygma is labelled *n*. Just behind Cu is the preclaval rima or crack-like line demarking the anterior limits of the claval or anal area. This crack frequently interrupts the basal portion of Cu, and may have been formed in connection with the developing ability to lay the wings back in the incumbent position.

The anal or claval area (i. e., the clavus of Hemiptera) extends from the above-mentioned claval rima to the jugalula labelled *a* in Fig. 1, and contains the three anal veins which are convex veins in Mecoptera in general. The first anal, labelled 1. A. in Fig. 1, has a well developed basal arch labelled *ba* which occurs as a basal ridge, with an accompanying pocket or fold developed in connection with the ability to lay the wings back along the abdomen in repose. The weakening of the costal margin and the consequent detachment of the basicostal sclerite or protuberance *bc* of Fig. 1, is probably also developed in connection with the folding of the wings along the abdomen in repose, so that all of these features are of importance from the phylogenetic standpoint, and it is surprising that no one has referred to such features in the wings of insects. I have found them in the Blattids, Isoptera, Cicadas, Gryllacridæ, Panorpids, etc. (Psyche, 34, p. 59 and Bull. Brooklyn Ent. Soc., 23, p. 113), and when such an important form as the fossil *Metropator* is figured with a basal arch in the first anal vein by Tillyard, 1926 (Amer. Jour. of Science, 11, p. 161) I think that this (together with the outline, venation, etc. of the wing) indicates that *Metropator* is more closely related to the Protorthopteroids than to the Palaeodictyoptera, although Handlirsch places *Metropator* in his order Palaeodictyoptera, and not in the order Protorthoptera as Tillyard states. *Eubleptus* (order Eubleptoptera) may be nearer the Palaeodictyoptera, but *Metropator* (Metropatoroptera) evidently represents a type worthy of ordinal rank, closely related to the Protorthoptera, and with a venation approaching that of some Mecoptera with reduced venation, through convergence. *Metropator* lacks the costal veinlets, the forked Cu_1 and other features which were undoubtedly present in the ancestral Mecoptera, and I think that Tillyard, 1926, is mistaken in considering this Protorthopteroid insect as an ancestral Mecopteron.

The resemblance of the wing of *Metropator* to that of a Mecopteron with reduced venation, is apparently due to convergence, or possibly to adumbration and the relationship of *Metropator* to the Mecoptera would be by way of a common Protorthopteroid or Protoblattoid ancestor, and would not be the direct relationship of ancestral and derived types.

As was mentioned above, the first anal has a well developed basal arch. The second anal is not so pronouncedly arched, and joins the third anal basally. The third anal has an almost straight trunk (anotruncus) which gives off four branches unilaterally—though some of these may be branches of the second anal vein. The cellules filling the anal or claval area make it very difficult to determine the course of the anals and their branches, and the interpretation here given is truly provisional. The trunk of the third anal demarks the claval or anal area from the jugalula *a* of Fig. 1 in many insects, and is a fairly serviceable landmark in *Notiothauma*.

Esben-Petersen refers to the jugalula *a* of Fig. 1, as the "clavus," but this lobe is not the homologue of the clavus of the Hemiptera, etc., and should not be designated as such. This lobe is homologous with the so-called alula of Coleoptera, etc., but the term alula was applied to the anal lobe of the Dipterous wing by Osten-Sacken, 1896, as was mentioned above, and since the jugum is formed in this region, it is preferable to refer to it as the jugalula, as in the case of the homologous structure in the roach and other insects (Isoptera, etc., described in Bull. Brooklyn Ent. Soc., 23, p. 113 and Psyche, 34, p. 59). The veins in the lobe labelled *a* in Fig. 1 may be called the axillary or postanal veins. They serve to strengthen the lobe when it is used as a jugum, as is the case in the fore wing of *Notiothauma*. They are apparently absent in the hind wing, since the lobe is not used as a jugum in this wing. The elongated sclerite just below the label *ba* in the lobe of the fore wing (Fig. 1) is probably the homologue of the alar ossicle called the basanale in the roach, etc. (paper cited above). The jugalular lobe *a* of Figs. 1 and 2 is bordered by the axillary cord or ligamentum, which bears a fringe of hairs labelled *af* in Figs. 1 and 2.

Since the venation of the hind wing is comparatively simple, it will not be necessary to discuss each of the veins in detail, and the labelling of the wing will be sufficient to indicate the homologies of the veins. There are a few points, however, which merit separate consideration in comparing the two wings.

The hind wing is somewhat shorter and narrower than the fore wing in actual millimeters, but in proportion to its length, the hind wing is a little broader (proportionately) than the fore wing, and is a little narrower at its base than the fore wing is. Its jugalular lobe *a* (Fig. 2) is likewise somewhat weaker than the corresponding lobe of the fore wing (*a* of Fig. 1).

The hind wing has no such pronounced curve in the costal margin beyond the humeral veinlet *h* (Fig. 2) as occurs in the fore wing (Fig. 1), and the cellules in the costal region of the hind wing are less numerous than in this region of the fore wing. The costal veinlets of the hind wing are more "normal" or regular; and the costal space is not so broad in the hind wing as it is in the fore wing.

The cross veins of the hind wing, like those of the fore wing, are frequently broken by "pellucidæ" (maculæ pellucidæ) or "bullæ," which are clear spots. Their true function is not definitely known. Only a few of these are indicated in the figures.

The cellules of the hind wing are not as irregular as those of the fore wing, and the venation of the hind wing is more "normal" than that of the fore wing, particularly in the medial field. M_5 is not labelled in Fig. 2, but it can be identified by the dotted line running up from M_{3+4}, which crosses M_5. Since M_4 is not fused with Cu_1 in the hind wing, I am inclined to think that it is not fused with Cu_1 in the fore wing either, so that the vein labelled M_3 in the fore wing is probably M_{3+4}.

The stem of Cu is extremely short in the hind wing (Fig. 2) and its fork looks more like a cross vein than a fork. Cu_1 is not united with M, and it forks into Cu_1 a and Cu_1 b, which is a very primitive feature not retained in other living Mecoptera, and the character of Cu, with its short stem, is suggestive of a Protoblattoid origin.

The first anal vein of the hind wing is not markedly curved at its base, and the second anal vein parallels it rather closely. The trunk of the third anal gives off three branches anteriorly (unilaterally) which leads me to think that the third anal of the fore wing branches in the same fashion. The fact that the anals exhibit no tendency to loop up as they do in the fore wings of certain Trichoptera, etc., shows that *Notiothauma* is a rather primitive Holometabolan, and its venation and wing characters indicate that it is one of the most primitive members of the order Mecoptera.

In referring to the "Protoblattoid" or "Protorthopteroid" ancestors of higher insects, it should be borne in mind that the Protoblattids and Protorthoptera are fundamentally alike, and the division into these two groups is one of convenience rather than a division into groups of ordinal rank, since the Protoblattids and Protorthoptera intergrade so markedly that it is doubtful that they represent groups of more than subordinal rank. Since the two groups thus intergrade, the terms "Protoblattoid" and "Protorthopteroid" are practically interchangeable because the Protoblattids are in reality "Protorthopteroid" or Protorthoptera-like, and the Protorthoptera are in reality "Protoblattoid" or Protoblattid-like, and it would be correct to state that the ancestors of the Mecoptera and other Holometabola were either Protorthopteroid or Protoblattoid; but since the Protoblattids are a little nearer the common stem forms from which the others were derived, it is somewhat more accurate to describe the ancestors of the Holometabola, etc., as "Protoblattoid." A study of the wings of such a primitive Mecopteron as *Notiothauma* very clearly indicates that the ancestors of the Mecoptera had (1) delicate tegmina, (2) wings which were broader in the distal half of the wing and were (3) broadly rounded apically. The wings were (4) incumbent in repose, and, to facilitate laying the wings back in repose, had developed (5) a break in the basal costal region, resulting in the formation of (6) a basicostal sclerite demarked from the rest of the costal vein, (7) a basal arch of the first anal vein with an accompanying (8) basal pocket or fold, and (9) a preclaval rima or crack which traverses the base of the cubital vein and aids in permitting the wing to be laid back in repose. (10) The costal area was very wide, and (11) cellules tended to develop in it. (12) The stem of Cu[1] was very short and (13) irregular cellules filled the cubital area. (14) The fore wings bore a jugalular lobe. Most of these features occur in the Protoblattids, and in many of their living representatives, the Blattids (indeed, some entomologists do not recognize the Protoblattids as an order distinct from the Blattids); but these features are not characteristic of the Megasecoptera and other forms which have been proposed as the types ancestral to the Mecoptera. I would therefore maintain that the ancestors of the Mecoptera were Protoblattoid, and from such ancestors arose all of the lower Holometabola—and in fact of the Hemipteroid insects as well.

The types intermediate between the Protoblattoids and the ancestral Mecoptera are as yet unknown, but the immediate ancestors of the Mecoptera must have been extremely like those of the fossil Neuropteron *Permorapisma*, although the wings of *Permorapisma* itself, are not rounded

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[1] Cu_1 was probably forked in the ancestral Mecoptera.

apically (see figure by Tillyard, 1926, Proc. Linn. Soc. N. S. W., 51, p. 278). In the American Journal of Science, 11, p. 133, Tillyard, 1926, proposes that the fossil Mecopteron, which he calls *"Protomerope,"* is ancestral to *Merope* and probably also to *Notiothauma,* but the shape of the wing of *"Protomerope"* is different from that of *Notiothauma,* the anals are not as primitive as those of *Notio*thauma, the first branch of Cu (i. e., Cu_1) is not forked as in *Notiothauma* (which is a very primitive feature in *Notiothauma*); and many other features prevent our deriving Notiothauma from *"Protomerope,"* which is more specialized in these respects than *Notiothauma* is. Under these conditions all that can be said of the hypothetical "Protonotiothaumidæ" ancestral to the Notiothaumidæ and Meropidæ, is that they were Protomecoptera, in which suborder the superfamily Meropoidea, including the Meropidæ and Notiothaumidæ, belongs.

The family Choristidæ (superfamily Choristoidea), which occupies a position at the base of the suborder Eumecoptera, may be descended from the fossil Permopanorpidæ, but the Choristidæ themselves, are so primitive in many respects, that they probably arose from forms more primitive than the Permopanorpidæ, and of a type almost as primitive as the ancestors of the Notiothaumidæ.

The Nannochoristidæ (superfamily Nannochoristoidea) possibly descended from the fossil Mesochoristidæ. There are several features, however, which suggest that the Nannochoristidæ and Panorpodidæ (*Panorpodes*) may have descended from ancestors resembling those of the fossil Mesopanorpidæ, and the shortened head in *Nannochorista* and *Panorpodes* may be a feature of some phylogenetic significance.

The Panorpidæ (superfamily Panorpoidea) were probably descended from the fossil Orthophlebiidæ. The Boreidæ (superfamily Boreoidea) were apparently descended from ancestors like the Panorpidæ. The Boreidæ, however, have an entirely different type of terminal abdominal structures (in both males and females) from those of the Panorpidæ, and the Boreidæ have become so extremely specialized that they might be placed in a distinct suborder, the Neomecoptera, distinct from the Eumecoptera, mentioned above.

The Bittacidæ (superfamily Bittacoidea) are quite different from the rest of the Mecoptera in the character of the terminal abdominal structures of the male and female, and their slender bodies are modified along lines leading away from the typical scorpionfly trends. I, therefore, have no hesitancy in placing them in a distinct suborder, the Metamecoptera. The origin of these insects is obscure, although there is some evidence that they might have descended from the same ancestors from which the fossil Neorthophlebiidæ, were derived. It is more probable, however, that the Bittacidæ were derived from ancestors resembling those of the Panorpidæ. In the character of the male genitalia, the Choristidæ suggest the origin of the peculiar type occurring in the Bittacasidæ, and this might be taken to indicate a common ancestry for the Choristidæ and Bittacasidæ. The terminal structures of the female, however, would not bear this out, and until more is known of the comparative anatomy of the Mecoptera, it will be impossible to determine what family is the most closely related to the Bittacidæ, which occupy a rather isolated position in the order Mecoptera.

The terminal abdominal structure of the female Mecoptera have been figured in the December, 1928, issue of the Journal of the N. Y. Entomological Society, and the features referred to above are shown in this paper. The genitalia of the males of the Mecoptera referred to above are shown in a paper published in the Trans. of the American Ent. Society, 1923, 48, p. 207. The terminal structures of related Mecoptera will be discussed in the paper dealing with the male of *Notiothauma,* in which the anatomical features of the allotype will be shown in detail.

Abbreviations

A. Anal veins.
a. Jugalula or "alula," containing the axillary veins.
af. Alafimbrium or alular fringe.
b. Bullae or "pellucidae."
ba. Basarcus, or basal arch of the first anal vein.
bc. Basicosta.
bcs. Basicostal bristle.s

C.	Costal vein.
cs.	Costal rima or suture.
Cu.	Cubital veins.
ds.	Dinotrichia or powerful bristles.
h.	Humeral veinlet.
M.	Medial veins.
n.	Nygma.
ph.	Posthumeral veinlet.
pst.	Pterostigma.
R.	Radial veins.
s.	Sockets of bristles.
Sc.	Subcostal vein.

Explanation of Plates 2, 3, 4 and 5.

Fig. 1. Fore wing of Notiothauma (female).
Fig. 2. Hind wing of same.
Fig. 3. Veins of fore wing, from photograph by Dr. Porter.
Fig. 4. Ventral view of veins of fore wing.
Fig. 5. Veins of fore wing of male allotype.
Fig. 6. Veins of fore wing from figure by Esben-Petersen.
Fig. 7. Enlarged view of basal portion of fore wing of female.

Plate 2 shows a lateral and a dorsal view of the allotype, male, of *Notiothauma reedi,* McL., from photographs made by Professor Davis, of the Department of Botany, M. A. C. In these photographs the Blattoid appearance of Notiothauma is well shown. Note particularly the flat incumbent wings, which are unlike those of any other living Mecopteron, in this respect. The figures of Notiothauma, with wings outstretched, do not give a correct idea of the remarkable appearance of this peculiar insect, as may be seen by comparing them with the photographs here given. The photographs are larger than "life size," in order to show the intricate venation.

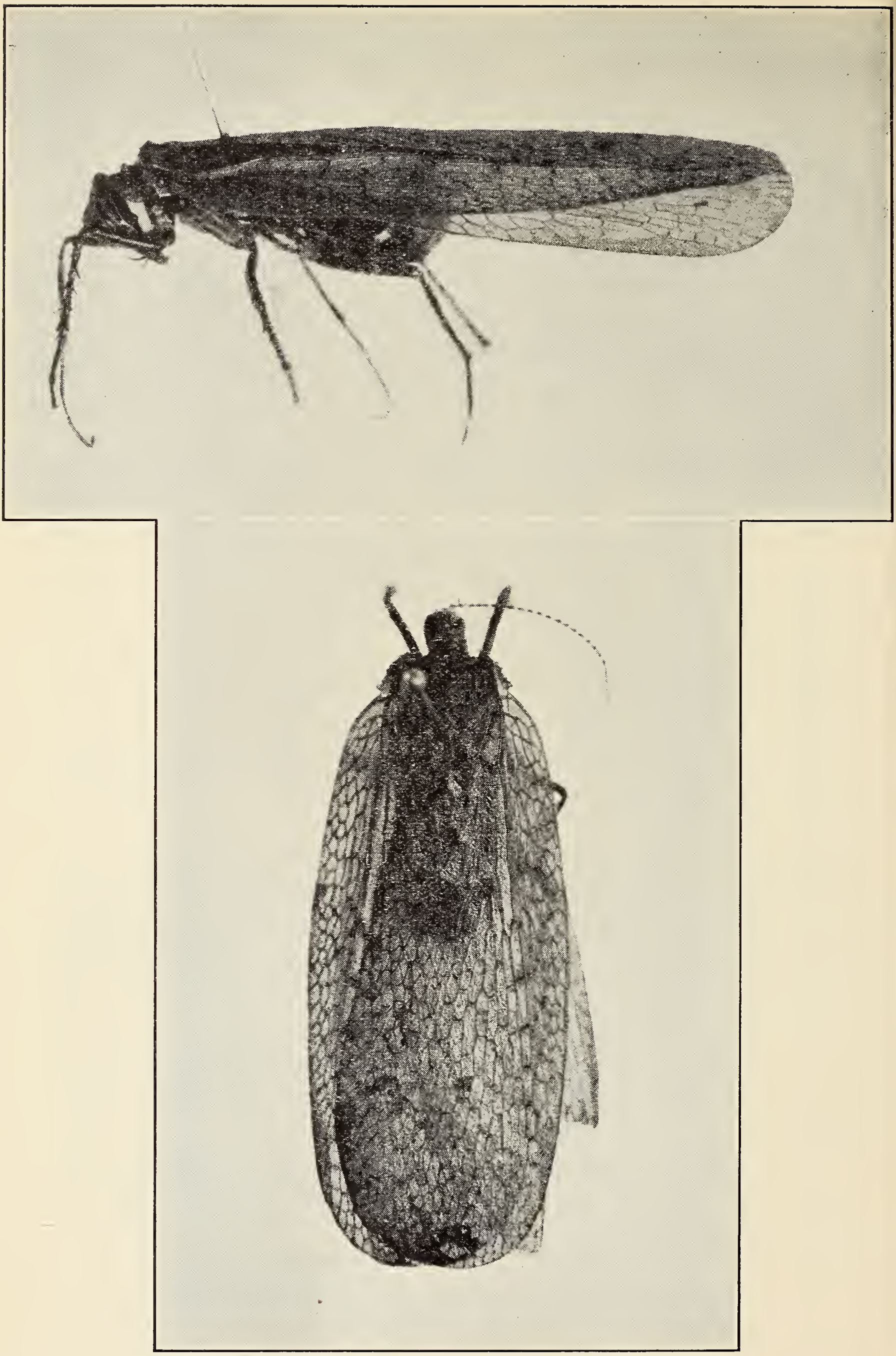

Plate 2
Crampton—Notiothauma

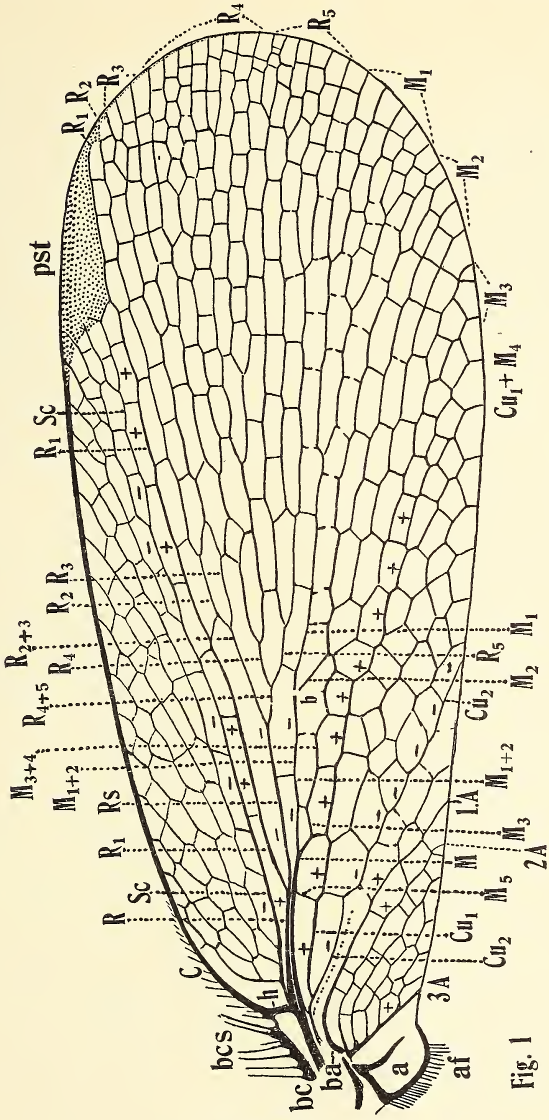

Fig. 1

PLATE 3
Crampton—Notiothauma

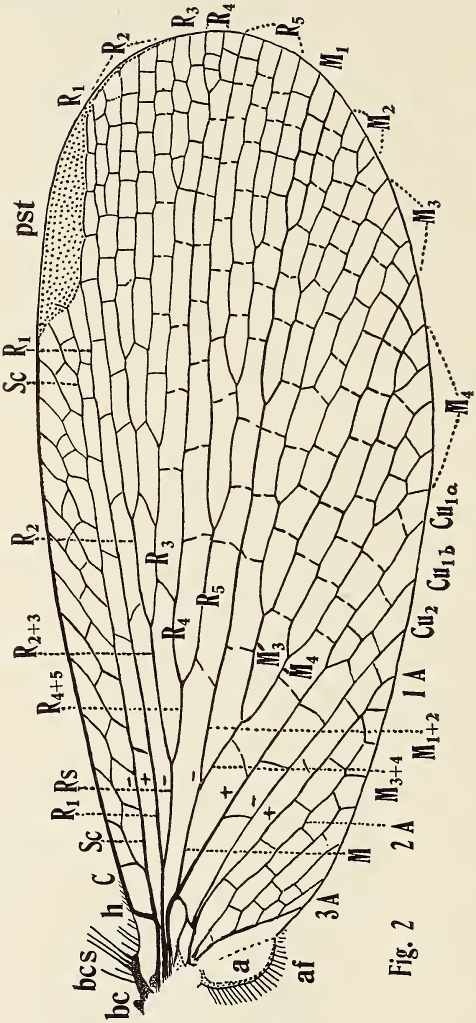

Fig. 2

PLATE 4

Crampton—Notiothauma

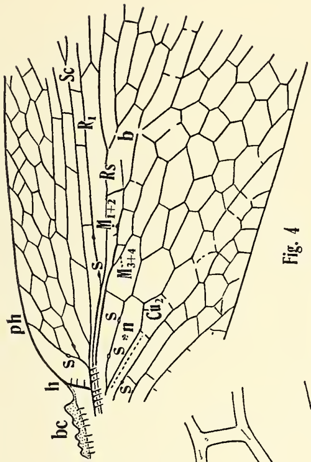

Fig. 4

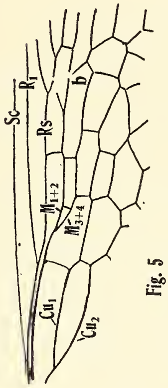

Fig. 5

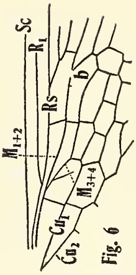

Fig. 6

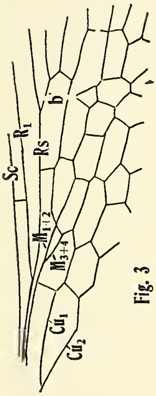

Fig. 3

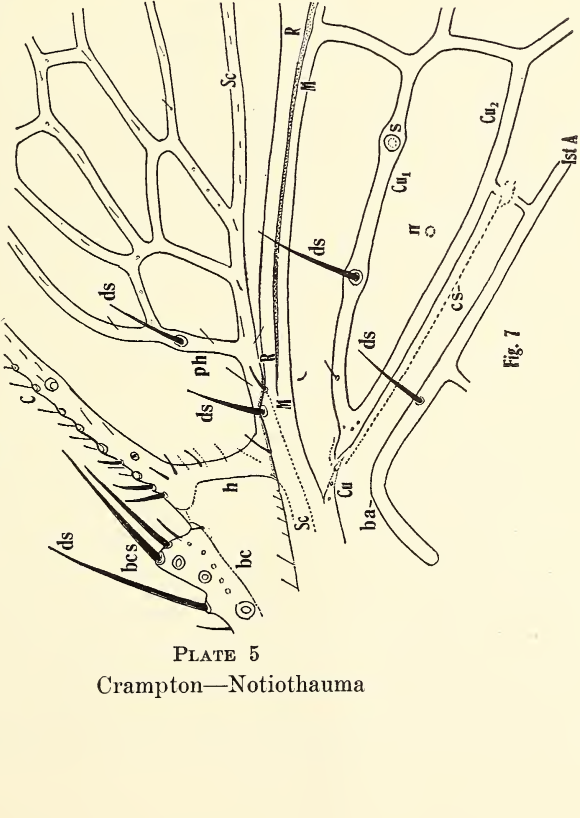

Fig. 7

PLATE 5
Crampton—Notiothauma

A NEW NEBRIA FROM MOUNT RAINIER

By P. J. Darlington, Jr.

An examination of the types of *Nebria kincaidi* Schwarz and *N. columbiana* Casey, which the authorities of the United States National Museum kindly permitted me to make recently, proves that the two species are absolutely identical. Schwarz's name has priority. This leaves the insect which has sometimes gone in collections as *Nebria columbiana* Casey without a name, so I propose that it be called

Nebria vandykei sp. nov.

Moderately stout, legs and antennæ slender. Color nearly uniform piceous or reddish piceous, but with the antennæ and parts of the under surface more or less rufescent; the head with two poorly defined reddish spots between the eyes; the elytra with weak purplish reflections. Head about five-sevenths as wide as the prothorax, eyes only slightly more prominent than the sides of the head behind them, antennæ more than one-half as long as the entire body. Prothorax about five-eighths as long as broad, strongly cordate, with the sides arcuate in anterior two-thirds and reflexed before the acute posterior angles; prothoracic base and apex moderately emarginate, base about five-eighths as wide as widest part; pronotum only slightly convex, median longitudinal line narrow and well impressed, basal and apical transverse impressions variable but usually well impressed, lateral margins rather narrowly reflexed. Elytra about three and two-thirds times as long as the prothorax and one-third to two-fifths wider, elliptical, with the widest point behind the middle; humeri narrow, completely rounded into the sides as in *Nebria ovipennis;* striæ deep, very finely and rather sparsely punctured; intervals posteriorly with a few inconspicuous interruptions. Inner wings only about one-third as long as elytra.

Length 10-13 mm. Width 4-5+ mm.

Holotype ♂ and allotype ♀ in the writer's collection from MOUNT RAINIER, WASHINGTON, near Paradise Valley, just below snow line at about 6000 feet elevation, July 18 and 13, 1927. A good series of paratypes from the same locality, July 13 to 20. All specimens taken by the writer. There is some variation in the precise form of the basal angles of the prothorax and in the punctuation of the elytral striæ, but the species is not a particularly variable one.

As has been said, this is the *Nebria* which sometimes goes in collections as *columbiana* Casey. It belongs to the *ovipennis* group, but differs from *ovipennis,* its closest relative, in the submetallic lustre of the elytra and the much longer antennæ. It resembles also *Nebria kincaidi* Schwarz (*columbiana* Casey), but the latter is a more convex and brilliant species, with a more strikingly cordate prothorax, with the elytral intervals more interrupted, and with more prominent eyes. It was probably Casey's failure to point out the last character in comparison with *Nebria ovipennis* Lec. which first led to the misidentification of his species. *N. vandykei* is obviously distinct from the other American species of Nebria with obliterated humeri (*ingens* Horn, *spatulata* V. Dyke, *riversi* V. Dyke, and *lyelli* V. Dyke), although I know *riversi* and *lyelli* only from descriptions.

I take great pleasure in naming this Nebria for Dr. Edwin C. Van Dyke, who has discovered and described so many fine species of the genus in western North America.

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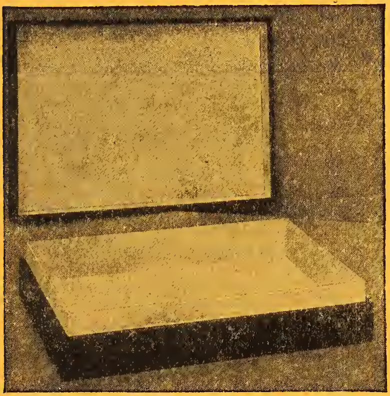
A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p. m. in Room J, basement of the Peabody Museum, Divinity Ave., Cambridge. Entomologists visiting Boston are cordially invited to attend.



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ANT-TREE NOTES FROM RIO FRIO, COLOMBIA

BY W. M. WHEELER AND P. J. DARLINGTON, JR.

The observations recorded in the following pages on the various insects inhabiting Triplaris, Cecropia and Acacia trees in the vicinity of Rio Frio, Colombia, were made by the junior author during 1928-'29. The only contribution of the senior author is the identification of the ants which regularly inhabit the trunks and twigs of Triplaris and Cecropia and the large thorns of Acacia, and some data secured in 1927-'28 in the same locality by Dr. George Salt. It has been impossible to obtain accurate specific identifications of the plants, because they were not in bloom when the observations were made.

I. TRIPLARIS AND ITS INHABITANTS

Two forms of this tree were found, one (Plate 1, lower fig.) with narrow, lanceolate leaves and apparently the same as the *T. americana* Linné which has been studied by the senior author in Panama, the other (Plate 1, upper fig.) with broader, more ovate leaves and perhaps merely a variety of the preceding. The narrow-leaved form is a small, straight, slender tree somewhat resembling a hickory in general appearance. Near Rio Frio it is rather closely restricted to the edges of brooks in and near the foot-hills of the Sierra Nevada de Santa Marta. It usually grows so close to the brook that it can get water during the dry season, for it is one of the few trees of the lower foothills which is not deciduous. No specimens of it were seen above 1500 feet.

When the narrow-leaved Triplaris is inhabited by *Pseudomyrma triplarina,* it ranks with the terrible nettle (*Jatropha urens* L.) that grows in much the same sort of place. Both plants offer tempting holds on the steep slopes along the brooks, and a few stings from either the nettle or the ants will cause the hands to swell painfully. Ants and their brood occupy cavities in the central stem and its lateral branches throughout the Triplaris, except near the base of the larger trees. The cavities, which are continuous and are apparently cut through the nodes by the ants, may be occupied up to the last or next to the last internode below the terminal bud. The entrances are perpendicular slits in the stem or branches and are about 120° around the stem from the base of the leaf next above. They are usually just below a node, but may be more than half way down to the node below. There is almost always at least one entrance to a node, and there may be several, one above the other.

In very young stems the medullary cavity is about half the diameter of the stem, nearly round in cross-section, except for the depressions noted below, and somewhat enlarged between the nodes. The passage through each node is greatly constricted. In stems an inch and a half in diameter the entrance may remain open, but the cavity even in the oldest stems is scarcely or not at all larger than in young twigs. The walls of the cavities in the latter are brown; in old twigs, black.

The depressions mentioned above are vertical, slit-like grooves in the walls of the cavities and are of two kinds, those which open into entrances and those which extend only to the inner surface of the bark and are used to house Coccids. The position of the entrances has been described; the Coccid houses have a rather more irregular location, but often seem to be incompleted entrances, to which in many cases they correspond in position. They are frequently placed just below leaf attachments, however, where there is often a smooth, slightly depressed area on the external surface of the bark. Whether these "Coccid houses" are natural or cut by the ants was not ascertained.

The Colombian Triplaris and its ants had been previously observed by Forel, and Dr. Salt. We quote the latter's notes of October 16, 1927: "Quebrada Rodriguez, Rio Frio. A small tree of Triplaris sp. (*americana* ? according to Johansen) about 12-15 feet high and 2 inches at 5 feet above the ground, was felled and some of the ants collected. They sting viciously, the poison causing the fingers to swell and bringing out red flushes right up to the arm. The ant-brood and coccids were found in the branches and at the tip. In every case the coccids were found at the upper or distal end of the internode, frequently right up against the partition, and the ant-brood at the lower or proximal end. In several places on the inside of the hollow trunk the wood was deeply pitted but not perforated. It was not determined whether the pits were made by the ants or were normal depressions. The exit holes of the ants are regular in position and undoubtedly are merely modifications of some previously existing structures (lenticels?) of the plant."

The following insects were found by the junior author associated with the narrow-leaved Triplaris (Plate 1., lower fig.):

1. *Pseudomyrma triplarina* Weddel subsp. *symbiotica* Forel. Probably the commonest and certainly the most vicious ant in the Triplaris. It does not inhabit every tree, however, nor does it always take complete possession, for it was sometimes found sharing trees with No. 3. Series of this ant were also taken by Dr. Salt in Triplaris, presumably of the narrow-leaved form, at Rio Frio and Aracataca.

2. *Azteca theresiæ* Forel. A common species forming large colonies. It bites but does not sting and was found sharing trees with Nos. 1 and 3. The var. *menceps* Forel of this species is a very common tenant of *T. americana* in Panama, according to the senior author's observations.

3. *Crematogaster* (*Orthocrema*) *parabiotica* Forel. A small, inoffensive ant which often colonizes single branches of trees inhabited by one or both of the preceding species.

Apparently these three ants are all capable of maintaining their colonies without leaving the home tree. At any rate, this is true of the Pseudomyrma, for two of the Triplares were banded with tanglefoot and their foliage thus isolated on December 17, 1928. One tree was about four inches through at the base and twenty feet tall; the other about five-eighths of an inch by nine feet. At the time both were inhabited by pure Pseudomyrma colonies, which remained reasonably healthy till the middle of February, when the experiment was discontinued. The larger tree, however, may have lost a part of its Pseudomyrma population (this point was, of course, very difficult to determine) and certainly acquired a small colony of Crematogaster in the interval. Only one or two ants were caught in the tanglefoot and none was ever seen to attempt to reach the ground. The ants do *not* maintain a cleared area about the tree.

4. *Camponotus* (*Myrmocladœcus*) *bidens* Mayr. A few specimens of this small, timid ant were taken on a Triplaris with Crematogaster in March. *C. bidens* and its congeners are known to nest in hollow, dead twigs of a variety of trees.

5. *Trachysomus thomsoni* Auriv. (det. Fisher). This big cerambycid beetle fells the living Triplaris by gnawing a girdle around the bark and wood of the trunk. It attacks trees up to nearly three inches in diameter. The larvæ feed in the wood of the pruned trunks. Three adults, which were bred out, emerged in July and August, but the precise time of pruning was not ascertained.

Trees that have been killed attract a number of wood-boring Coleoptera, which are listed below. The order of their appearance was determined from a tree which was felled with a machete on December 17.

6. *Steirastoma stellio* Pasc. (det. Fisher). This is a cerambycid which was seen only during the first week after felling. Seven specimens were taken, all clinging to the lower side of the felled trunk, so the species is probably nocturnal.

7. *Odontocera* sp. nov. (being described by Fisher). This cerambycid, of the tribe Necydalini, appeared during

the first week after felling and continued to come for nearly a month. It bred abundantly in the Triplaris. The beetles are diurnal and may be seen hovering and dipping over the dead wood like Vespidæ. There is one vespid which they very much resemble and which sometimes occurs with them. The beetles were caught or bred out in January, March, May, June, July and December, so the species is probably multiple-brooded. Four specimens were taken in June near Santa Marta, on wood which was not Triplaris, but they may not have been breeding in it.

The two following species behave like this undescribed Odontocera, to which they are closely related. They were so scarce by comparison, however, that they furnished only scanty data.

8. *Odontocera fasciata* Ol. (det. Fisher). Eleven specimens were taken in January, May and December. Some were breeding with No. 7, some flying to dead Triplaris.

9. *Odontocera* sp. nov. (being described by Fisher). Five specimens were cut from dead Triplaris with No. 7 in May.

10. *Amphicerus cornutus* Pallas (det. Fisher). This large bostrychid beetle appeared on the dead Triplaris January 15, about a month after felling. The first specimens were cut from tunnels which entered the hard wood of the trunk at right angles, but curved around parallel to the grain at a depth of about half an inch. On February 17, two months after the tree was felled, five of these beetles were cut from the ramifications of a single tunnel system. The tunnels were, of course, made entirely by the adults and no sign of eggs or larvæ could be found. Two specimens were taken at Santa Marta in May, probably at light.

11. *Dendrobiella sericans* Lec. (det. Fisher). This small bostrychid was first noticed during the third week after the Triplaris was felled, when adults were boring into the dead trunk. The species was common.

12. *Scalidia* sp. (det. Fisher). This cucujid appeared with the small bostrychid (No. 11), on which it probably

preys. At any rate on January 11 one of the cucujids was seen trying to pull a bostrychid out of its gallery entrance by the declivity of the elytra.

13. *Chrysobothris viridiimpressa* C. & G. (det. Fisher). One specimen of this buprestid was taken in tanglefoot on a living Triplaris early in January. Two or three other individuals were seen, all on plants of other species, so the occurrence of the beetle on the ant-tree was probably accidental.

14. *Membracid,* sp. A small, simple species with spotted wings, of which both adult and immature individuals were collected at leaf axils on the Triplaris. The tree was inhabited partly by Azteca and partly by Crematogaster. Neither ant seemed to be paying any attention to the hoppers, however.

15. *Pseudococcus probrevipes* Morrison. These Coccids live with both the Pseudomyrma and the Azteca. They are usually found in the groove-like channels or pits which are mentioned on page 108, but they may occur at the sides of entrances or around the nodes, always, of course, inside the tree. They are often so crowded into their "houses" that, if feeding is possible only on the inner surface of the bark, they must take turns at it.

The broad-leaved Triplaris (Plate 1, upper fig.) is a smaller, more compact tree than the narrow-leaved form and grows in a different habitat, at the boundary of forest and new clearing far from water. It may perhaps be the same species modified by unfavorable conditions. The wood structure was not examined in detail but seemed to be the same as in the narrow-leaved form. The only ant taken in the broad-leaved Triplaris was *Pseudomyrma triplarina symbiotica,* but it is comparatively scarce and colonizes only a small proportion of the available plants. The following insects inhabit the twigs or live on the foliage:

16. *Thyridid,* sp. The greenish larvæ of this moth were found on April 7 in the medullary cavities of Triplaris which had *not* been colonized by ants. The same or a very

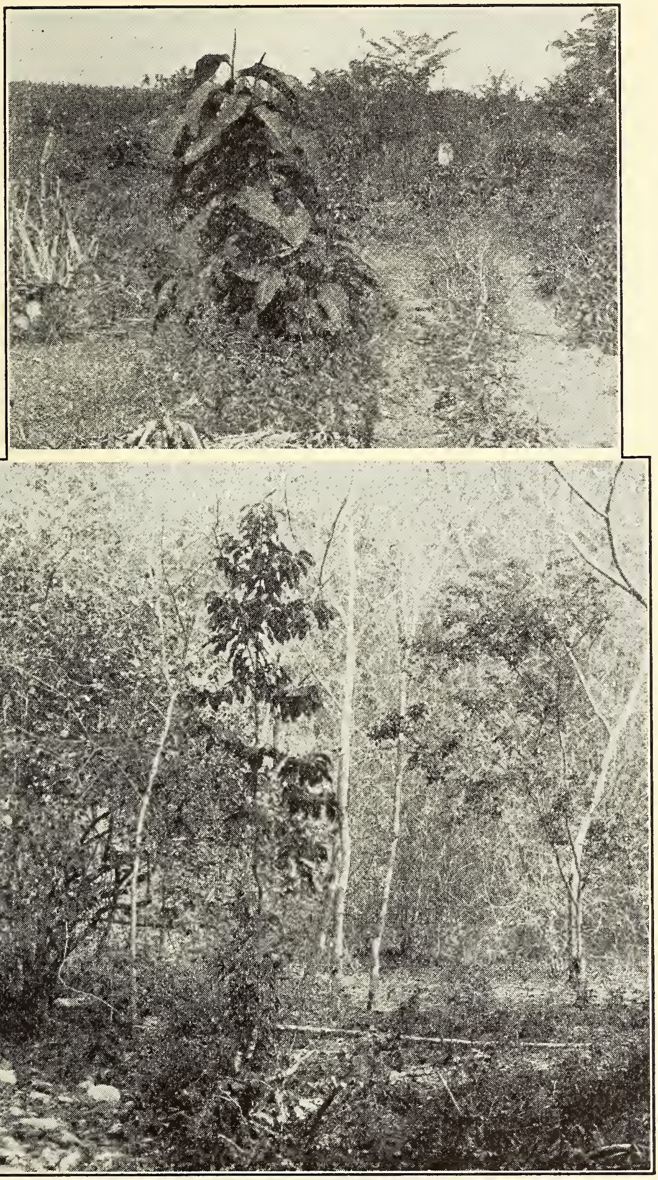

Plate 6

Wheeler and Darlington—Ant-Tree Notes

similar larva has been frequently taken by the senior author in the twigs of *T. americana* in Panama.

17. *Cassidid*, sp. This beetle was brilliant green in life. It was common on Triplaris foliage in May. Other specimens were collected in March and November. When the beetles were taken no ants were visible on any of the trees, but this may have been because the latter were too young to have been colonized, or more probably because the colonies produced in the internodes by the recently fecundated females were still undeveloped.

18. Coccids undetermined. Although these may have been present in the ant-inhabited trees, they were taken only in the cavities which had not been colonized.

II. CECROPIA AND ITS INHABITANTS.

Cecropias, called locally "guarumo," are common trees in second-growth land and similar situations from sea-level up to at least 4500 feet. They are absent in the very arid regions, however. As has been noticed by other observers, they are among the first trees to come in when cultivated land is abandoned. Although the ants (*Azteca alfari* Emery) which inhabit the Cecropia bite severely, the tree is so conspicuous and easily avoided that it does not cause much trouble. The ants seem to get all the necessities of life from their trees. At any rate a well-colonized tree which was isolated by machete work and tanglefoot on December 15 seemed to have its population unreduced at least up to February 27. The peculiar structure of the plant has been so often described that it need not be considered in this place. The following insects were found associated with the Cecropias:

19. *Azteca alfari* Emery. Practically all the plants, except the very young ones, are inhabited by this ant.

20. **Azteca xanthochroa** Roger. subsp. **salti** Wheeler, subsp. nov. The worker minor measures 2.5 mm. and is

gaster, antennæ and legs deep castaneous brown, the head black, the mandibles and corners of the clypeus red. Pilosity shorter and less abundant, especially on the head. Antennal scapes extending a distance greater than their apical diameter beyond the posterior corners of the head.

The female (deälated) measures 10-12 mm. and has a longer and posteriorly narrower head than any of the more shining than the typical form of the species. Thorax, other forms of *xanthochroa,* with nearly straight sides, deeper excision of the posterior border and less convex eyes. Thorax and gaster somewhat darker, more reddish yellow; head, antennæ and femora red, clypeus and mandibles deep red. Hairs on the body and tibiæ blackish, long and abundant; appressed pubescence also long but yellowish.

Described from numerous workers and fifteen females, constituting small incipient colonies, taken by Dr. George Salt from the internodes of young Cecropias at Vista Nieve, Sierra Madre de Santa Marta, Colombia, at an altitude of 5000 feet.

21. *Cœlomera cayennensis* Fabr. In life this Chrysomelid beetle has bluish-black elytra and a reddish prothorax. It is very common on young plants, but *never,* in the experience of the junior author, on the older ones. The old plants often have the leaves stippled with minute holes, the origin of which was not discovered, but never have the marks of beetle feeding. Nor were any of the chrysomelids seen on Cecropias containing developed colonies of Azteca, but this may, of course, have been because the beetles preferred the young plants as food and not because they had been driven away from the older ones by the ants. Beetles were taken in January, February, May, June, July, November and December. They are, therefore, probably either multiple-brooded or always present.

During the rains, probably in May, the junior author feels reasonably certain that he saw large Scarabæids (apparently *Pelidnota* sp.) feeding on young Cecropias, but he did not know at the time that the plants were worth study.

22. Coccids. These were found in the cavities of the Cecropias with Azteca.

It is noteworthy that dead Cecropia logs failed to attract borers, although they were carefully examined at different times.

Birds were not seen to visit Triplaris, but the Cecropias were observed to be favorite feeding grounds of several species, particularly in November. Some of the species noted were:

Forpus spengeli (Hartlaub), a minute, green and blue parrot,

Brotogeris jugularis jugularis (Müller), a small green parrot,

Momotus momota subrufescens Sclater, the local motmot,

Pteroglossus torquatus nuchalis Cabanis, a toucan,

Centurus rubricapillus rubricapillus Cabanis, a common woodpecker,

Thraupis episcopus cana (Swainson), a common tanager. None of these birds was ever seen to act as if it had been attacked by the ants.

III. NOTE OF ACACIA.

Ant-inhabited acacias were found only near Aracataca, in the extreme southern part of the region over which the junior author collected. The largest plant examined was hardly more than ten feet high. Though he had no opportunity to study the relations of the ants to the plants in detail, he secured a number of the former from the large thorns. They prove to be specimens of *Pseudomyrma spinicola* Emery subsp. *gaigei* Forel. The types of this form were taken by Dr. F. M. Gaige at Fundacion, south of Santa Marta, probably from thorns of the same species of Acacia. The senior author has found a very similar form of *Ps. spinicola* in the thorns of *A. penonomensis* on the Pacific side of the Panamanian isthmus. The spines of the Colombian Acacia secured by the junior author resemble those of the Mexican *A. Hernandezi* Safford, but the plant is probably undescribed, because no bull-thorn acacias seem to have been recorded from Colombia.

DESCRIPTION OF PLATE 6

Above

Triplaris sp. ("Broad-leaved Triplaris"). A five-foot tree in characteristic habitat near Rio Frio.

Below

Triplaris sp., probably *T. americana* Linné ("Narrow-leaved Triplaris"). A twenty-five-foot tree in characteristic habitat near Rio Frio. The felled tree upon which wood-boring insects were collected lies across the foreground.

DESCRIPTIONS PLUS TYPES *VS.* DESCRIPTIONS ALONE.[1]

By Clarence E. Mickel,
University of Minnesota.

In a recent article in Psyche [36(3):228-231, September, 1929] entitled "Down with the Type-Cult," Professor Embrik Strand of the University of Riga, Latvia, condemns the practice of designating type specimens when a new species is described, charges that their use is contrary to the International Rules of Nomenclature, and urges the principle that the description should be the final and only authority in deciding disputed points regarding the identity of a species.

The principal arguments advanced by Professor Strand in his opposition to the use of types may be summarized as follows: (1) that the early authors such as Linné, Fabricius and others did not designate or use types, therefore we should not; (2) that the establishment of species on the basis of types is opposed to the rules of nomenclature; (3) that even if one asserts that the types have been used only in order to verify and better the descriptions, it is likewise an abuse, if it leads to conclusions that are quite contradictory to the descriptions; (4) that type specimens are the fashion because certain taxonomists by their use are able to dominate taxonomy, and therefore have a personal interest in maintaining the practice; (5) that in most cases the types are not accessible to the worker, that on this account it will soon be impossible to write a monograph if the examination of the types is to be considered a necessary prerequisite, and that therefore the practice of designating

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and using types should be abolished; (6) that the entomological public is obviously apt to place more confidence in the new "examiner" of the type than in the original describer, and that to protect the latter and do him justice the practice of designating and using types should no longer be tolerated; (7) that when a specialist or reviser secures a second party to compare his specimens with the type, swindles are often perpetrated on the entomological community, and therefore the practice of using types should be dispensed with; and finally (8) that the description is quite an absolutely constant, invariable thing which is accessible to the whole world, and is therefore everything, and in case of a disputed point with regard to the identity of a species the description should be the final and only standard or authority.

It will be advantageous to consider these charges and arguments one by one and see how much basis in fact there is for maintaining them.

(1). The first point is that since early entomological workers did not use types, we should not; that since our forefathers did not do so-and-so, we should not; a sort of ancestor worship. If the work of the older authors be examined it will be found that they did not limit species as strictly as we do today; they did not realize the value of geographical, ecological and other precise data in taxonomic work, and consequently stated what data was available to them in exceedingly general terms. They could not foresee that the specimens of the species which they described would be of great value to future generations, and therefore paid little attention to them. Like certain workers of today they were so absorbed in writing descriptions of new species that this activity seemed to them to be the ultimate aim of taxonomy, and they therefore had no time for taking proper care of the specimens on which their work was based. Neither did they have any conception of the enormous number of species of insects that would eventually be found inhabiting the earth. If there were only ten, or a hundred, or a thousand, or even ten thousand species of insects known for the world the necessity for type specimens might not seem very obvious; but when the number of species rises to hundreds of thousands and possibly millions, then the need for some standard of reference for each species becomes very plain. So the older workers, who did not realize the enormous number of species of insects with which taxonomy would have to deal, had not come to feel the need of types, and to argue that since the older workers did not designate type specimens, we should not do so today, is to argue that the taxonomy of a hundred, or one hundred and fifty years ago is good enough for us, that progress and advancement in technique and analysis is undesirable in the field of taxonomic research. No taxonomist who is seriously interested in the improvement and advancement of taxonomic work would ever be tempted to adopt such a principle.

(2). The establishment of species on the basis of types is opposed to the rules of nomenclature. First it should be pointed out that the rules of nomenclature are not concerned with the establishment of species, but only with the names of species, subspecies, genera and other categories in use in the field of zoology. If by this statement Professor Strand means an attempt to establish a specific name on the basis of a museum specimen only, then he is quite correct and is supported in his contention by Opinion one, of the International Commission on Zoological Nomenclature, which states that in no case is the word "indication" to be construed as including museum specimens. If, however, he means that in an attempt to decide the identity of a species with a valid specific name, the use of, or designation of, a type specimen to solve the problem, is opposed to the International Rules, then he most certainly is incorrect, since the International Commission has ruled on that point in Opinion seventy-eight regarding the validity and identity of the names of two ticks. The validity of the names was decided on the basis of the first properly published description or indication, while the identity of each was decided on the basis of type specimens, which in both cases were designated some time after the first publication of the names.

(3). If the conclusion reached by using a type specimen to supplement a description is contradictory to the latter, then it is an abuse. To show the impossibility of using any such principle as a criterion as to whether the use of types is scientific or not, it is only necessary to call attention to the innumerable cases in entomological literature where a description of a new species has been drawn up based on a series of two or more specimens. Such a description is a composite one, including characters seen by the author in all of the specimens before him. In many such cases we know now, or at least the evidence available leads us to believe, that this series of specimens consists of more than one species. Therefore, the description includes characters of all the species represented in the series of specimens which the author had before him when he wrote the description. For the sake of simplicity we will suppose that two species were represented in such a series of specimens. If a single specimen from the original series of specimens is designated as the type, then the species which it represents will have some characters which are contradictory to the description, because the latter is composite. If a specimen of the second species represented in the original series is designated as the type the result will be the same; it will be contradictory to the description. Then one is at an impassé, if this principle is to be adopted; the description applies to neither of the two species, since whichever one is selected brings results contradictory to the description, and the only other recourse is to place the description in that zoological graveyard "*species incertæ sedis*," where it will remain forever. If the description is everything, and nothing but that is used, the result is the same, since no object in nature is to be found but what is contradictory to the description to some degree, and the name, therefore, finds its way into the list of "*species incertæ sedis.*" The adoption of this principle then, i. e., that if a type is used to supplement a description, and the conclusion reached thereby is contradictory to the description, then the use of the type is an abuse, would only lead to more confusion, additional names for which we could find no objects in nature, and more inaccuracies in taxonomic work.

(4). It is implied that type specimens have come to be so widely used, not because they have added an element of certainty and exactness to taxonomic work, but because certain taxonomists by their use are able to dominate taxonomy, and therefore have a personal interest in maintaining a type system, that they secure for themselves either power or personal aggrandizement by the perpetuation and strengthening of such a system. Granting for the moment that such a motive were possible, would the situation be any worse than that which now exists and which allows an individual to acquire eminence and renown as a taxonomist, although he contribute nothing more to taxonomy than an endless number of descriptions of new species, to which his name must be attached. The idea that the describing of species may be a major objective in taxonomic work is seriously questioned by many present-day entomologists. Just what personal power and aggrandizement can be secured by an individual by basing his taxonomic work on type specimens is not made clear, and the charge that the practice of designating types for species is maintained by those who personally profit from the system, sounds strikingly similar to the charge usually made by the opposition, who refuse to see any good in any new idea, and who in order to encourage prejudice against it, accuse the proponents of promoting their own personal interests. As a matter of fact, type specimens were first used, and their use continues and is being perfected, because they have contributed an element of standardization to taxonomic work. A type specimen constitutes a standard by which other individuals of the same species may be measured and compared, and when so used it contributes accuracy and exactness to a field where doubt and confusion have been prevalent. When a nation desires some standard for a unit of weight, measure, etc., does it write up a lengthy description of the particular unit and declare that this description will be the only and final authority to determine what the unit actually is? It does not. Some sort of a material standard representing the particular unit is set up and is very carefully kept and preserved. When questions of doubt arise as to the exact characteristics of the unit, the standard is the ultimate and only source of comparison by which any particular characteristic of the unit may be determined.

(5). Kleine's (1928) complaint is cited to the effect that the types in most cases are not accessible to the worker and shortly it will be quite impossible to write a monograph if an examination of the types is to be considered a necessary prerequisite for such work. Under present conditions, with types scattered in various places, there can be little question but that the amount of work and expense necessary to produce a monograph of any group of organisms would be greatly reduced if the examination of type specimens could be dispensed with, and any scientific worker is certainly at liberty to write a monograph based on nothing more than the descriptions of the species involved. But the author of such a monograph must remember that the scientific world will judge his contribution by the accuracy and exactness which he has been able to achieve by his method of treatment. The scientific world has learned from sorrowful experience that monographic works based on nothing but published descriptions are so inaccurate and untrustworthy as to be practically valueless, and while monographs prepared according to that method may still be produced, they are not very likely to receive serious consideration. The very fact that taxonomists have come to realize that scientifically sound and accurate work cannot be produced when based solely on descriptions, is the motivating force that has driven them to use a type specimen as a standard when some disputed point is to be decided. The use of type specimens has enabled taxonomists to achieve results of greater scientific value than the use of descriptions alone, and as long as types continue to contribute such a quality to taxonomic work, just so long will they be used, regardless of additional work or expense.

(6). Another objection to the use of types raised by Professor Strand is as follows: "That the entomological public is obviously apt to place more confidence in the new examiner of the type, than in the original describer. Who guarantees that the new examiner of the type is abler than the original describer in this respect? I think that it has often happened that the reviser has degraded a number of species into synonyms because he did not see the distinctive marks which the original describer stated, and which in reality are present." The truth is that the entomological public has no more confidence in the reviser, or new examiner of the type, than it has in the original describer. The work of both must stand or fall on its merits. As a matter of fact the original describer is better protected against injustices if he designates a holotype, than he is if he refuses to acknowledge the usefulness of types and clings to the theory that the description is everything. A description may be so poor that it is indistinguishable from that of several related species and if the description was everything the species would then be relegated to synonymy; but if a holotype has been designated, a standard can be examined and the status of the disputed species determined in relation to other species of its group. For every species that has been relegated to synonymy unjustly due to an examination of a type, three or four can be cited which have been elevated from synonymy to validity due to the fact that a type specimen was available for examination, and three or four more could be cited which are probably valid species, but which have been placed in synonymy because they are indistinguishable from previously described species on the basis of the description, and either no type is available, or if available, has not been examined. The best guarantee which a taxonomist can secure against injustices in the estimation of his work is a properly designated holotype for every species described, said holotype deposited in an institution where all may see.

(7). The comparison of specimens with the type by persons other than the reviser or specialist is resorted to relatively few times in entomological taxonomic work. That is, comparing the number of types actually examined by the reviser, with the number examined by proxy, the latter will be found to be relatively small. Judging from my own experience, the safeguards set up by the reviser to prevent the second party from arriving at an erroneous conclusion when comparing certain specimens with the type, are ample to prevent errors in most cases. Such precautions also testify to the good faith of the reviser and indicate that he is seeking for the truth regardless of what it may be. If taxonomists as a class are so intellectually dishonest as to swindle the entomological public in this way, as Professor Strand claims, how much easier it would be to perpetrate such swindles if the description were everything. It happens rather often that the descriptions of two species are indistinguishable when compared word for word. In such a case the reviser would need to go no further; his report would be that here are two descriptions exactly alike and therefore one of them must be relegated to synonymy. If the descriptions were everything no one could challenge his conclusion, since there would be no source of evidence with which to support such a challenge. Species have been relegated to synonymy by this method many times in the past, with the result that when the types were finally located and authenticated it was found that the description referred to a good and valid species. Descriptions or types, either one, will not prevent intellectually dishonest persons from perpetrating swindles, nor will the use of either one tempt an honest man to use dishonest methods in his research. If Professor Strand knows of concrete examples of such swindles, as he claims, it is his duty to bring them to the attention of entomological taxonomists, together with the facts and evidence to prove that they are swindles. To point out concrete examples and expose them as swindles will do more to eliminate dishonest work from the field of entomological taxonomy, than assailing a method of technique and mode of thought which has improved the quality of taxonomic work.

(8). And finally it is contended that the description is quite an absolutely constant, invariable thing which is accessible to the whole world, while the question is asked: "Who guarantees that the animal designated as the 'type' really is the type"? The implication in the question is, that taxonomists as a group, in the field of entomology, at least, are so dishonest and unreliable that type specimens in general cannot be relied upon to be what they claim to be, i. e., the original specimens from which descriptions or figures have been drawn, and in many cases designated as type by the author himself. If this implication of dishonesty and unreliability were true, who could guarantee that any published description was applicable to any organism existing in nature? If a worker is dishonest enough to manipulate types or type labels, he is dishonest enough to write descriptions of species based on nothing more than fancies of his imagination, with no counterpart in nature whatever. To be dishonest with respect to scientific descriptions or type specimens is like cheating at solitaire—one is only cheating himself. It is true that rogues may be found in every field of human activity, but they are usually comparatively rare in scientific professions. With respect to honesty and reliability, I believe that taxonomists as a group will compare favorably with any other group of scientists, or with other selected professional groups, and the implication that type specimens in general are unreliable, due to the dishonesty of taxonomic workers, seems to me to be entirely unjustifiable.

The theory that the description is everything is one that is not universally tenable. Article twenty-five of the International Rules of Nomenclature states: "The valid name of a genus or species can be only that name under which it was first designated on the condition (a) that this name was published and accompanied by an indication, or a defition, or a description." Opinion one of the International Commission states: "The word '*indication*' in Article twenty-five-a is to be construed as follows: with regard to specific names, an 'indication' is (1) a bibliographic reference, or (2) a published figure (illustration), or (3) a definite citation of an earlier name for which a new name is proposed." In the case of two of these there is no description which can be everything. A bibliographic reference is a substitute for a description in validating a name. A published figure is either a substitute for a description, if the latter is lacking, or it is a supplement to the description in case the latter is present. If the description is everything and objection is made to the type because it is a supplement to the description and therefore erroneous conclusions may be drawn from it, then a published figure is in the same class as the type. It is a supplement to the description and conclusions drawn from it may be contradictory to the description. If the principle "the description is everything," were rigidly construed, type specimens, published figures, museum specimens, or any description subsequent to the original one could not be used in the preparation of a monograph. How far would taxonomy progress if such a principle were adhered to? We would then have a mass of innumerable dogmas (descriptions) of which every word must be literally believed as true, and which would be looked upon as the final and only source of information regarding natural science. Such a condition actually existed in science for hundreds of years. From 200 A. D. to 1543 A. D. the written words of Galen describing the anatomy of the human body were looked upon as the final and only authority in this field. Galen's descriptions were everything. If discrepancies were found between Galen's descriptions and a dissected human cadaver, the descriptions were right, the cadaver wrong. During the period that this type of thought prevailed the spirit of scientific research was absent in all fields of knowledge, and anatomy as a science was stagnant. It was only when Vesalius overthrew authority and resorted to the dissection of the human body itself that anatomy began to progress as a science. Since Vesalius' time descriptions have been a necessary and useful method of recording scientific knowledge, but they have not been the final and only authority in anatomy or in any of the other sciences. In taxonomy individual specimens of the various species of animals and plants are our only source of information, and to outlaw such specimens, or even one selected specimen, designated as the type or standard, and to substitute therefore a written description is to substitute dogma for science, to substitute authority for research, a folly of the worst sort.

SUGGESTIONS REGARDING THE USE OF TYPES

Two practices now exist in the preservation and use of type specimens which make the work of the taxonomist who attempts any sort of a monographic revision much too difficult and expensive. Inasmuch as careful, accurate, analytical, monographic work is more needed in entomological taxonomy today than ever before, the modification of these practices in such a way as to remove the difficulties would have the effect of encouraging that type of work. These two practices are: (1) the policy of never loaning types from public museums under any circumstances; and (2) the practice of individual taxonomists in retaining holotypes in their private collections.

When any taxonomist undertakes the study of any limited group of insects, he usually finds that the holotypes are scattered over the earth among various institutions and individuals. In order to examine these holotypes it is necessary under present conditions to expend large amounts of money and time traveling to and from all of these places in order to accomplish the work. It frequently happens that the individual has neither the funds nor the time at his disposal to undertake the study of the types, and the result is that he produces either a distinctly inferior piece of work than that of which he is capable, or he produces nothing at all. The types are indispensable and should be religiously preserved, but we surely ought to be able to find some way to modify the present practice in order to make it possible for a deserving taxonomist to study the holotypes concerned in his work without forcing him to incur impossible burdens of expense and time which are now necessary. No changes in the policy of handling types should be made without due consideration of all the possible consequences, but there must be some way in which these difficulties could be overcome. Possibly some system of interinstitutional loans might be devised whereby the necessary type material could be concentrated at some institution near the worker concerned, and the latter be allowed to work there under proper supervision. There may be other possibilities in the way of solutions of this problem, but it is a serious enough one to challenge the best thought of all concerned.

The practice of individual taxonomists in retaining types in their private collections is a distinct disadvantage to entomological taxonomy as a whole. In the first place it is an incentive to an individual for the mere describing of new species in order that he may gain the holotype for his own collection. If any incentives are allowed to exist in present-day matters to benefit entomological taxonomy as a whole, they should operate to discourage mere describing of new species, and encourage careful, monographic work. This the practice does not do. In the second place a holotype once designated and published, no longer rightfully belongs to the individual, but belongs to the whole entomological fraternity. This principle has been recognized with regard to the published description. The latter once published, belongs to entomological science and not to any individual. Any rights which the author may have had with regard to it are lost to him upon publication. This principle is much more true with regard to holotypes upon which descriptions are based. The holotypes are the standards with which other individuals of the same species may be compared. Standards, as such, belong to the entomological community as a whole and not to any individual. What nation would allow any individual for one moment to possess any standard of weight, measure, etc., as private property and exercise his rights of private property over it? Such standards are recognized as belonging to the community and are preserved by national governments as such.

The retention of holotypes in private collections then, should be discouraged, and individual workers should be encouraged, if not compelled to deposit holotypes in some one of the many existing institutional collections. Many of the petty disputes and personal enmities which have arisen, and will continue to arise, over the matter of access to holotypes in private collections would thereby be mostly eliminated. It is admitted that the original describer might occasionally have to visit the institution where his types were deposited, but this would be no greater hardship for him than for any other taxonomist working in the same field. All of the rights of the original describer would thereby be preserved, and the interest of the entomological community would be better served than at present.

CONCLUSIONS

1. A type specimen constitutes a standard by which other individuals of the same species may be measured and compared, and when so used it contributes accuracy and exactness to a field where doubt and confusion have been prevalent.

2. The argument that since early entomological workers did not use types, we should not, is not worthy of consideration by a scientific worker.

3. The establishment of the identity of species by means of type specimens is not opposed to the rules of nomenclature; on the contrary, the International Commission of Zoological Nomenclature has used this means of identifying species in rendering Opinion seventy-eight.

4. The principle that if a type is used to supplement a description and the conclusion reached thereby is contradictory to the description, then the use of the type is an abuse, is untenable, and would only lead to more confusion and more inaccuracies in taxonomic work.

5. Type specimens have come to be widely used and accepted in taxonomic work, because they add an element of certainty and exactness to such work, and not because certain taxonomists have a personal interest in maintaining the practice.

6. The use of type specimens has enabled taxonomists to achieve results of greater scientific value than the use of descriptions alone, and as long as types continue to contribute such a quality to taxonomic work, just so long will they be used, regardless of additional work or expense.

7. The best guarantee which a taxonomist can secure against injustices in the estimation of his work is a properly designated holotype for every species described, the holotype to be deposited in an institution where all may see.

8. The comparison of type material by proxy does not tend to promote intellectual dishonesty among taxonomic workers. The exposing of concrete cases of dishonesty will do more to eliminate it than to abandon the use of type specimens.

9. With respect to honesty and reliability taxonomists as a group, will compare favorably with any other selected professional group, and the implication that type specimens in general are unreliable, due to the dishonesty of taxonomic workers, is entirely unjustifiable.

10. To eliminate type specimens and make the description everything, would be to substitute dogma for science, to substitute authority for research, an intolerable alternative.

11. Some method should be devised by which type specimens would be made more accessible to taxonomic workers than they are at present.

12. The practice of individual taxonomists in retaining types in their private collections is a distinct disadvantage to entomological taxonomy as a whole and should be discouraged.

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NEW SPECIES OF THE GENUS XYSTICUS (ARACHNIDA).

By Elizabeth B. Bryant.

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In a recent revision of the spiders in the genus Xysticus at the Museum of Comparative Zoölogy, five new species have been found. Two more have been figured, one for the first time and the other to show more definitely the striking features of the palpus.

Xysticus aprilinus sp. n. (Fig. 4).

♀ 5 mm. long, cephalothorax 2.5 mm. long, 2.5 mm. wide.

Cephalothorax light, with a broad, brown stripe each side of the median light stripe, marginal markings faint and lacking the terminal light spots; dark spot at end of thoracic groove missing; abdomen much shrunken, showing no markings but occasional dark dots; abdominal bristles long; legs light with a light brown stripe edged with faint irregular dark marks on all legs, faint broken band at end of femur IV; sternum, venter and under sides of legs light; spines, I tibia, 4-2, no lateral, metatarsus 5-4, 1 lateral. Cephalothorax as long as femur I. Head very broad; bristles at edge of clypeus long. Epigynum longer than broad, very dark, with a simple round cavity showing no septum.

1 ♀ Texas; El Paso, 5 April, Soltau coll., N. Banks Collection.

The two broad, brown stripes on the cephalothorax, the light, unspotted legs makes this distinct from any other species.

Xysticus coloradensis sp. n. (Figs. 1, 3, 7).

♂ 5.5 mm. long.

Cephalothorax light, mottled brown each side of the median light stripe, ending with two pairs of small, dark spots on each side surrounded by a clear, cream color; the median light stripe with scolloped edges and faint dark marks behind the eyes, the usual dark spot at the end of the thoracic groove very small; bristles at the edge of the clypeus long; abdomen light with many small irregular dark marks with no distinct pattern; abdominal bristles long; legs light with many dark spots, light stripe on anterior legs indistinct; spines, I femur, many long spines on upper surface, tibia 4-4, the two middle pairs longer than the diameter of the joint, 3 lateral, metatarsus, 4-4, longer than diameter of the joint, 4 lateral, tarsus less than one half the length of the metatarsus. Cephalothorax as long as I femur. Sternum, coxae and venter light with small dark dots.

Palpus. The upper process of the tibia, ending in a sharp point under the tutaculum; the middle process prolonged into a large knob, the end covered with small bristles, between the upper and middle process is a large bristle; the lower process light colored, extending over the palpal organ, twisted with a broad tip. On the upper side of the tarsus are three long bristles. The tutaculum prolonged into a sharp process covered with curved hairs. The upper apophysis of the palpal organ is reduced to a small rounded knob; the lower is prolonged into a sharp curved point which rests on the outer curve of the tube.

♀ 6 mm. long; cephalothorax 2.5 mm. long, 2.5 mm. wide.

The female has the same markings as the male; the scolloped edge of the light stripe is more pronounced. The abdomen is spotted and shows a faint serrate median light stripe. The legs are spotted and the light stripe faint, spines, I tibia, 4-3, the two outer middle ones as long as the diameter of the joint, no lateral; metatarsus, 3-3, 2 lateral. The tibia is very short, only once and a half the length of the patella. Cephalothorax longer than I femur. Sternum and venter light with scattered dark spots.

Epigynum is a simple round cavity showing no median septum.

1 ♂ holotype. Col., Fort Collins, N. Banks Collection.

2 ♀ cotypes Texas; El Paso, 5 April, Soltau coll., N. Banks Collection.

2 ♀ New Mex.; Las Vegas, N. Banks Collection.

1 ♀ Col.; Ft. Reynolds, Dr. Miller coll.

It is probable that the two females from Texas are the same species as the male, as they have the same scolloped edge of the median light stripe, the two pairs of lateral spots on the cephalothorax, and the small dark spot at the end of the thoracic groove, and the spotted abdomen.

Xysticus floridanus Banks (Figs. 2, 5).

Trans. Amer. ent. soc.; 1896, 23, p. 70.

♂ 3.2 mm. long.

Cephalothorax clear, yellow-brown with a V-shaped light mark extending from the posterior lateral eyes to end of thoracic groove; abdomen with a serrate median light mark, bordered by three pairs of irregular brown spots, sides light brown; legs, femur I and II yellow-brown, tibia, darker brown, metatarsus and tarsus yellowish; posterior legs pale without markings; sternum and venter pale. Cephalothorax shorter than femur I. Head very broad. Spines, I femur 3, tibia 4-4, long spines, no lateral, metatarsus, 3-3, the second and third very long, and no lateral.

Palpus. Tibia with the usual three processes; the upper, a pointed flattened lobe; the middle a broad plate-like projection, and the lower a slender curving hood. The palpal organ is very simple. The upper apophysis is missing and the lower is light colored and in the lateral view appears only as a slight swelling in the lower part of the palpus. The tutaculum is very small.

1 ♂ holotype. Fla.; Punta Forda. N. Banks Collection.

Xysticus fraternus Banks (Figs. 6, 8).

Journ. N. Y. ent. soc.; 1895, 3, p. 90.

Xysticus hamatus Keyserling, Verh. z. b. Ges. Wien, 1884, 34, p. 521, pl. 13, fig. 22 (name preoccupied by Thorell, 1875).

Xysticus hamatinus Banks, Bull. U. S. nat. mus., 1910, p. 48.

In his description, Keyserling fails to describe the palpus and the only figure given omits the most striking character. This, Mr. Banks described as "a long plate-like piece projecting straight across the bulb towards the top of the palpus." The lower of the two apophysis usually found in the center of the palpus is prolonged into a slender piece which extends obliquely across the center; the upper apophysis is reduced to a small darkened, obtuse point which lies under the upper end of this piece. The end of the tube is bent almost at right angles and is probably one of the dark hooks figured by Keyserling.

The tibia has the usual three processes, the upper, resting against the tarsus, under the tutaculum, the lower a broad flattened piece and the middle reduced to a very small projection between the two. The palpus is much larger than is usual in the genus.

The type of Keyserling is from Bee Spring, Ky. Mr. Bank's type is from Sea Cliff, N. Y. In the M.C.Z. collection it is found from Cohasset, Mass. (17 June, 1914, E. B. Bryant Coll.) south to Falls Church, Va., and west to Las Vegas, New Mexico.

Xysticus keyserlingi sp. n. (Figs. 9, 10).

♂ 4.2 mm. long.

The cephalothorax with sides mottled with brown, much darker at the posterior part, median pale stripe with brown markings to form lyre-shape mark, ending with inconspicuous dark spot at the end of the thoracic groove; abdomen with median spear-shape mark of brown, and three pairs of lateral brown marks; anterior sides almost white; legs mottled with brown, I and II with distinct brown stripe; spines I tibia, 4-4, metatarsus, 4-4, longer than diameter of joint, 2 lateral. Sternum, underside of legs and venter mottled with brown. Cephalothorax longer than I femur.

Palpus. Tibia with the usual three processes, the upper a flattened lobe ending in a distinct spine bent at right angle; the middle process lobed and the lower long, slender

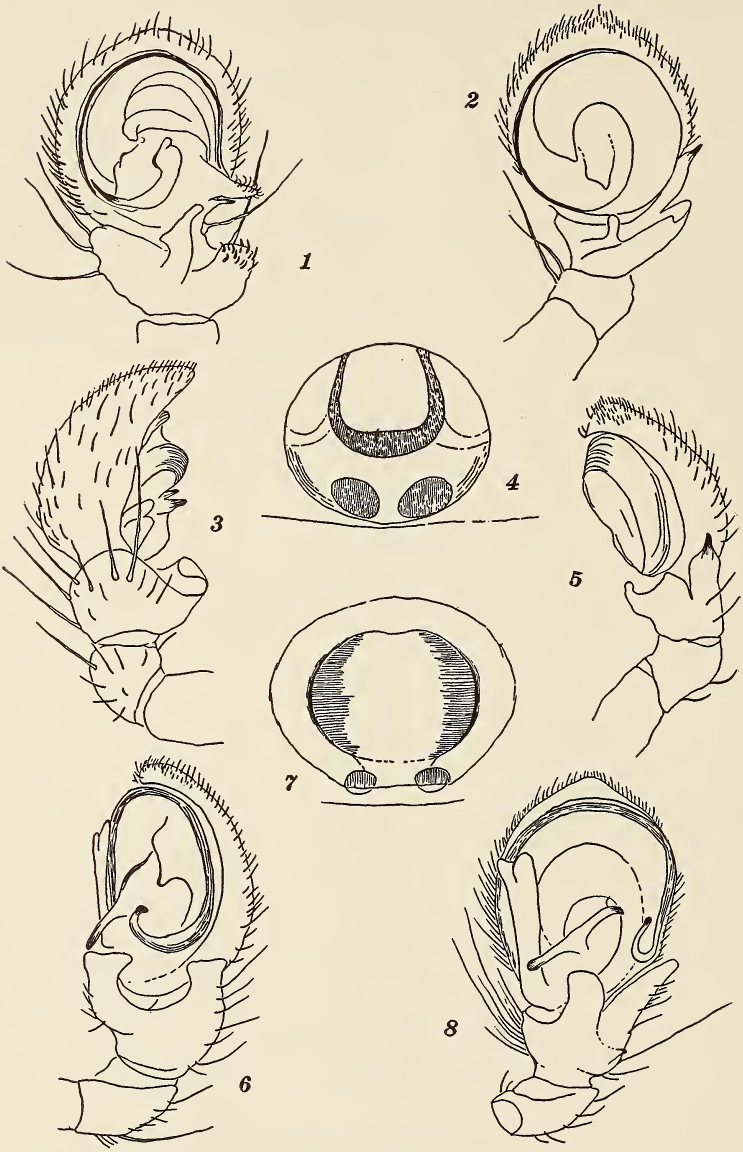

Plate 7

Bryant—Xysticus


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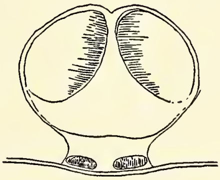
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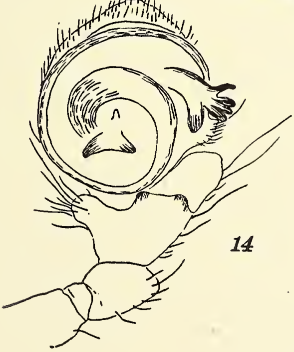
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PLATE 8

Bryant—Xysticus

and curving, two-thirds the length of the palpus. On the upper side of the tibia are two long bristles. The palpal organ is simple. The tube extends once and a half around the palpus. The lower apophysis is missing and the upper is white, spatulate with a thickened edge. The tutucalum is very small.

1 ♂ holotype. New Mexico; Las Vegas. N. Banks Collection.

Xysticus pallidus sp. n. (Figs. 11, 12, 14).

♂ 3.5 mm. long.

The cephalothorax pale mottled brown on each side ending in a darker brown spot, small dark spot at end of thoracic groove; abdominal marks characteristic of the genus, a central serrate light stripe, with four pairs of dark lateral marks. Anterior legs light with very small dark spots, with pale line on femur and tibia; posterior legs with larger, dark spots, and dark rings at end of femur IV and basal end of tibia. Few spines on femur I, tibia 4-4, longer than diameter of joint, 2 lateral, metatarsus, 4-4, longer than diameter of joint, 2 lateral, tarsus more than half the length of metatarsus. The cephalothorax as long as femur I.

The palpus is large. The tibia has the usual three processes, the upper large and broad, the middle broad and short and the lower a rounded knob with many long hairs. The tube of the palpal organ is bent at the tip at right angles as in *X. stomachosus,* and is supported by a lobed process. The upper apophysis is reduced to a small point and the lower is bilobed.

♀ 4.5 mm. long.

Cephalothorax pale brown on each side, with two pairs of darker brown spots; posterior part white, small dark spot at end of thoracic groove; abdomen lighter than cephalothorax without distinct marks. Anterior legs light and covered with many fine spots, the light stripe distinct on upper side of femur, patella and tibia; posterior legs pale with a distinct dark spot on the femur and a broken band at the distal end, patella with a dark spot at the tip, tibia with dark spot, near and one at the tip; spines of legs, I tibia 4-3, no lateral, metatarsus, 4-4, 2 lateral; sternum light with many small dark dots. Cephalothorax longer than I femur.

The epigynum is large and dark.

1 ♂ holotype, 1 ♀ allotype; Mass.; Ipswich on beach, 14 June, 1914. E. B. Bryant Collection.

This pair was found with the cocoon at the head of the beach under trash. It was first identified as a small *X. stomachosus* but closer examination shows that it is a different species. In *X. stomachosus* the spins on tibia I are 7-5, metatarsus 5-5. And the palpus and epigynum are quite different.

Xysticus vernalis sp. n. (Figs. 13, 15).

♂ 3.5 mm.

Cephalothorax dark mottled brown, with a broad median light stripe shaded with light brown at the anterior end, and a distinct dark spot at the end of the thoracic groove; abdomen with the characteristic markings of the genus, a pair of oblique lateral marks at the basal end and three pairs of transverse marks, connected by a median spot; sternum and venter light with many dark spots; legs brown, showing a light line bordered with dark on femur; patella and tibia; tibia and metatarsus lighter than femur; anterior tarsi light; spines, I few scattered on upper side of femur, tibia 4-4, two middle pair longer than diameter of joint, 3 lateral, metatarsus, 3-3, the two middle pair longer than diameter of the joint, 2 lateral. Cephalothorax as long as femur I.

Palpus. The upper process of tibia ends in a short, obtuse recurved spine, the middle process a blunt spatulate lobe and the lower process an inconspicuous knob bearing three long bristles. Three long bristles on the inner side of the tibia. In the palpal organ the upper apophysis is large, dark and bent downward, the lower is slender, dark and pointed, the two are separated by a clear white spatulate lobe. Below the lower process is a long slender filament lighter in color than the two median, which extends up and reaches the beginning of the bulb. The tutaculum is small and is edged with short curved hairs.

1 ♂ holotype, Mass.; Petersham 27-31 May, 1913. E. B. Bryant Collection.

Cotypes:

1 ♂ N. S.; Cape Breton, N. Sydney, July, 1906. E. B. Bryant Collection.

1 ♂ Me.; Portland Harbor, Long Is., June, 1901. E. B. Bryant Collection.

3 ♂ N. H.; Mt. Washington. N. Banks Collection.

1 ♂ Mass.; Holliston, 22 June, 1924. J. H. Emerton coll.

1 ♂ N. Y.; Sea Cliff. N. Banks Collection.

1 ♂ Ala.; Auburn. N. Banks Collection.

1 ♂ Ill.; Chicago. N. Banks Collection.

1 ♂ Iowa; Ames. N. Banks Collection.

EXPLANATION OF PLATES

Plate 7.

Fig. 1. *X. coloradensis* sp. n., ventral view of palpus.
Fig. 2. *X. floridanus* Banks, ventral view of palpus.
Fig. 3. *X. coloradensis* sp. n., lateral view of palpus.
Fig. 4. *X. aprilinus* sp. n., epigynum.
Fig. 5. *X. floridanus* Banks, lateral view of palpus.
Fig. 6. *X. fraternus* Banks, lateral view of palpus.
Fig. 7. *X. coloradensis* sp. n., epigynum.
Fig. 8. *X. fraternus* Banks, ventral view of palpus.

Plate 8.

Fig. 9. *X. keyserlingi* sp. n.. lateral view of palpus.
Fig. 10. *X. keyserlingi* sp. n., ventral view of palpus.
Fig. 11. *X. pallidus* sp. n., lateral view of palpus.
Fig. 12. *X. pallidus* sp. n., epigynum.
Fig. 13. *X. vernalis* sp. n., ventral view of palpus.
Fig. 14. *X. pallidus* sp. n., ventral view of palpus.
Fig. 15. *X. vernalis* sp. n., lateral view of palpus.

AUSTRALIAN BEES IN THE MUSEUM OF COMPARATIVE ZOOLOGY.

By T. D. A. Cockerell

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Having undertaken to prepare a manual of Australian bees for the Royal Zoölogical Society of New South Wales, I have been obliged to examine the undetermined material existing in various museums, in America and Australia. This task proves heavier than was anticipated, owing to the large number of specimens and species submitted. The Australian bee-fauna is extremely rich, as might be expected from the nature of the flora, and when I have done the best I can, there will still remain hundreds of species to be discovered and described.

Apis mellifera ligustica Spinola

Babinda, April 8; Halifax, June 1. Collected by F. X. Williams. Not native in Australia. In the Australasian Beekeeper, XXVII, Oct. 15, 1925, p. 68, Mr. T. Raymend published a supposed native Australian species, *A. ænigmaticus* (on p. 69 called *A. trigona*), said to occur in Victoria and S. Australia. Apparently no specimens are extant, and nothing is known except the comb.

Lestis bombylans (Fabr.)

2 ♀, Cooktown, Queensland (*E. A. C. Olive*).

Mesotrichia bryorum (Fabr.)

2 ♀, Halifax, July 11 (*Williams*).

Crocisa lamprosoma Boisduval

Halifax, June (*Williams*).

Crocisa omissa Cockerell

Seven from Halifax, May 9—June 20 (*Williams*). 1 ♀ Sydney, Feb. 28 (*Williams*).

Crocisa rotundata Friese

One from Melbourne (*Hy. Edwards*).

Anthophora cingulata (Fabr.)

♀, Halifax (*Williams*); ♀, Cairns (*Williams*); ♂, "Palm Island to Cooktown" (*A. G. Mayer*) *A. emendata* Sm. is a synonym.

Anthophora chlorocyanea Cockerell

1 ♂, 1 ♀, S. Australia (*H. Edwards*). In the female the scape is all black; in the male none of the ventral segments is emarginate, but the scape has a light mark.

Anthophora zonata (L.)

In 1921 I treated the common variable species of Queensland as *A. pulchra* Sm., which is its name if separated from *A. zonata;* but it now seems impracticable to recognize two species. In the males the face may be light yellow or white.

4 ♀, 4 ♂, Halifax (*Williams*); 2 ♀, 1 ♂, Mossman (*Williams*); 1 ♀, 2 ♂, Babinda (*Williams*).

Anthophora salteri Cockerell

1 ♀, with light face-markings white. Sydney, N. S. W., Feb. 28—March 8, 1919 (*Williams*).

Hyleoides concinnus (Fabr.)

Sydney, N. S. W. (*Williams*).

Coelioxys albolineata Cockerell

3 ♀, Halifax, and 1 ♀, Cairns (*Williams*).

Coelioxys albolineata var. *darwiniensis* Cockerell

1 ♀, Halifax, June (*Williams*). The femora are bright red.

Megachile mystacea (Fabr.)

3 ♀, 2 ♂, Halifax (*Williams*); 1 ♀, Brisbane, March 24 (*Williams*).

Megachile ustulatiformis Cockerell

2 ♂, Halifax, June 1-17, and June 20-July 9. (*Williams*).

Megachile hilli Cockerell

2 ♀, Halifax, June 1-17 and July 11-20 (*Williams*). When describing *M. hilli,* I wrote: "I had to consider whether this could be the female of *M. ustulatiformis,* and, while this is possible, it appears improbable." The present specimens, collected in the same locality, lend support to the view that these are sexes of one species.

Megachile pictiventris Smith[1]

1 ♀, Babinda, April 18 (*Williams*).

Megachile cincturata Cockerell

2 ♀, Cairns, April 1-12 (*Williams*).

Megachile ignescens Cockerell

1 ♀, Halifax, June 1-17 (*Williams*). This had been labelled *pictiventris,* but is easily separated by the abdominal hair-bands.

Megachile lucidiventris Smith

1 ♀, Sydney, N. S. W. (*Williams*). This is very like *M. suppresipennis* Ckll., but easily separated by the denticulate lower margin of clypeus.

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[1] Reviewing my material of *M. pictiventris,* I find I have confused with it a different ♀, taken by Turner at Mackay, Queensland, in January, 1900. It is distinctly more robust, and the beautifully metallic (green and purple) abdomen has white hair-bands, weak or failing in middle. The light hair of face is white (not at all yellowish), and the abdomen, seen from above, shows no outstanding black hairs toward the apex; characters which separate it at once from *M. igenescens.* This beautiful species may be called *Megachile rowlandi* n. sp., after Rowland Turner.

Megachile viridinitens n. sp.

♀. Length about or nearly 15 mm.; a parallel-sided black species, metathorax and base of abdomen densely covered with white hair, ventral scape entirely black, hair of legs black, wings dark fuscous except basally. The appearance is exactly that of *M. fumipennis* Smith, and I had hastily assumed it to be identical until I noticed the following differences: middle of lower margin of clypeus with two little shining tubercles; hair of face entirely black; no white hair on prothorax (except fringing tubercles) and no converging lines of white hair on anterior part of mesothorax; mesothorax finely punctured, the posterior middle minutely rugosopunctate; abdominal segments 1 to 4 strongly green, the callosities sublaterally shining, with sparse, strong punctures. Cairns, Queensland (*W. M. Wheeler*).

Megachile chrysopyga Smith

1 ♂, 3 ♀, Sydney, N. S. W. (*Williams*); Melbourne (*H. Edwards*).

Megachile quinquelineata Cockerell

Mr. F. X. Williams took females at Halifax, July 11-20; Cairns, April 1-12; Babinda, April 18; Mossman, April 24.

Megachile ciliatipes Cockerell

Mr. Williams took males at Halifax, July 11, and Babinda, April 16 and 18. It seems very likely that this is the male of *M. quinquelineata,* but I find that it is practically identical with the male of *Androgynella detersa* (Ckll.). The female *A. detersa* has no ventral scape; it cannot be a mutant from *M. quinquelineata* directly, because the last tergite is covered with pale hair, whereas in *M. quinquelineata* this is not the case.

Megachile gilbertiella Cockerell

1 ♀, Halifax, July 11-20 (*Williams*). This specimen has the red of fifth tergite confined to the apical margin.

Megachile rhodogastra Cockerell

♂. Length about 10 mm.; black, parallel-sided, rather robust; face with much creamy-white hair, cheeks with long pure white hair; antennæ long, black, the flagellum very faintly reddish beneath; mandibles black; clypeus very densely punctured, without a smooth line; mesothorax dullish, extremely densely and finely punctured; scutellum closely punctured; hair of thorax white, but some black on scutellum, as also on vertex; tegulæ very dark rufous; wings brownish, especially stained along the veins; first recurrent nervure twice as remote from base of second cubital cell as second from apex; legs black, tibiæ swollen, anterior coxæ not spined, anterior tarsi simple, middle tarsi with long grey hair behind, hind tarsi with very bright red hair on inner side; apical part of abdomen with tegument red.

3 ♂, Halifax, May 9-15, and June 1-17 (*Williams*). The above descriptive notes are from one of the specimens which seemed to be different, having the hind tarsi with bright ferruginous hair, and lacking the thick black fringe posteriorly. After close study, I conclude that there is only one variable species, but the matter deserves further study in the field.

Megachile cetera Cockerell

1 ♀, Halifax, June (*Williams*).

Nomia tomentifera Friese

8 ♀, 1 ♂, Babinda, April 8-16 (*Williams*); 1 ♀, Kuranda, April 16 (*Williams*).

Nomia darwinorum Cockerell

6 ♂, 2 ♀, Halifax, May 9-15, June 1-17 (*Williams*); 2 ♀, Babinda, April 18 (*Williams*). This is precisely *N. darwinorum,* described from the male, collected by Turner at Port Darwin. The female agrees with the earlier described *N. rubroviridis* Ckll., from the northwest coast, except that the flagellum is variably reddened beneath, and the hair of the apical tergites is very dark fuscous, not

ochreous. I think *N. darwinorum* is surely not more than a race of *N. rubroviridis,* but it is desirable to see the male of the latter.

Nomia halictella Cockerell

1 ♀, Mossman, April 24 (*Williams*); 1 ♀, Cairns, May 18 (*Williams*).

Nomia triangularis (Cockerell)

11 ♀, 2 ♂, Halifax, May and June (*Williams*); 1 ♀, Babinda, April 18 (*Williams*). The male was described by me as *N. pseudoceratina.* I described the female in 1905 as *Nomia halictella* var. *triangularis;* in addition to the differences cited, may be mentioned the darker tegulæ and tarsi. I feel sure I now have the sexes correctly associated, and it is evident that the species is quite distinct from *N. halictella.*

Nomia australica Smith

1 ♀, Melbourne (*H. Edwards*), has both clypeus and scape black. 1 ♂, S. Australia (*H. Edwards*), has scape clear red, black at end, but another with same data has the scape darker only faintly reddened. 3 ♂, Melbourne (*H. Edwards*).

Nomia frenchi Cockerell

1 ♂, Melbourne (*H. Edwards*); 2 ♂, S. Australia (*H. Edwards*).

Nomia gilberti Cockerell

1 ♀, Halifax, June or July (*Williams*).

Nomia flavoviridis Cockerell

1 ♂, Halifax, June; 40 ♂, 4 ♀, Babinda, April. All taken by Williams.

Nomia williamsi n. sp.

♂. Length about 7.3 mm., anterior wing 5.4 mm.; black with white hair; mandibles dark rufous apically, face rather broad, densely covered with white hair; scape entirely black (in *N. argentifrons* Sm. it is rufotestaceous in front); flagellum long, reaching scutellum, black above, dull red beneath; mesothorax and scutellum closely punctured; postscutellum with dense white (not at all fulvous) tomentum; area of metathorax broadly triangular, densely rugosoplicate, dull; sides of metathorax dull, except a broad shining band just below sides of area; mesopleura dull, anteriorly with white tomentum; tegulæ clear testaceous; wings hyaline, the apical region faintly clouded; stigma large, light orange fulvous, nervures pale testaceous; legs reddish black, with the knees bright ferruginous, tibiæ red at extreme apex, tarsi pale reddish, the basitarsi more whitish; hind legs not modified; abdomen moderately shining, hind margins of first two tergites reddened; apices of segments with rather narrow bands of dense white hair, broadly interrupted on first two; venter simple, except for a large patch of pale fulvous-tinted tomentum.

Halifax, June 1-17, 1919 (*F. X. Williams*). Very close to *N. halictella* Ckll., but smaller, with white instead of fulvous hair, and darker flagellum.

Nomia babindensis n. sp.

♀. Length about 6 mm., anterior wing 4.4; robust, indigo blue, the abdomen mainly black, but blue on first tergite and in the apical depressions of the others, second tergite with a shining brown hind margin. Head broad, face with very thin dull white hair, vertex with very long erect black hair; mandibles rufescent at apex; clypeus shining, broadly black apically, bigiblous, with a median depression; supraclypeal area with a shining median pale, slightly pinkish, band; front dull; antennæ dark; a little black hair on scutellum, but thorax above very bare; mesothorax dullish, minutely punctured; scutellum weakly bigibbous; area of metathorax short, dull, very finely sculptured; mesopleura shining blue in middle; tegulæ very dark brown; wings greyish hyaline, stigma small, dark brown; second cubital cell nearly square; first recurrent nervure meeting second intercubitus; legs brownish black, with pale hair; hind margins of tergites with short pale hair, not forming conspicuous bands.

Babinda, Queensland, April 8-16, 1919 (*Williams*). Readily known among the metallic species by the small size and blue color, with dark tegulæ and mainly black abdomen.

Meroglossa chiropterina n. sp.

♀. Length about 7.5 mm.; robust, black, with the light markings of head and thorax bright chrome yellow, consisting of face, and broad lateral marks going nearly up to level of end of scape, tubercles and quadrate spot behind, axillæ, scutellum and postscutellum; clypeus with a shield-like elevation, much longer than broad, the sulcus on each side of it black; supraclypeal mark a narrow triangle in middle of supraclypeal area, or it may be absent, and the clypeal yellow may be strongly notched above in middle; mandibles, molar space and cheeks black; scape swollen, ferruginous, black above at apex; flagellum black above, light ferruginous beneath; mesothorax dull and very densely punctured; tegulæ black; wings hyaline, with dull ferruginous stigma and nervures; first recurrent nervure meeting first intercubitus; legs black; abdomen black, simple, closely punctured.

3 ♂, Halifax, June 1-17, 1919 (*Williams*). In structure more like *M. eucalypti* Ckll., but by the black abdomen more like *M. sculptissima* Ckll. These bees belong to the subgenus *Meroglossula* Perkins. The specific name is derived from the resemblance of the face to that of a bat.

Palæorhiza disrupta (Cockerell)

Five from Babinda, April 16; one from Halifax, May 9-15; all collected by Williams. The Babinda specimens vary in the markings of the postscutellum which may be all green, to yellow with a green central band.

Hylæus alcyoneus robustus Cockerell

Two males from Sydney (*Williams*). One of these is intermediate between the type and var. *robustus,* having the ventral processes small.

Hylæus cyaneomicans (Cockerell)

Females were collected by Williams as follows: 2, Babinda, April 18; 1, Cairns, May 18; 18, Halifax, June, July.

Hylæus rotundiceps (Smith)

♀, Sydney (*Williams*).

Hylæus frederici (Cockerell)

♀, Southerland, N. S. W., Nov. 14 (*W. M. Wheeler*).

Hylæus eburniellus (Cockerell)

♀, Sydney, Feb.—March (*Williams*).

Hylæus brevior (Cockerell)

A male from Sydney, Feb. 28—March 8 (*Williams*).

Euryglossina perpusilla (Cockerell)

Two from Sydney, Feb. 28—Mch. 8 (*Williams*).

Euryglossina chalcosoma (Cockerell)

One from Sydney, Feb. 28—Mch. 8 (*Williams*) has the mesothorax strongly suffused with purple, but certainly belongs to this species.

Trigona carbonaria Smith

Fourteen from Halifax, six from Babinda, one from Cairns, and one from "Cordelia Hill, 600 ft., Halifax," all collected by Williams. These Queensland specimens mostly have the flagellum clear red beneath, but do not have the black hair scutellum which characterizes subsp. *hockingsi* Ckll., from the Cape York Peninsula.

Allodape simillima Smith

Eight from Halifax, June 17 (*Williams*).

Exoneura bicolor Smith

♀, Melbourne (*H. Edwards*).

Exoneura hamulata Cockerell

Females of this variable species from Australia (*H. Edwards*), Hornsby, N. S. W. (*Wheeler*) and Melbourne (*H. Edwards*).

Binghamiella antipodes (Smith)

4 ♀, 4 ♂, Sydney (*Williams*). 1 ♀, Melbourne (*H. Edwards*). For an interesting discussion of this species, see Raymend, Victorian Naturalist, Jan., 1929, p. 240, and a plate showing the structural features.

Paracolletes flavomaculatus Cockerell

Two females, Kuranda, Queensland (*Wheeler*).

Paracolletes fimbriatinus Cockerell

Male, Melbourne (*H. Edwards*).

Paracolletes semipurpureus (Cockerell)

♀, Southerland, N. S. W., Nov., 1914 (*Wheeler*). The color of the abdomen varies; in this specimen it is yellowish green.

Paracolletes hackeri Cockerell

♀, Sydney, Feb. 28—March 28 (*Williams*).

Paracolletes carinatus (Smith)

♀, Southerland, N. S. W., Nov., 1914 (*Wheeler*).

Paracolletes carinatulus Cockerell

♂, Halifax, June, and Sydney, Feb. 28—March 8 (*Williams*). These differ from the type in having the head and thorax bluish-green, the scutellum and metathorax quite blue. Noteworthy characters for the species are the polished green clypeus, dark antennæ (slightly reddened apically), pale thoracic pubescence and mainly red legs.

Sphecodes profugus Cockerell

3 ♀, 4 ♂, Halifax, May and June, one male as late as July 11-20; 1 ♀, Cairns, April. All collected by Williams. The male has the antennal segments strongly nodose; the abdomen has the first three segments red, the others black.

Nomioides perditellus Cockerell

1 ♂, Babinda, April 18. (*Williams*).

Parasphecodes arciferus Cockerell

2 ♂, Melbourne (*H. Edwards*). This sex is new; it has the ventral tubercle on abdomen just as in the female. Clypeus with a central pit, and with its apical portion very broadly dull yellow, this color extending upward in median line as a pointed projection. Antennæ long, reaching base of metathorax, black. First three abdominal segments dark chestnut red, the others black. Legs black.

Halictus urbanus Smith

♀, Sydney, Feb. 28—March 8 (*Williams*).

Halictus murrayi Cockerell

♀. Small (anterior wing 3.4 mm.), or rather larger; thorax usually purple blue, varying to blue-green; tegulæ refous; legs black; abdomen shining black; area of metathorax more or less distinctly plicatulate. This is not *H. urbanus* var. *stradbrokensis* Ckll., which is larger, with dark tegulæ, and area of metathorax regulose, not plicate. *H. urbanus* is a puzzling species, running into a number of local races, and *H. murrayi* is certainly very closely allied.

Queensland; 10 ♀ from Babinda, April 8-16, 1919 (*Williams*); and one from Halifax, June 17 (*Williams*). *H. murrayi* was described from the Northern Territory: it now appears more widely distributed and variable than was supposed.

Halictus subcarus n. sp.

♀. Length about 5 mm., anterior wing about 3.5; head rather broad, dark green with fine white pubescence on face and front; mandibles red except at base; clypeus shining, the apical half black, with a few very large punctures; supraclypeal area and front dull; flagellum bright ferruginous beneath; mesothorax and scutellum bright prussian green, the former dull, the latter more shining, but not polished; metathorax dark green, the basal area with short but strong plicæ, the margin of the area thickened, obtuse, blackish; pleura dark green; tegulæ clear fulvous; wings hyaline, stigma dark reddish, nervures pale reddish, outer recurrent and intercubitus colorless and almost obsolete; second cubital cell higher than broad; femora black, with knees red; tibiæ and tarsi bright ferruginous; hind spur with two large long spines; abdomen olive green, with fine pale pubescence, hind margins of tergites reddened; venter with much white hair. Under the microscope, the mesothorax is seen to be minutely tessellate and finely punctured, and the front below the ocelli is longitudinally striate. The face is conspicuously narrower than in *H. williamsi*, and the clypeus is more produced. It is easily known from *H. floralis* Sm. by the dull scutellum.

3 ♀, Halifax, Queensland (*Williams*). The type July 11-20, 1915; two others June 20—July 9, 1919. From *H. pavonellus* Ckll. it is known by the larger head, with more produced clypeus, green mesothorax and clear red hind tibiæ.

Halictus williamsi n. sp.

♀. Length about 5.5 mm., anterior wing about 3.7; head broad, round seen from in front, very dark green, with thin hoary pubescence on face and front; mandibles bright red apically; clypeus dull, with very dense lineolate-reticulate sculpture; supraclypeal area brassy, also with lineolate sculpture, but a little more shining; front dull; antennæ black, the flagellum obscurely reddish beneath apically; mesothorax and scutellum dull, yellowish green; metathorax dark green, the rather large basal area coarsely plicate, with heavy obtuse margin, which is microscopically sculptured all over; tegulæ clear fulvous; wings hyaline, faintly dusky; stigma dark brown, nervures brown, outer recurrent and intercubitus almost obsolete; second cubital cell broader than high; femora black, knees, tibiæ and tarsi bright ferruginous; hind spur as in *H. subcarus;* abdomen very broad, shining black conspicuously but thinly pruinose-pubescent, especially on apical part; hind margins of tergites coppery reddish; surface of tergites microscopically transversely lineolate, and with perhaps a faint metallic cast; venter with much white hair. ♂, Much smaller and more slender, length hardly 3.5 mm., antennæ black, flagellum not very long; no light mark on clypeus; mesothorax dull olive green, scutellum more shining; abdomen narrower.

Queensland (*Williams*). 1 ♀, Halifax, June 20—July 9; 1 ♂, Babinda, April 8-16, 1919.

Female *H. williamsi* is easily known from *H. mundulus* Ckll. by the dark stigma, and from *H. urbanus* Sm. by the color of mesothorax and appearance of the abdomen. The male may be compared with *H. hackeriellus* Ckll., from which it is known at once by the red tibiæ, and dull dark front of head.

Halictus stirlingi Cockerell

2 ♀, Babinda, April 8-16 (*Williams*).

Halictus lanarius Smith

Males, Halifax, July 11 (*Williams*) and Australia (*H. Edwards*).

Halictus blackburni Cockerell

Five females, Halifax, June and July (*Williams*).

Halictus sturti Cockerell

1 ♀, Halifax, June 17 (*Williams*).

Halictus mesembryanthemi Cockerell

♂, Halifax, July 11 (*Williams*); tarsi reddened by cyanide.

A NOTE ON THE PARASITIC BEETLE, *HORNIA MINUTIPENNIS* RILEY[1].

By Phil Rau
Kirkwood, Mo.

In the Ecology of a Clay Bank[2], (p. 236), I have already recorded that the parasitic beetle, *Hornia minutipennis,* was twice taken from the nests of the burrowing bee, *Anthophora abrupta.* Riley has named this species from beetles taken from the nests of this bee (*sponsa=abrupta*) collected in this region. Since the publication of the ecology paper, I have gathered a few meagre notes on the habits of this parasite, and since so little is known of its behavior, I beg leave to present them here.

It is well known that the beetle larvæ in the triungulin stage attach themselves to the pubescence of the bees and by this method are transported to the bees' nests, where they feed upon the bee larvæ and attain their maturity.

In 1925, on May 5 and 17, I found one female each time, walking about on the lumps of clay containing the nests of the Anthophora bees, which I had brought into the laboratory. Some time later, June 7, I found on the surface of the clay mass five distinct clusters of triunguli, which apparently had hatched from eggs which I had not noticed. These masses or colonies were separate groups, and the larvæ did not move about at this stage. However, when I came near or brushed them with bits of cotton or dead Anthophora bees, they readily attached themselves to fibers and hairs.

On another occasion a very small hole was discovered in one of the bee cells. Upon opening the cell, an adult female beetle was discovered inside; hence I assumed that the beetle had made the opening. In still another cell, where a hole of the same size was found, I removed a dead mother beetle and hundreds of living triunguli. Another

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[1] Identified by Mr. E. A. Schwarz.

[2] Trans. Acad. Sci. St. Louis **25**: 236-7, 1926.

cell which I opened contained a fat female but no eggs or young; an additional cell (found open) contained the shedding skin of the mother and several live triunguli. My first thought was, upon finding the first small opening, that I had discovered the mother in the act of biting her way out. But upon finding in another cell, behind a similar hole, a dead mother and her live young, I began to suspect that the mother beetle does not leave the nest. This would indicate that one or two conditions must obtain; either fertilization must have taken place through the small aperture in the wall of the *Anthophora* cell, or the eggs of the *Hornia* must have hatched without fertilization. My present data are insufficient to give preference to either theory.

I doubt that locomotion by the adult is a factor in their dissemination; their wings are small and useless in flight, their legs are too weak for lengthy walks, and the body too heavy for either type of movement. I have, however, as already stated, seen two adults (in addition to the one recorded in the Ecology paper) slowly lumbering along the clods of earth containing cells of the anthophora bee, but these beetles probably had escaped from clods broken by me for observation.

The colonies of live triunguli discovered on June 7 were placed outdoors on the clay bank, among a weak colony of bees. They were watched for about ten days. During that time, all the colonies held together without any evidence of dissemination. They seemed to get along without food, unless they ate part of their own number, for the bank afforded them no means of subsistence. On June 25, more than two weeks after they had been placed out of doors, the colonies were still intact, although much reduced in size. However, some must have been moving about, for several were found dead in a nearby spider web.

The idea seems prevalent that the eggs hatch in the fall and the young hibernate. In this species, at least, the eggs are laid in the spring. One female, taken from a cell several years ago, laid many eggs in a vial in the spring. This corroborates Riley's statement that the eggs, laid loosely in the burrows of the bees, hatch in June, but our creatures did not substantiate his statement that the young are extremely active.

THE ARRANGEMENT OF THE MAJOR ORDERS OF INSECTS

By C. W. Woodworth

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The relationships of the minor orders have been very frequently discussed, but that of the major orders have been given very scant consideration. The six major orders have been arranged in more than thirty different ways and in the last ten years fifteen authors have used ten different arrangements, half of which had not been employed previously.

The following table gives in chronological order the arrangements that have been used, the initial of the orders Orthoptera, R (Rhynchota) Hemiptera, Coleoptera, Diptera, Hymenoptera, and Lepidoptera, being employed to make a formula for each arrangement. The sign ‡ is used to separate those authors using the same arrangement but in the reverse order.

1735 C O R L H D (Aristotle, Aldrovandus) Linnæus 1735, Geoffroy 1764, Illiger 1798, Latreille 1796, Leach 1817, Lacordaire 1838, Harris 1841, Ruschenberger 1852.

1752 L H R O C D Degeer 1752, Olivier 1789.

1775 C O H L R D Fabricius 1775, 1787, 1792, Lamark 1819, Latreille 1821, Westwood 1839, Carpenter 1858, Gervais and Van Beneden 1859, Staveley 1871, Girard 1873, Le Baron 1874, Thomas 1876, Kirby 1892 ‡ Brumpt 1922.

1798 C O H D L R Clairville 1798.

1805 H C O R L D Cuvier 1805, Hagen 1863, Cook 1889.

1806 C O R H L D Latreille 1806, 1832, Percheron 1835, Snellen von Vollenhoven 1868.

1821 R O D H L C Oken 1821, Redtenbacher 1858.

1823 H C O L D R MacLeay 1823, Stephens 1834, Swainson 1835.
C O H R L D Kirby and Spence 1823, Dumeril 1823, 1860, Rye 1864.

1832 R O D L C H Burmeister 1832. Nicholson 1870, 1871, 1873, Carus 1880, Landois 1905 ‡ Dohner 1862, Sharp 1886.

1841 L D H C O R Newman 1841.

1849 L D R H O C Agassiz 1849 ‡ 1850.

1856 O R C D L H de Hoven 1856, Packard 1869, 1879, 1883, 1886, Kingsley 1884, Orton 1884, O'Kane 1912, Essig 1926 ‡ Packard 1863, Tenney 1865, Fernald 1884.

1864 H D L C R O (Ray) Dana 1864, Leconte and Horn 1883, Howard 1895 ‡ Kellogg and Doane 1915, Comstock 1924, Leonard 1928.

? D R L O H C Figuier.

1881 H C D L R O McLachlan 1881 ‡ Brauer 1885, Comstock 1888, 1895, Kellogg 1905, Folsom 1906, Herrick 1907, 1925, Wellhouse 1926.

1882 O C H R D L Mayer 1882, Shipley and MacBride 1901.

1885 O R D L C H Claus and Sedgwick 1885, Claus 1887, 1891, Blanchard 1890, Lindsey 1895, ‡ Mayet 1890, Riley 1892.
O R D C L H Balfour 1885, Sharp 1886.

1890 O R C L H D Hyatt and Armes 1890, Schiedt 1892, Smith 1897, Sanderson and Jackson 1912, Folsome 1922, Metcalf and Flint 1928.

1895 O C H R D L Hertwig 1895, Hertwig and Kingsley 1902.
O C H L D R Sharp 1895, Handlirsch 1903, 1923, Perrier 1904, Brues and Melander 1915.

1900	O R L H C D	Davenport 1900.
1906	O R C D H L	Woodworth 1906.
1908	O R L C D H	Osborn 1908, Daugherty 1912, Sanderson and Peairs 1917.
	O H C L D R	Froggatt 1908, Lefroy and Howlett 1909.
1920	O R H L D C	Crampton 1920.
1921	O C R L D H	Fernald 1921, Lefroy 1923.
1923	O R H C L D	Martini 1923
1925	O R L C H D	Imms 1925.
1926	O R C H D L	(Swammerdam) Tillyard 1926.

Only three authors had great influence on the arrangement of the orders. *Linnæus* separates those with thickened front wings: probably he also appreciated the coördinated thoracic structure, the large movable prothorax in one group and the consolidated thorax in the other. *Fabricius* combined the three mandibulate orders and the three haustellate, and finally *Oken* grouped together the four orders with complex metamorphosis and within this group the three dominant orders were brought together. He also maintained the proximity of the members of the Linnæan group with consolidated thorax.

These three men all antedated Darwin so that the arrangements in no case expressed any idea of phylogeny, and many later students probably adopted one arrangement or another without seriously considering questions of origin or development. The first evolutionist to suggest a new arrangement was Dana who adopted the sequence used by Ray and the last Tillyard adopted that of Swammerdam. Thus the arrangement that suited the sense of fitness of these great pre-Linnean naturalists corresponds with the ideas of students of phylogeny. Indeed, the general thought has been that the historic groupings, or at least some of them, were essentially natural.

The most decided trend after the days of Darwin has been towards the groupings of Linnæus and Oken and away from that of Fabricius, which had previously dominated, because of the growing conviction that each haustellate order had an independent origin. This and the other trends can be best shown in tabular form, which gives the period during which each proposed arrangement was employed.

BASES OF ORDER GROUPINGS

Thorax	Linnæus 1735-1852
	DeGeer 1752-1789
	Latreille 1806-1868
	Newman 1841
Mouth	Fabricius 1775-1922
	Clairville 1798
	MacLeay 1823-1835
	Kirby and Spence 1823-1864
	Agassiz 1849-1850
	Figuier
	Mayer 1882-1901
	Hertwig 1895-1902
Thorax and Mouth	Cuvier 1805-1889
	Fernald 1921-1923
Thorax, Metamorphosis and Dominance	Oken 1821-1858
	Hyatt and Armes 1890-1928
Metamorphosis and Dominance	Burmeister 1832-1905
	Claus and Sedgwick 1885-1895
	Balfour 1885-1886
	Davenport 1900
	Martini 1923
	Imms 1925
Thorax and Metamorphosis	de Hoven 1856-1926
	Dana 1864-1928
	Woodworth 1906
	Crampton 1920
	Tillyard 1926

Mouth and Metamorphosis	McLachlan 1881-1926
	Froggatt 1908
	Lafroy and Howlett 1909
Mouth, Metamorphosis, Thorax and Dominance	Sharp 1895-1923
Metamorphosis	Osborn 1908-1917

A conception of high and low development that came with the theory of evolution has had the most profound influence on classification as seen by the fact that only one of the pre-Darwinian arrangements began with the Orthoptera and this order formed one end of the series in every system but one that has been proposed since that period. Entomologists are practically unanimous in placing the Orthoptera lowest, but there is no agreement as to which order is highest, six selecting Hymenoptera, four favor Lepidoptera, the same number Diptera, two Hemiptera, and one Coleoptera. There is a fair degree of agreement regarding which order stands next to Orthoptera, twelve selecting Hemiptera, four Coleoptera, and one Hymenoptera, these latter five being those still clinging to the Fabrician division based on the mouthparts, while the majority favor the division based on metamorphosis following Oken.

There is an agreement among all recent students of phylogeny that each of the six major orders have been derived independently from lower forms, and difference of opinion as to the affinities and arrangement of these hypothetical ancestors explain in large part the diversity of arrangement.

The writer has suggested that a chronological arrangement be followed, since now for a good many years our knowledge of the fossils is adequate to permit of this arrangement. This does not apply to the minor orders in which the palæontological evidence may never be adequate. Handlirsch, who has given very great attention to the fossil insects, has clung to the arrangement of Fabricius, which has required the shifting of the Diptera and Hemiptera beyond the Lepidoptera. Had he set these where they would come naturally according to his palæontological evidence, the arrangement would have been the same as that proposed by me. Tillyard, who has most recently proposed an arrangement, differs from my proposal only in the relative position of Hymenoptera and Diptera, which was based on newly discovered ancient fossils which he identified as hymenopterous, perhaps erroneously. Whether he is right or not, there is abundant evidence in the completeness of the differentiation of the families of Diptera in Tertiary times to establish its seniority to the Hymenoptera. The same kind of evidence makes Lepidoptera the youngest of all.

The chronological order permits the expression of all the accepted genetic relationships with the lower group as acceptably as any other, and is the only basis for the arrangement of the major orders, the adoption of which would result in uniformity. This order is

Orthoptera

Hemiptera

Coleoptera

Diptera

Hymenoptera

Lepidoptera

ÆNICTOMYIA, A NEW MYRMECOPHILOUS PHORID FROM THE PHILIPPINES

By Charles T. Brues

Among the extensive collections of ants obtained by Dr. J. W. Chapman on the island of Negros in the Philippines are several specimens of a most remarkable species of Phoridæ which he found living with ants of the genus Ænictus. Dr. Chapman has very kindly placed these specimens at my disposal with the suggestion that I describe the species, which proves to be a wholly unknown form, which must form the type of a new subgenus.

In the very recent classification of this family by Schmitz, the new ænictophile falls in the genus Diploneura, which Schmitz has divided into three subgenera, Diploneura *sensu stricto,* Tristœchia and Dohrniphora, but it differs from all of these by a very complete development of the dorsal macrochætæ on the thorax as well as by the excessive length of the bristles on the head and wings.

The following tabular arrangement will indicate the characteristics that serve to distinguish the several subgenera:

1. Hind tibiæ with two dorsal (extensor) lines formed of closely spaced and imbricated bristles, and between these with a series of minute well separated bristles; mesopleuræ bare above 2
   Hind tibiæ with only a single row of bristles forming a line of the dorsal surface, mesopleuræ hairy above 3

2. Fourth longitudinal vein sinuous, the base curved upwards and the apex downwards *Diploneura,* s. str.
   Fourth longitudinal vein straight, not distinctly sinuous, nor curved at base of apex .... *Tristœchia*

3. Mesonotum completely bristled; with a median row of four macrochætæ; four achrostichals, three or four dorsocentrals and six marginal scutellar bristles; the macrochætæ all as long or longer than the mesonotum; base of third vein bearing one very long bristle.................................*Ænictomyia,* subgen. nov.

   Mesonotum minutely hairy, without macrochætæ except near lateral and posterior margins; base of third vein bare or with one or two very short bristles *Dohrinphora*

Aenictomyia subgen. nov.

Although clearly related to Dohrniphora, the type of this subgenus exhibits several striking characters. The bristling of the entire body is unusually long as well as the cilia on the costal vein. The very complete and conspicuous chætotaxy of the mesonotum is very unusual, as in practically all Phoridæ the median and anterior macrochætæ are completely suppressed, although those along the posterior and lateral margins are generally more or less well developed. The front is completely bristled; the proboscis geniculate and strongly chitinized; eyes hairy; palpi strongly bristled; cheeks each with three very strong macrochætæ; propleura hairy, with a large macrochæta; mesopleura hairy above; front tibia with a series of four small macrochætæ on dorsal surface; middle tibia with a strong basal pair; hind tibiæ without macrochætæ before apex; fourth wing-vein curved; seventh not distinct.

Type: *Diploneura* (*Ænictomyia*) *chapmani* sp. nov.

Diploneura (Aenictomyia) chapmani sp. nov., Fig. 1.

Female: Length 1.2-1.5 mm.

Yellowish brown, the middle portion of the front, the mesonotum more or less, the tergites of the second and third abdominal segments and the apical one darker brown, the legs lighter, except the hind pair; wings hyaline with the heavy veins light brown. Front wider than long, the surface smooth, impunctate; the upper margin sharp and forming a slightly raised rim except at the sides; two closely approximated supra-antennal bristles directed upwards and backwards; lower transverse frontal row consisting of four equidistant bristles, the lateral ones well removed from the margin of the eye; middle row further from the lower one than from the upper, of four equidistant bristles; upper or ocellar row close to the occipital margin; postocular cilia strong, especially above; cheeks each with three very large and strong bristles; bristles of palpi rather strong and densely placed. Proboscis beyond the basal angle about as long as the head-height, gently curved downwards to the tip. Antennæ small, oval; with a moderately long, weakly pubescent arista. Mesonotum smooth, highly polished, without any microscopic hairs be-

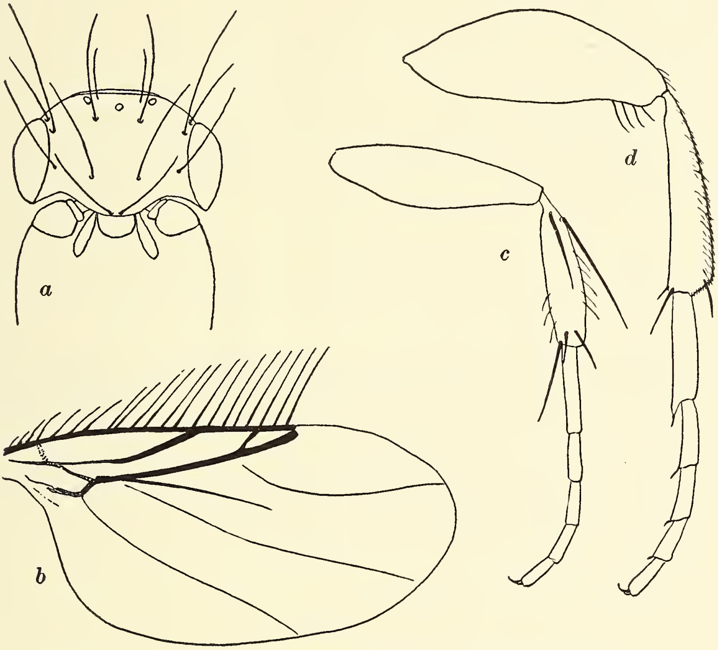

Fig. 1. *Diploneura (Ænictomyia) chapmani* sp. nov.

tween the large macrochætæ; six scutellar bristles, the median ones much further from one another than the others so that there is a group of three on each side, the middle one of which is much longer than either the lateral or median one. Propleura sparsely hairy, with four small bristles at the base of the coxa and a large, erect one at the upper angle; mesopleura sparsely hairy on the upper half. Front tibia with a series of four moderately long bristles on the outer (extensor) edge, one at the basal third, one at middle and two between middle and apex. Middle tibia with a pair of long bristles near base (Fig. 1, c) and two short ones externally at tip. Hind tibia without long bristles. Abdomen very weakly chitinized; with a distinct large dorsal plate on the second and a small transverse plate on the second segment. Wings rather small, costa extending beyond the middle (Fig. 1, b), its cilia very long; third vein forked well before apex; base of third vein with one very long bristle near base; seventh vein not distinct.

Described from three specimens taken by Dr. J. W. Chapman with *Ænictus martini* Forel, at his summer camp in the mountains near Dumaguete, Negros Oriental, Philippine Islands. Dr. Chapman tells me that the Phorids ran along in the foray during the migration of the colony, making faster progress than the ants.

THE DOLICHOPODID GENUS NEMATOPROCTUS LOEW IN NORTH AMERICA

By M. C. Van Duzee

Buffalo, N. Y.

This genus was established in 1857, Neue Beitr., Vol. v, p. 40, for two species. The type designation by D. W. Coquillett, *Chrysotus distendens* Meig. as *Porphyrops annulatus* Macq., the first species mentioned.

Including the three species described here there are thirteen species known, three from Europe, two from Java, one from Africa and six from North America.

The species of this genus differ from those of Argyra by having the first antennal joint bare above, third short, rather rounded, with a nearly basal arista.

Dr. T. Becker places Nematoproctus, Argyra and its subgenus Leucostola in the Diaphorinæ. Dr. J. M. Aldrich includes them in the Rhaphiinæ, to which they seem to me to be much more closely related; we have species of Argyra which are separated from the Porphyrops group of Rhaphium by having from one to three small hairs on upper surface of first antennal joint and the arista not quite apical. Nematoproctus is separated from the subgenus Leucostola by the small third antennal joint with its dorsal arista and the longer hypopygial appendages of the male.

Key to the species of North American Nematoproctus

1. Orbital cilia and the beard yellow; tarsi of male plain (New Jersey) .... *venustus* Melander
   Orbital cilia and beard snow white 2
2. Feet ornamented 3
   Feet plain 4

3\. Middle tarsi with last two joints a little flattened and widened (Va., N. Y., Ohio)
terminalis Van Duzee

First joint of fore tarsi fringed with long black hairs on apical half, second joint on whole length (Pennsylvania) ....*junctus* Van Duzee

4\. Posterior edge of pleuræ and first three abdominal segments yellow (Connecticut)
flavicoxa new species

Pleuræ wholly black; second and third abdominal segments yellow, at least on the sides 5

5\. First and second abdominal segments wholly yellow, except very narrow anterior and posterior margins; hind femora almost wholly yellow (Connecticut)
varicoxa new species

Second and third abdominal segments with yellow on the sides; hind femora black above (Pennsylvania) ....*metallicus* new species

Nematoproctus flavicoxa new species

Male: Length 5 mm.; of wing 4.5 mm. Face nearly as wide as the front, silvery white, its sides parallel; palpi longer than width of face, scarcely half as wide as long, yellow; front green, white pollinose; antennæ black, first joint mostly yellowish, bare above, third joint small, about as long as wide, somewhat conical, arista inserted near the base; occiput green with bronze reflections above the neck; orbital cilia white, a few of the upper cilia black.

Thorax blue-green, dorsum very shining, front slope grayish white pollinose, reddish coppery spots extend along the sides from the suture over the roots of the wing; pleuræ white pollinose, posterior edge yellow; first three abdominal segments yellow, hind margins of these segments narrowly black, the yellow portion shows very slight green reflections; fourth and fifth segments green with coppery reflections at base, sixth violet; venter yellow; dorsum of abdomen and sides beyond second segment with black hair; sides of second with long yellow hair; hypopygium black with numerous bristly hairs on posterior surface, its outer lamellæ black, as long as height of hypopygium, fringed with stiff black hairs on outer edge; no inner appendages visible, except a hair-like one.

Coxæ yellow, anterior pair with rather long, abundant, pale yellow hair and three long and three short black bristles near tip; middle coxæ blackened on outer surface of basal half, their hair pale yellow; posterior ones with one erect bristle on outer surface; all femora and fore and middle tibiæ wholly yellow; basal two thirds of hind tibiæ yellow, spical third black; fore and middle femora with rather short, yellowish hairs below; fore and middle tarsi yellow, becoming blackish towards tip; hind tarsi wholly black; first joint of fore tarsi with a row of longer hairs below, which are shortest at tip and extend along second joint; joints of fore tarsi as 45-16-11-9-9; of middle ones as 57-24-20-11-9; joints of posterior pair as 41-39-26-17-11. Calypters and their cilia whitish; halteres pale yellow.

Wings nearly uniformly tinged with brownish gray; third vein bent backward towards their tips; last section of fourth vein slightly and gradually bent forward from near its middle, then backward so as to be parallel with third at tip, ending in apex of wing; last section of fifth vein straight, it is as 57, cross-vein as 22; sixth vein a little sinuous; anal angle of wing prominent.

Described from one male, taken by C. H. Curran, June 22, 1929, at Avon Old Farms, Avon, Connecticut.

Nematoproctus metallicus new species

Male: Length 3.5 mm.; of wing the same. Face narrow, not half as wide as front, silvery white, its sides parallel; palpi narrow, longer than width of face, yellow, silvery white pollinose; front blue-green, white pollinose; antennæ black, first joint wholly yellowish, bare above, rather long; third joint moderately large, conical, about as long as wide, arista inserted near its base; occiput black, green just back of the vertex, white pollinose; orbital cilia white, only a few of the very small upper cilia black.

Thorax green, dorsum shining, anterior edge dulled with gray pollen; posterior edge of pleuræ black, but seen from behind the space above and between the hind coxæ is yellow; dorsum of abdomen green, three first segments with coppery reflections, fourth and fifth more bluish, sixth wholly blue; sides of second and third segments with large yellow spots; venter of first four segments yellow with a few small yellow hairs, hairs on dorsum black; hypopygium black with only a few short black hairs on posterior surface, outer lamellæ black, narrow, as long as height of hypopygium, fringed with stiff black hairs and a few white ones, inner appendages short, stout, with a few minute hairs.

All coxæ, femora and tibiæ yellow; fore coxæ with a few yellow hairs and two black bristles; tips of hind femora black above; most of apical half of hind tibiæ and whole of their tarsi black; fore and middle femora with short yellow hairs below; fore and middle tarsi black from tip of first joint; first joint of fore tarsi with a row of hairs of nearly equal length below, which are about as long as diameter of joint and continued the whole length of second joint, all joints of fore tarsi with long hairs at tip, above; joints of fore tarsi as 33-14-9-7-7; of middle ones as 40-18-14-7-6; first three joints of hind tarsi as 30-31-18. Calypters and their cilia whitish; halteres pale yellow.

Wings tinged with brownish gray; third vein bent back at tip; last section of fourth vein a little arched, parallel with third at tip, ending just back of apex of wing; last section of fifth vein nearly twice as long as cross-vein; sixth vein a little sinuous; anal angle of wing prominent.

Described from one male, taken by the author, June 4, 1925, in the bed of the old canal, near Amnity Hall, Benvenue, Pennsylvania. Type in the author's collection.

Nematoproctus varicoxa new species

Male: Length 5 mm.; of wing 4 mm. Face rather narrow, a little more than half as wide as the front, silvery white, its sides parallel; palpi yellow, about as long as width of face, with many black hairs, which are nearly as long as the palpi; front blue-green, with white pollen; antennæ black, first joint bare above, a little yellowish below, third small, somewhat conical, as long as wide, arista basal; occiput green, white pollinose; orbital cilia and the beard white, a few of the minute upper cilia black.

Thorax blue-green, dorsum bright, shining with a little white pollen on the front slope; reddish coppery spots on the sides extend from the suture over the root of the wings; pleuræ more black, especially the posterior edge, a little white pruinose; first abdominal segment coppery and green, with long black bristles above; second and third segments yellow, second narrowly black at base and very narrowly on hind margin; third segment with a narrow, sharply defined, white pollinose band at base, followed by a black band of equal width, posterior margin very narrowly black; fourth purplish black on basal half, more green on apical half, fifth colored as the fourth, only more blue posteriorly, sixth segment small, violet; hairs on dorsum of abdomen black, on lower edge of sides of three basal segments long and yellow, above these are a few long black hairs; venter with many long yellow hairs; hypopygium black, posterior surface with about twelve bristles; outer lamellæ black, narrow, about as long as height of hypopygium, fringed on one side with stiff black hairs; two pair of inner appendages, first black, wide at base, tip somewhat knob-like with several minute spines, the other yellowish, hair-like, about half as long.

Fore coxæ wholly pale yellow, with rather long yellow hair, four large black bristles and one small one; middle and hind coxæ black with yellow tips; all femora and tibiæ yellow, hind femora a very little darkened at tip, hind tibiæ blackened from near their middle, extreme tip of middle tibiæ sharply black; fore and middle femora with long yellow hairs on lower surface; fore tibiæ with a row of rather long black hairs on lower posterior edge and a row of about six bristles on upper posterior edge of basal half, which are longer than diameter of tibia; tarsi plain, anterior ones yellow with last three joints blackish, first joint with a row of stiff black hairs below, these are as long as width of joint at base, becoming shorter towards the tip, they are continued on the following joints, long on second, shorter on third and quite short on two last joints; middle tarsi yellowish with tips of first two joints and whole of last three brown; hind tarsi wholly black; joints of fore tarsi as 45-19-12-9-9; of middle ones as 57-20-20-10-10; joints of posterior pair as 37-41-27-16-9. Calypters and their cilia whitish; halteres yellow.

Wings slightly tinged with brownish gray; third vein bent backward at tip; fourth vein scarcely parallel with third except at tip, not but little bent, ending just back of apex of wing; last section of fifth vein as 51, cross-vein as 30; sixth vein sinuous; anal angle of wing prominent.

Described from one male, taken by C. H. Curran, June 25, 1929, at Avon Old Farms, Avon, Connecticut. Type in the American Museum.

The three forms described in this paper are very much alike in the form of fore tarsi, color of wings and form of the long outer hypopygial appendages. *Metallicus* has the abdomen wholly metallic above, tips of hind femora conspicuously black above at tip and third antennal joint a little larger; *flavicoxa* differs from both the others in having the tibiæ and femora wholly yellow, and the posterior margin of pleuræ yellow, it differs from *varicoxa* in having all coxæ yellow, middle tibiæ wholly yellow. They all differ from each other in the form of the palpi, bristles on posterior surface of hypopygium and the inner hypopygial appendages.

THE NESTING HABITS OF THE TWIG-DWELLING BEE, *PROSOPIS MODESTUS* SAY[1]

By Phil Rau
Kirkwood, Mo.

The nests of this little bee were always found, in my experience, in the top hollows of sumac twigs. Only the upper part of the cavity was used—usually 2½ or 3 inches, never more. Traces of mud partitions and various other relics in the lower, unused portion made it evident that the tunnels had been used before, but whether this bee always uses old borrowed burrows or whether she may sometimes do her own excavating I cannot say positively. The young of this species construct very thin and transparent, delicate cocoons which entirely cover the body. The cocoons are close together and between them are heavy dividing walls, but I have not yet been able to tell with certainty whether these disc-like walls are actually partitions of waxy substance built by the mother, or whether they are only the front wall or head-piece of each cocoon. These disc-like walls are semi-transparent in the center, and pale yellow, grading to a dark brown color and to greater thickness at the edges. The compact little cocoons, of brittle material which resembles the central portion of the hard disc, are packed in very close together, so close in fact that frequently two adhere to each other.

A good example of most of these characteristics was a little nest which was discovered in a twig in a park in

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[1] Regarding the identity of this species, I quote from a letter from Prof. T. D. A. Cockerell. The bee is "*Prosopis modestus* Say in the sense of Metz (1911). Your male seems to agree with *P. minyra* Lovell (*modestus* var. according to Metz). The female *minyra* has not been distinguished from that of *modestus*. It will be necessary to collect series of your insect to make sure what it should be called, but it is *modestus* in the broad sense."

February, 1920. It was brought home, and during the week of March 25 to 30, four adults of this species emerged. The hollow in the stem was three inches deep, and in this case I could see no evidence that this tunnel had been used previously. The cavity contained eleven cocoons, with no partitions between them excepting the heavy discs described above. The cocoons were crowded so close together that some of them adhered to each other as if built together.

The five lower cocoons contained dead larvæ. Of the six upper ones, four had, at the time of examination, already given forth their adults during the week preceding, and two contained fully developed insects, all black and ready to emerge. Those which had emerged, counting downward from the top, were Nos. 1, 2, 3, and 5, while 4 and 6 were about to come forth. This suggests that the usual order of emergence is from top to bottom of the twig, with occasional exceptions in the case of an individual here and there, due to weakness, sex or some handicap.

Another nest in a sumac twig was found to contain, on April 1, four bees of this species and one parasite. The two lower bees were in a far advanced pupal stage in their cells, while the two upper ones were already making their way out. Each insect had its hard disc above it; above the uppermost one of these was a vestibule of ½ inch, and above this a loose filling, ⅜ inch in depth, of finely broken pith. Here too, the youngest and uppermost was the first to emerge, making it easy for those that were to follow. Her method of emergence was most ingenious. She did not attempt to bite her way through the hard disc forming the partition; that material was too hard, and it was too difficult to get a jaw-hold on the concave surface. So she detoured and bit her way upward through the soft pith in the wall, making a new passage around the side of the obstruction. Don't condemn her for her laziness; respect her for her ingenuity.

The parasite was in the topmost cell. This adult was ½ inch in length, much longer than the host and must have destroyed more than one young of the *P. modestus*.

Up to April 12, three bees had emerged, and the last cell still contained its bee, which was really the eldest of the family (counting from date of oviposition) and was only now completely developed and ready to emerge, the last of the series. The hard disc forming the lid of each of the cells was in no case broken through, but all the insects had bitten out a new channel through the pith and around this lid and thus escaped upward into the gallery. The middle of April terminated the season of emergence of these bees in all the nests which came under my notice.

MUSCID LARVÆ TAKEN IN "SCIARA ARMY WORM"

In the spring of 1929 I observed a mass of fungus-gnat larvæ, usually referred to as a "Sciara army worm" moving across a lawn in Chambersburg, Penna.

With the Sciara larvæ and moving along with them were two Muscid larvæ. When not covered over in the moving mass their white bodies were quite conspicuous in contrast with the darker color of the Sciara larvæ.

I collected both specimens and the adults emerged on July 23rd. They proved to be *Muscina pascuorum Mei.* as determined by Mr. A. B. Champlain of the Penna. Dept. of Agriculture, Harrisburg, Pa. Apparently this species has not hitherto been reported from Pennsylvania, nor has the larva been observed before in America.

J. R. Stear

Chambersberg Laboratory
Penna. Bureau of Plant Industry.

FOSSIL BEETLE ELYTRA

By T. D. A. Cockerell
Boulder, Colorado

Mr. Darlington's remarks in the September Psyche suggest that it may be useful to make a further statement as follows:

(1.) Beetle elytra are of value for stratigraphy, because they are present in many different rocks, and often in considerable numbers. The faunæ are recognizable if well figured, and the species are not too few.

(2.) Fossil elytra are also of value as showing the amount of diversification of these structures in different periods, and especially the antiquity of various characters or structures.

These two reasons seem to me to justify the description and naming of fossil elytra.

(3.) On the other hand, in the majority of cases it is impossible to refer the elytra to definite genera, or in some instances to definite families. Thus a species may be recognizable though its generic position is unknown. In all such cases it seems best to use "blanket-genera," such as *Carabites*, rather than to refer the species to numerous supposedly extinct genera, which cannot be accurately defined.

(4.) It is however probable that when students intensively investigate the elytral structures of modern beetles, many more good generic characters will be found than are now known to exist. If so, it may be possible to return to the fossils, and feel some assurance of their correct position.

PARATENETUS CRINITUS FALL

Sherborn, Mass., has furnished another surprise, or rather several of them, in five or six specimens of what appears to be the above species which was described from New Mexico. At least three of the specimens were taken by sifting. The dates of capture are:—May 11, 1913; May 2, 1915; April 4, 1916; April 9, 1925; November 7, 1926. A specimen was seen in a lot of beetles submitted for determination by Mr. A. P. Morse of Wellesley; this was also taken in Sherborn. This species is easily distinguished by its darker color and the long hairs of the elytra; all my examples are smaller than the general run of specimens of the other species. A specimen was sent to Mr. Fall who states that it appears to be the same as the N. M. type, in spite of the locality.

C. A. FROST, Framingham, Mass.

NOTE ON THE DISTRIBUTION OF TWO SPECIES OF COLEOPTERA[1]

BY ELIZABETH W. KINGSBURY

It seems worth while to place on record the following data concerning two species of Coleoptera. I am indebted to Mr. C. A. Frost for kindly identifying the specimens.

Chrysobothris verdigripennis Frost (Buprestidæ)

This species was described from Maine, and only the original locality is cited in Leng's Catalogue. Mr. Frost has no previous record of its having been found west of Ontario. I captured a female specimen at Buffalo, Wyoming, on July 24, 1929, at an altitude of about 7500 feet.

Uloma punctulata Leconte (Tenebrionidæ)

This species is recorded in Smith's list of New Jersey insects (1910), but the most eastern locality given in Leng's Catalogue is Indiana. On March 26, 1929, I found one individual under the bark of a pine log at Lakehurst, New Jersey, thus confirming Smith's record.

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[1] Contributions from the Department of Zoology, Smith College, No. 162.

SOME NOTES AND DESCRIPTIONS OF CERIOIDINE WASP-WAISTED FLIES (SYRPHIDAE, DIPTERA)[1]

F. M. Hull
College Station, Texas

Several interesting studies of this unique group of flies have appeared in recent years. Since their publication I have discovered some new additions to the North American fauna, notes and descriptions of which I am presenting below together with new locality records of other species. I wish to thank Mr. H. J. Reinhard for permission to describe two species collected by him in South and Central Texas.

The strong similarity in appearance between these flies and certain wasps has caused frequent comment. The writer believes this similarity of aspect to be more accurately expressed from a lateral position than a dorsal one. The ever increasing number of discovered Cerioidine forms marks the group as a successful one for the present and one is inclined to wonder if in this case it may not actually be attributed to the mimicry of more aggressive types.

Polybiomyia macquarti Shn.

The Rio Grande Valley seems to be the home of this small slender form. I collected one male at Harlingen, Texas, June 29, 1921, flying about flowering grasses, and one male at Beeville, Texas, August 30, 1928, while resting on a leaf.

Polybiomyia townsendi Snow

One male. Las Cruces, New Mexico, July (F. M. Hull). On greasewood.

Polybiomyia festiva n. sp.

This species is characterized by the reddish color of the thorax and of the face. The markings resemble *P. town-*

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[1] This paper is a contribution from the Plant Lice Laboratory of the Texas Agricultural Experiment Station.

sendi. Where the middle of the second segment of the abdomen in *townsendi* is uniformly red, it is red with a black median stripe in *reinhardi* and the median posterior section is also partially covered with punctate pollen.

Length, 14.5 mm. including antennæ. Female. Vertex yellow, tinged with reddish on every side; front from posterior ocelli to a sharp line just before antennifer reddish, continued narrowly along the median line to antennal prominence and with radiating rugosities in the middle anterior to the ocelli. Antennifer reddish, and this coloration continued from its base as a broad stripe down the face, a narrow one laterally to eye margins, and a stripe on either side of the face. A small black spot on either side of the antennifer above. Lower front and ground color of face yellow. Cheeks red; a black stripe proceeds obliquely from the eye margins two-thirds of the distance to the oral margin. The median red stripe of the face with a broad stripe of microscopic pubescence, thus leaving three slender, shining red stripes. Antennifer half the length of first joint of antennæ. First joint a little shorter than length of second and third combined and a little longer than the second joint alone. Style short. Entire antennæ reddish brown.

Thorax entirely reddish with a short black stripe on either side of the dorsum posteriorly and a shorter, transverse, black dash along the inner ends of the suture, a yellow spot on the humeri, just before the base of wing on mesopleuræ, sternopleuræ, and on the metapleuræ. Scutellum yellow. Halteres reddish. Squamæ pale brown.

Abdomen entirely dark brownish red save for a median black stripe on the posterior third of the second segment and a black tinge on the posterior corners and sides of the same segment. Pollen or pubescence of segments, especially punctate, and together with the lunulate markings quite conspicuous, and extending on to basal half of second segment. Posterior borders of second, third, and fourth segments shining reddish brown. Venter extensively shining black, on the sides reddish. Legs reddish, the sides of the hind femora more deeply and the bases of the tibiæ more yellow. Wings infuscated along anterior margin to tip of wing, the brown coloration reaching completely to spurious vein and bordering the first posterior cell narrowly on its anterior margin. Spur or stigma present. In *P. townsendi* the infuscation does not reach into first basal and first posterior cells.

Type, a female. College Station, Texas, April 4, 1920 (H. J. Reinhard).

Polybiomyia reinhardi n. sp.

This species is allied to *P. bellardi* Shannon. The posterior margin of the abdominal segments are reddish brown, not yellow, and the yellowish coloration of *bellardi* is consistently replaced by reddish brown. Moreover, the wings are infuscated heavily along their entire length to end of costa, the black of the face below antennæ reaches the margins of the eye laterally, etc.

Length about 19 mm. if the entire length from tip of curved abdomen to end of antenna be included. Female. Upper occiput and vertex swollen, tumid, light reddish brown becoming dark brownish red about ocelli and on the sides of the front above. Front brownish yellow on the sides, below with a rounded lobe of black protruding on either side from the middle; middle of front broadly shining black with short silvery pubescence. Face yellow, with a broad wedge-shaped black vertical stripe, extended at right angles just below antennæ in a bifurcate band to eye margins; a lateral oblique black stripe runs from oral margin to eye margin. Vertical median stripe with silvery pubescence medianly and laterally and oblique stripe with a narrow posterior border pubescent. Cheeks and the broad wide lower occiput reddish brown. Entire rim of oral margin black. Antennifer and antennæ reddish brown, the second joint nearly equal in length to the first; third joint half as long as second; style pale, conspicuously silvery pubescent, two-fifths as long as the third joint. Face and lower lateral front unique in bearing many small pimple-like bumps or papillæ bearing short setæ. Entire face and head shining as if varnished.

Thorax shining black with three obscurely indicated pollinose vittæ, one broad median one and a very narrow one on either side. Humeri and a spot before the base of the wing bright yellow. Pleuræ shining black without yellow markings, a brown spot on mesopleuræ, upper pteropleuræ and on the metapleuræ. Scutellum yellow with a narrow brown transverse band. Dorsum papillosetose with a transverse stripe along the suture, not connected medianly.

First abdominal segment dark reddish, with a black spot in the middle above and on either side and with a narrow posterior black border. Second segment black, on the sides and posteriorly dark red, anteriorly yellow; very much constricted. Remaining segments shining black with deep red posterior border and prominent gray pollinose lunules.

Legs shining red, the basal half of all the tibiæ becoming pale yellow, and the femora basally, paler in color. Halteres and squamæ brownish yellow. Wings dark brown on the whole anterior half the infuscation, reaching to the tip of wing or end of costa.

Type, female and three paratypes, females, Dilley, Texas, May 4-11, 1920 (H. J. Reinhard).

This interesting form is certainly related to *bellardi* in the pattern of the pleuræ, thorax, and abdomen. However, the several specimens of this species differ from that species in a number of points. Among them are the face with its papillosetæ and its peculiar bulges, and the ventral concavity of the abdomen with the unusual shape of the last two abdominal segments. Structurally it would appear nearest related to *schwarzi* Shnn. The shining, glossy black of *schwarzi* Shnn. renders that species abundantly distinct.

NOTES ON THE PREY OF WASPS

By Richard Dow

The first three records are based on specimens in the collection of Dr. J. Bequaert, who has kindly permitted me to publish on his material. I am also indebted to Prof. N. Banks, Mr. C. W. Johnson, and Mr. Wm. T. Davis for assistance in determining specimens.

Ageniella accepta (Cress.)

Lycosa sp., immature [N. Banks]
Riverhead, L. I., N. Y.; Aug. 1, 1917; Wm. T. Davis

It is customary for the species of Ageniella and Pseudagenia to mutilate their spiders by removing the legs. The present spider forms no exception, as all eight legs have been nipped off at the coxæ. According to Hartman (Bull. Univ. Texas 65:47. 1905), this Psammocharid also preys on Attids.

Crabro (Thyreopus) argus Pack.

Rhaphium vanduzeei Curran [C. W. Johnson]
White Plains, N. Y.; Sept. 10, 1921

This is apparently the first reference to the prey of the above wasp. The fly has been described since the compilation of the New York list.

Tachytes mandibularis Patt.

Conocephalus saltans (Scud.) [Wm. T. Davis]
White Plains, N. Y.; Sept. 10, 1921

Orchelimum fidicinium Rehn & Hebard [Wm. T. Davis]
Oyster Bay, L. I., N. Y.; Aug. 31, 1929

In the case of the second record, the wasp was flying with the Orchelimum, and both were caught in one sweep of the net. The wasp was killed, but the grasshopper was brought back to the laboratory for observation. Two days later it was still alive, and when stimulated, moved the abdomen, the antennæ, and both pairs of palpi. That evening and also the next morning, it was moving the antennæ and palpi spontaneously. The following morning (Sept. 4), it was dead.

When Patton described *T. mandibularis* (Ent. News 3:90. 1892), he gave the prey as Xiphidium (now Conocephalus). F. X. Williams found it preying on an immature Orchelimum (Kans. Univ. Sci. Bull. 8:198, 1913), and Wm. T. Davis has an additional record for *Orchelimum fidicinium* in the New York list (p. 23).

SOME NEW NEOTROPICAL NEUROPTEROID INSECTS

By Nathan Banks
Museum of Comparative Zoölogy, Cambridge, Mass.

The following new species from the collection of the Museum of Comparative Zoölogy are mostly from Cuba and chiefly obtained in the past few years.

Psocidæ

Compsocus gen. nov.

Belongs to the Amphientominæ. Head moderately broad, bent down, clypeus fairly large, ocelli present, legs rather short, hind pair longer, tarsi of three joints, femora rather swollen, on hind tibia only a few spines on lower apical half. In hind wings the media is forked, and the axillary separate from anal. In fore wings the subcosta is long, curved, and ends in radius, forming a long cell; but one axillary vein, but this plainly forked toward base, axillary and anal end together; radius forked once, media twice; the cubital fork is near to margin and so almost forms an areola postica; surface of wing with many minute, short scales, some stout and rounded at tip, others longer and forked at tip, each kind in separate patches.

Compsocus elegans sp, nov.

Figure 4.

Black; antennæ very fine and thin; legs black, tarsi pale, hind basitarsus with dark band near middle. Wings black, with three hyaline white spots along hind margin, one at end of anal, one over lower branch of cubitus, and one over end of upper cubitus and reaching up to radial branch. On the surface of wing about 12 large silvery white spots; about five tending to form a row across near end of stigma, one of which is in end of stigma and extends beyond to next vein, one in the base of radial fork, two behind it, and one in the median fork; about middle of length are two more silvery spots, and before this an interrupted band from costa just beyond subcostal cell, and extending across radius, and two spots nearer to base; hind wings fumose, veins darker. In fore wings the short, rounded scales are in pale areas, the forked scales densely placed to form dark areas. Both wings iridescent.

Length 2.2 mm.

From Barro Colorado Island, Panama, 23 June. A remarkably beautiful species.

Hemipsocus pretiosus sp. nov.

Figure 5.

Head dull yellowish, unmarked; antennæ also, likewise the thorax, abdomen blackish above, femora dark, tibia and tarsi pale; head, thorax and antennæ with moderately long, pale hair. Fore wings mostly brown; veins nearly black, the longitudinal veins with white spots, particularly prominent beyond the middle; two larger white spots on posterior margin just beyond the end of the cubital vein; veins with erect hairs arising from black spots; the vein bounding areola postica and the cross-vein above it are hyaline-white; hind wings grayish hyaline. Wings shorter than in *H. roseus,* but the venation is very similar, the fork of the median vein, however, reaches back to the cross-vein to areola postica or even onto the cross-vein.

Length of fore wing 2.2 mm.

One from Soledad, Cuba, 18 February (Myers) and the other from Royal Palm Park, Florida (Blatchley).

Thyrsopsocus pretiosus sp. nov.

Figure 3.

Head, thorax, and abdomen black, a pale V-mark on thoracic notum in front. Antennæ brown or black, with black hair on third joint, basal joints and base of four joint pale; legs black or brown, paler on apical part of tibia and basitarsus, middle tibia whole pale. Wings hyaline, with a large black spot occupying most of apical part as in the figure, containing three large pale areas; in front, one each side of the stigma, and one over most of the posterior cells; stigma dark at each end and behind to radius, yellowish through the middle; on basal part of wing two transverse black spots, and a longer oblique one above and into part of the cell. Veins dark, but end of discal cell and lower part of outer side, and the forking of radius yellow; hind wings hyaline, with dark veins.

Length of fore wing 6 mm.

From Barro Colorado, Panama, 18, 23 July.

Thyrsopsocus bellulus sp. nov.

Figure 1.

Head pale yellowish brown; antennæ black, with black hair, basal two joints pale yellowish; thoracic notum pale, a dark band across connecting bases of fore wings; scutellum dark, with pale margin; abdomen dark above, near tip is a large yellowish spot each side, venter pale; legs pale, tips of tarsi dark. Wings hyaline, with mostly pale brown marks in apical part of wing as figured; the stigma yellow and the yellow extended back to radius; black marks at base of stigma, on each side along connection to radius, and in the posterior edge of cell, and two transverse marks in basal part of wing, the hinder one curved and extending toward base; veins mostly dark brown, the basal part of radius and some of media yellow, also most of stigmal vein; hind-wings hyaline, with dark veins.

Length of fore wing 6 mm.

From Carmelina, Honduras, March, on orange (W. M. Mann).

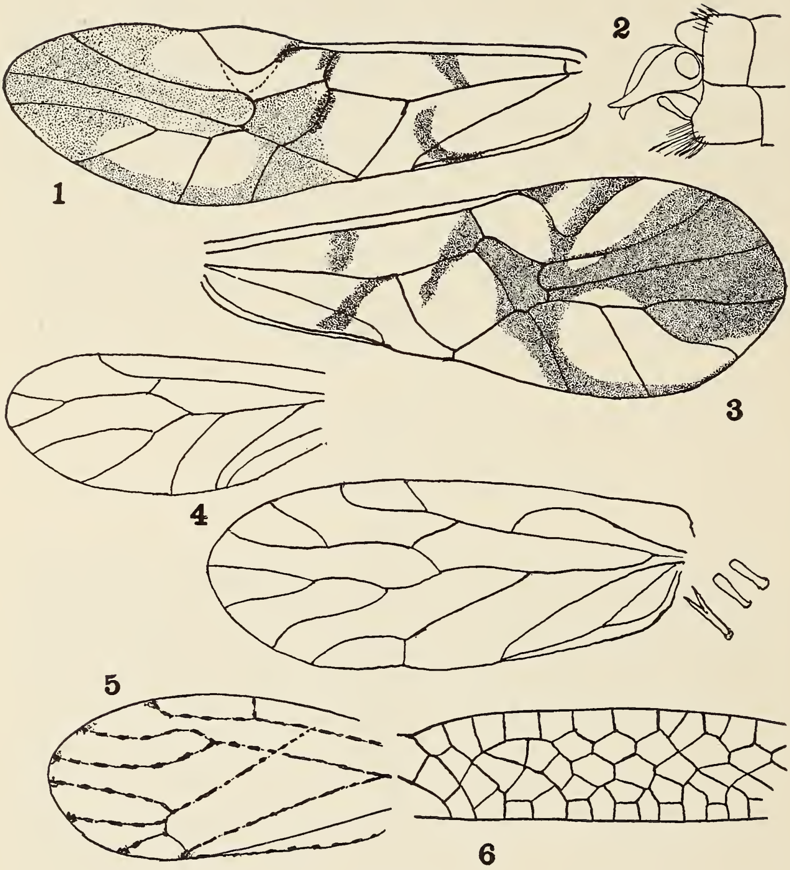

PLATE 9

Banks—Neuropteroid Insects

Ephemeridæ

Callibaetis completa sp. nov.

♀ Body of the usual pale brownish, with many small dark dots, especially on the abdomen, beneath with larger, paired dots, above on abdomen the basal segments show a large dark spot in middle, tending to form a stripe; second joint of antennæ mostly dark brown; legs pale, the tarsal joints faintly dark at endings. Wings hyaline, a broad brown stripe along front margin, covering the first three veins, and on base a little more; this brown fills the costal area to base, and also at tip, it contains a number of transverse hyaline white marks, mostly over veins, very few of these pale spots in the apical fourth, behind the brown is fairly even. The veins are brown, and cross-veins also; there are a few cross-veins near tip, about eleven in a curved series from middle back to near base, before middle near middle of length are three cross-veins, and toward base three more.

Length fore wing 7.5 mm.

From Soledad, Cuba, 20 June (G. Salt).

Hemerobiidae

Hemerobius cubanus sp. nov.

Head brownish yellow, no distinct marks; antennæ similar, but paler toward tips; thorax also similar, with long pale hair above; abdomen darker brown; legs pale, the tibiæ (especially of second and third pairs) swollen toward tip, the hind ones with a dark line on the hind edge of the swollen part.

Wings nearly hyaline, or faintly fumose; veins brown and pale in spots, and brown at origins, and from the brown spots are often extensions of brown out on the membrane; the gradates dark brown, and bordered with brown; stigma not distinct; the brown marks are closer and more distinct in the posterior basal part of wing; hind wing with some brown near tip over the cross-veins and also near base over the branches from anal vein. Wings about of shape of *H.*

humuli, the costal area toward base a little broader; three branches to the radial sector, the last soon forked and again before the connection back to radius; about five inner and seven outer gradates, outer ones partly between forks, inner ones somewhat in pairs, the hind pair nearly interstitial.

Fore wing 6.5 mm. long.

From Pico Turquino, Cuba, 5000 ft., 20 July; and Sierra Maestra, Cuba, 1100-1300 ft., 10-20 July, both collected by C. S. Bruner and C. H. Ballou.

Megalomus cubanus sp. nov.

Figure 2.

Head dull yellowish; antennæ pale brownish, basal joint yellowish; pronotum with about six or eight brown spots, rest of notum also largely dark; abdomen yellowish, as also legs. Wings faintly smoky, with yellowish venation, marked with black along the margin, groups of two or three dark dots; the gradates and an oblique streak up from end of anal nearly black, a brown spot at extreme base of wing, and often small dark dots at forking of veins; just beyond the first gradates there is a narrow pale stripe across wings; hind wing with dark before stigma, the basal part of radial sector and some apical dots dark. Costal area as wide as head plus the pronotum; five radial sectors, the fifth forked at first gradates and upper branch forked again before the second gradates. The median forked just before origin of second radial sector, cubital forked before first gradates.

Expanse 13 mm.

From Soledad, Cuba, 6 March (J. E. Myers).

Has appearance of *M. minor,* but gradates not as oblique as in that species.

Coniopterygidæ

Coniopteryx marginalis sp. nov.

Head yellowish brown; antennæ pale yellowish, legs also, a faint dark mark at tip of femur; mesonotum brown, with a rounded dark brown spot each side near base of wing, pleura nearly black; abdomen pale, dark at tip. Wings fumose, veins darker, most of the cross-veins bordered with hyaline white; along the outer and hind margin are about six dark spots, each between ends of veins; the nearest base is a large one just before the end of cubitus, the next a very small one just beyond the cubitus, then three large spots, in median fork, between media and radius, and in fork of radial sector, and then a small one just above end of radial sector. Hind wings unmarked; both wings mealy white. General shape and venation practically as figured for *C. nivosa* Enderlein.

Length 3 mm.

From Sierra Maestra, Cuba, July 10-20, 1070 to 1350 ft.. C. S. Bruner and C. H. Ballou.

Myrmeleonidæ

Myrmeleon wrighti sp. nov.

Figure 6.

Head mostly black; lower face toward mouth, and the sides toward eyes pale; palpi and antennæ mostly black. Pronotum dull black, a trace of a pale median line in front, and the lateral margins narrowly pale, and a faint pale mark each side behind; rest of notum dark; pleura mostly dark. Femora black in apical half, middle femora almost wholly black, front and mid tibiæ with sub-basal and apical black marks, hind tibiæ black beneath and at tip; tarsi almost wholly black, bases of first and fifth joints only pale; bristles black. Abdomen dull black, a little pale each side at tip; hair short, black above, white below. Wings unmarked; venation interruptedly black and white; stigma pale.

Pronotum much broader than long; first tarsal joint about one-half of fifth; spurs about equal to first joint. In the fore wing seven cross-veins before radial sector, in hind wings four, the first very oblique, about eight branches of the radial sector; in hind wing three or four branches of first anal vein; in fore wing about twelve connections between radial sector and radius before the stigma.

In fore wing (and also in hind pair) there is no definite line in cubital area parallel to cubitus as is present in nearly all species; there is the usual curved beginning of such a line, but it soon runs into the center of a series of diamond-shaped cells.

Length fore wing 34 mm., width 7.3 mm.; length hind wing 30 mm., width 6 mm.

From Cuba (Chas. Wright).

Readily separated from the common Cuban *M. insertus* by larger size, as well as peculiar structure of cubital area.

Austroleon garciana sp. nov.

Head pale, a large dark interantennal mark reaching up to vertex, a narrow dark band across above clypeus, last joint of palpi marked with dark, vertex with two conjoined dark spots above, each enclosing a pale spot behind, antennæ dark, faintly annulate with pale. Pronotum pale, two rounded dark spots in front, two streaks behind and a lateral dark stripe, margin with some long, curved, white bristles; meso- and metanotum much marked with dark, the scutelli with a median dark spot, pleura brown, with several pale spots, legs pale, dotted and spotted with brown, third and fourth tarsal joints almost wholly black, front coxa with several curved white macrochætæ, also a row above on the front femur; spurs equal to two tarsal joints. Abdomen dark, several segments show one or two pale spots or streaks each side above, hair above black on basal part, paler toward tip, venter with white hair.

Wings hyaline, veins dark, with pale spots, a rather distinct spot at the rhegma, radial sector in the hind wings almost wholly dark. Wings slender, much more so than in

A. cubitalis Navas; venation generally similar to that species, two or three cross-veins in hind wings before radial sector, three in fore wings, about five branches to radial sector. The hind wing is so slender that the branches of cubitus are nearly simple, only a few forked and no cross-veins between them as in *A. cubitalis;* the marginal hair is shorter than in *cubitalis.* Fore wing, length 16-18 mm., width 3.5-4 mm. Hind wing, length 15-17 mm., width 2.5-3 mm. Abdomen 16-18 mm. long.

From S. Barbara, 15 March, and N. Gerona, 1 March, Isle of Pines, Cuba, both by C. S. Bruner.

Differs from *cubitalis* Navas not only in smaller size, more slender wing, but also in pronotal marks, *cubitalis* having a single median mark behind; the spots on vertex also different. Both specimens lack the spots along cubitus seen in *cubitalis.*

EXPLANATION OF PLATE 9

Fig. 1. *Thyrsopsocus bellulus,* fore wing.

Fig. 2. *Megalomus cubanus,* male genitalia.

Fig. 3. *Thyrsopsocus pretiosus,* fore wing.

Fig. 4. *Compsocus elegans,* hind and front wings and scales.

Fig. 5. *Hemipsocus pretiosus,* front wing.

Fig. 6. *Myrmeleon wrighti,* cubital area of wing.

PROCEEDINGS OF THE CAMBRIDGE ENTOMOLOGICAL CLUB

Ten meetings were held in 1929, including one special meeting in September. The programs were as follows: Jan. 8, Dr. J. Bequaert, "Notes on Masarid Wasps." Feb. 12, Prof. W. J. Crozier, "The Behavior of Arthropods." March 12, Prof. N. Banks, "Secondary Sexual Characters in Insects." April 9, Prof. W. M. Wheeler, "The Identity of the Ant Genera Gesomyrmex and Dimorphomyrmex"; Mr. C. W. Johnson, "Notes on Some Hippoboscidae." May 14, Prof. C. T. Brues, "An Entomological Excursion to the Hot Springs of the Southwestern United States." June 11, Dr. L. R. Cleveland, "Some Studies on Termites and their Intestinal Protozoa, with Special Reference to the Symbiotic Relationship between Certain Termites and their Protozoa." Sept. 10, Summer Collecting Notes. Oct. 8, Prof. C. T. Brues, "Notes on the Insect Fauna of a Pine Forest"; Mr. P. J. Darlington, "Collecting Notes on Florida Beetles"; Dr. F. M. Carpenter, "Phytophagous Larvæ in the Palæozoic." Nov. 12, Prof. W. M. Wheeler, "A History of Our Knowledge of the Ant Lions." Dec. 10, Mr. C. W. Johnson, "Some Notes on the Insects of Nantucket."

Following a motion passed at the October meeting, the November and December meetings of the club were held in the Peabody Museum, Cambridge. The November meeting was the first to be held in Cambridge since March, 1903.

Two new members were elected in December, making the total membership ninety-one.

RICHARD DOW, *Secretary.*

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CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p. m. in Room J, basement of the Peabody Museum, Divinity Ave., Cambridge. Entomologists visiting Boston are cordially invited to attend.

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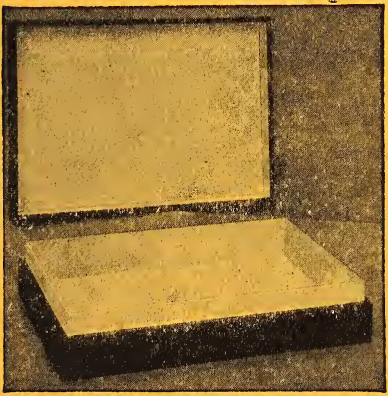

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PSYCHE

VOL. XXXVII SEPTEMBER, 1930 No. 3

TWO NEW ANTS FROM JAVA

By George C. Wheeler and Esther W. Wheeler
University of North Dakota

Phaulomyrma[1] new genus

♂ Head flattened, slightly emarginate behind. Eyes protruding, large (diameter about one-third the length of the head), and situated near the anterior border. Clypeus indistinct or large and somewhat convex. Antennæ 13-segmented. Thorax compressed. Legs slender; two spurs on the middle and hind tibiæ; metathoracic legs, long, extending beyond the tip of the abdomen. Wings hairy; fore wings large, with one or three reduced veins; the margins fringed with hairs; hind wings much smaller. Hairs abundant especially on the dorsum. Integument smooth or with scattered hairy punctures. Genitalia large and projecting. Sagittæ wide at the base. Subgenital plate bifurcated.

Type: *Phaulomyrma javana* new species.

This genus is to be distinguished from *Leptanilla* by the presence of wing veins and the unusually large genitalia. It is our opinion that *Leptanilla tanit* Santschi should also be included in this genus.

Phaulomyrma javana new species

♂ Length—1.2 mm.

Head large, about one-fifth of the entire length, slightly longer than broad, somewhat narrowed behind; the posterior border emarginate.

---

[1] *Phaulos*, trifling, paltry + myrmex, ant.

Eyes large, diameter equal to one-third the length of head, prominent, hairy, hemispherical, situated very far forward. Ocelli oval, almost on the vertex.

Antennæ thirteen-jointed, half as long as the body; flattened; inserted on the anterior margin of the head; twice as far apart as the distance from the eyes. First segment thickest, one-third as wide as long; second, one-half the length of the first, curved and thickened apically; third, as long as the first; fourth to the thirteenth gradu-

Fig. 1. A. *Phaulomyrma javana,* lateral view ♂. B. *Phaulomyrma javana,* front view of head.

ally lengthening until the thirteenth is one-third longer than the first and one-half as wide.

Mandibles minute, labial palpi prominent, one-jointed. Frontal carinæ very short and indefinite. Clypeus indistinct.

Thorax at its maximum breadth two-thirds the width of the head, compressed into a somewhat cuneiform shape with the thin edge above. Sutures distinct. Pronotum concealed from above. Dorsal profile in lateral view ascending evenly and obliquely, forming an obtuse angle at the middle of the mesoscutellum, depressed at the sutures of the metanotum, which is rounded. Epinotum rounded.

Anterior leg thickened, spur one-half the length of the first tarsal joint; mesothoracic leg shorter and much more slender than the others; meso- and metathoracic tibiæ each with two simple spurs. Hind leg reaching just beyond the tip of the abdomen.

Fore wing three times as long as its greatest width, which is at one-quarter of the length from the apex. Costal and radial veins present, also a cross-vein near the base. Stigma poorly defined. Hind wing very narrow, eight times as long as its greatest width (just beyond the middle) and one-half the length of the fore wing.

Abdomen as wide as the head, one-half the length of the entire insect, and strongly curved so that the sagittæ extend forward to the base of the abdomen. Petiole convex below, attenuated anteriorly; posterior third subcylindrical. Node hemispherical.

Hairs abundant except on the genital capsule which is naked; longer on mouth parts and front, and longest on the dorsum of thorax, apex of node, and dorsal tufts on each abdominal segment; more sparse and half as long ventrally. Eyes with numerous very short hairs. Wings conspicuously hairy; the hairs on the surface short, those fringing the margin much longer, decreasing in length toward the base.

Color ferrugino-testaceous, antennæ lighter. Legs and mouth-parts light yellowish brown. Integument smooth.

Genitalia large and non-retractile. Lamina annularis slightly compressed. Sagittæ widened at the base, the apex extending beyond the stipites; the latter hairy, acuminate, slightly curved, and folded within the lamina annularis.

Volsellæ thin, plate-like, with broadly rounded free margins. The prongs of the bifurcated subgenital lamina slender, one-fourth as long as the genitalia.

Described from two males from Buitenzorg, Java (III-'07), collected by F. Muir. (Ex. coll. W. M. Wheeler.)

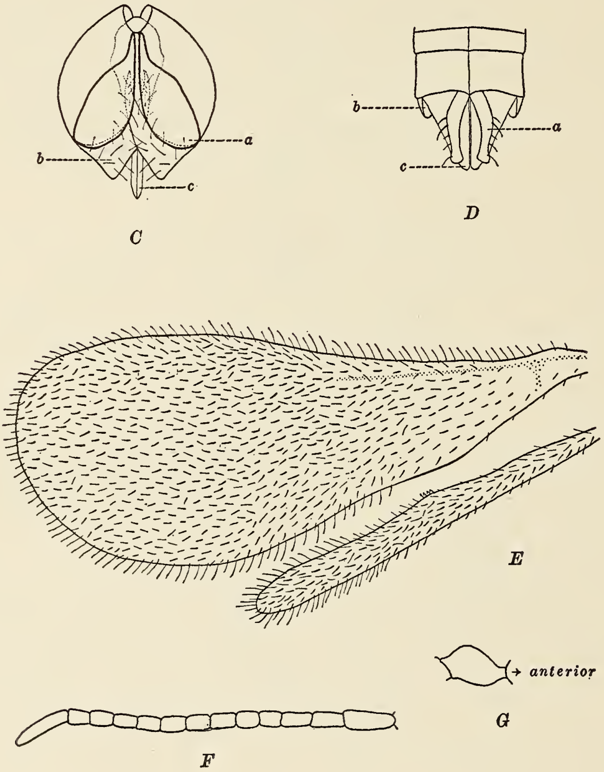

Fig. 2. C. *Phaulomyrma javana,* ventral view of male genitalia. *a,* Volsellæ; *b,* Stipites; *c,* Sagittæ. D. *Leptanilla santschii,* ventral view of male genitalia. E. *Leptanilla santschii,* wings. F. *Leptanilla santschii,* antenna. G. *Leptanilla santschii,* right lateral view of petiole.

Leptanilla santschii new species

♂ Length—1.2 mm.

Head large, about one-sixth the entire length of the body, one and four-fifths times as long as wide, somewhat narrowed behind.

Eyes large, protruding, diameter about one-third the length of the head, situated far forward, hairy, posterior margin slightly emarginate. Median ocellus oval, the others rounded and placed near the vertex.

Antennæ thirteen-jointed, little more than one-half the length of the body. Insertions twice as far apart as the distance from the eye, and situated close to the mouth. First segment almost one-third as wide as long; second and third each, nearly one-half the length of the first; fourth to twelfth, one-third longer than wide; last joint, slightly longer than the first and about one-half as wide.

Mandibles minute. Palpi prominent, single jointed. Frontal carinæ and clypeus indistinct.

Thorax compressed laterally, thinner above than below, depressed at mesoscutellum; measuring one-third the entire length of the body, one-half again as long as deep, four-fifths as wide in dorsal view as the head. Epinotum rounded.

Anterior legs very thick; mesothoracic legs shorter and more slender than the others. Femora thick. Mesothoracic tibia with one spur, metathoracic with two. Hind legs extending beyond the end of the abdomen.

Fore wing two and one-half times as long as its greatest width, which is at one-third the length from the apex. Costal vein and a cross-vein near the base very faintly suggested.

Hind wing ten times as long as its greatest width, which is near the middle, and two-thirds as long as the fore wing.

Abdomen one-third the length of the body and two-thirds the width of the head, rather straight to the sixth segment, which turns downward abruptly, so that the genitalia are at right angles to the rest of the abdomen. Genitalia one-sixth the length of the body. Node one and one-half times as long as high. Pedicel very short.

Genitalia conspicuous and probably non-retractile. Sagittæ rather thick, bent forward at the tip, slightly longer than the volsellæ which are curved, slender with knob-like apices and several long hairs. Stipites short, broad, and blunt, less than one-half as long as the sagittæ.

Hairs abundant, longer on mouth parts, front, dorsa of the thorax, node, and abdomen; longest on the sixth abdominal segment; shorter on the antennæ; sparser and much shorter ventrally. Eyes with many, very short hairs. Wings conspicuously hairy; the surface hairs short; those fringing the margin twice as long. Genitalia naked, except the volsellæ.

Color ferrugino-testaceous; legs, genitalia, and mouthparts lighter.

Integument smooth.

Described from a single male from Buitenzorg, Java. (Ex coll. W. M. Wheeler.)

In his "Social Life Among the Insects"[2] (p. 335) Dr. W. M. Wheeler has suggested that the Tribe Leptanillini would have to be removed from the Dorylinæ and raised to the rank of a subfamily. The senior author[3], in his study of the larva of *Leptanilla revelierei sardoa* Emery, has supported this view.

The Leptanillinæ resemble the Dorylinæ in the following characteristics. The frontal carinæ are close together and do not cover the antennal insertions; the petiole consists of two segments in the worker, one in the male and female. A sting is present. The female is wingless; the thoracic sutures are more or less vestigial. In the male the subgenital lamina is usually bifurcate; cerci are absent. The tibiæ have spurs, which are sometimes rudimentary. The larva resembles the known doryline larvæ in the shape of the body, which is elongate, slender, subcylindrical, orthocephalic, and nearly straight, and in the small feebly chitinized mandibles.

In contrast, the following characters of the Leptanillinæ differentiate them from the Dorylinæ. The workers are monomorphic and minute; the maxillary palpi are one-jointed; the antennæ are always 12-segmented. The lobed hypopygium of the female extends beyond the pygidium.

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[2] New York: Harcourt, Brace & Co. 1923.

[3] Psyche 35:85-91, 1928.

In the male the mandibles are very short and have rounded points; the fore wings have few veins or more commonly none at all; the hind wings are veinless; the genitalia are non-retractile. The larva differs in the constriction of the body at the first abdoimnal segment; the absence of hairs on the head; and the presence of long hairs on the abdomen, especially the extremely long pair at the posterior end. But these differences become trivial and insignificant beside three characteristics which not only separate it from doryline larvæ but render it unique among all the known ant larvæ, namely, the plowshare-like structure projecting from ventral side of the prothorax, a "tympanum" on either side of the fourth abdominal segment, and the toothed flaps at either side of the labrum.

We offer the following as a formal definition of the subfamily:

Subfamily *Leptanillinæ* (W. M. Wheeler) (1910)

☿ Hypogæic, monomorphic, minute. Clypeus with a straight border, sometimes with two lobes prolonged between frontal carinæ, which are short. No carinæ on cheeks. Mandibles straight and toothed. Maxillary and labial palpi each with one segment. Eyes absent. Antennæ 12-jointed, inserted farther apart than in the Dorylinæ and having a filiform funiculus. Promesonotal suture marked, other dorsal sutures completely absent. Epinotum unarmed. Tibiæ with a pectinate spur. Claws simple. Petiole of two segments, both nodiform and of almost the same size. Gaster elongate, oval. Pygidium simple.

♀ Head and thorax like that of the worker. The suture behind the anterior legs fading out dorsally. Wingless. Postpetiole not separated from the following segment by a constriction. Gaster long; cloaca open leaving the sting exposed. Hypopygium longer than the pygidium, with two lateral lobes bent back dorsally.

♂ Head large, more or less rectangular. Clypeus and frontal carinæ somewhat as in worker or indistinct. Mandibles very short, small, rounded, and toothless. Maxillary and labial palpi prominent, one-jointed. Eyes conspicuous, hairy. Antennæ 13-segmented. Scape nearly or quite as long as the next two segments together. Funiculus filiform, terminal segment long. Mesothoracic tibiæ with one or two simple spurs, metathoracic with two. Fore wings with few or no veins; stigma never well defined; hind wings veinless. Petiole one-jointed. Genitalia large, non-retractile; subgenital plate bifurcate.

Subfamily *Leptanillinæ* (W. M. Wheeler)[4]

Genus *Lepantilla* Emery[5]

Leptanilla Emery, 1870, ☿, Bull. Soc. Ent. Ital. 2:196. Emery, 1904, ☿, Arch. Zool. 2:107. Santschi, 1907, ♂, Rev. Suisse Zool. 15:305.

Leptanilla butteli Forel, 1913, ☿ Zool. Jahrsb. 36:25. Federated Malay States: Selangor.

Leptanilla doderoi Emery, 1915, ☿, Ann. Mus. Civ. Stor. Nat. Genova 46:253, pl. 4, fig. 3, 4. Emery, 1916, ☿, Bull. Soc. Ent. Ital. 47:96, Sardinia: Teulada.

Leptanilla exigua Santschi, 1908, ♂, Ann. Soc. Ent. France 77:519, fig. 1, 3. Emery, 1910, ♂, Gen. Insect. p. 33. Tunis: Kairouan.

Leptanilla havilandi Forel, 1901, ☿, Ann. Ent. Soc. Belg. 45:373. Emery, 1910, ☿, Gen. Insect. p. 33. Singapore.

Leptanilla minuscula Santschi, 1907, ♂, Rev. Suisse Zool. 15:309, fig. 3. Santschi, 1908, ♂, Ann. Soc. Ent. France 77:520, fig. 2. Emery, 1910, ♂, Gen. Insect. p. 33. Tunis: Kairouan.

Leptanilla nana[6] Santschi, 1915, ☿, Bull. Soc. Hist. Nat. Afr. Nord. (7me année) 6:55-57, fig. 2. Tunis: Kairouan.

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[4] We have not included here the Genus *Leptanilloides* Mann (Psyche 30:13-14, 1923), because the sexual forms are unknown. To quote Mann (p. 15)—

> "In general habitus this [*Leptanilloides*] is very similar to *Leptanilla*, but the structure of the head associates it more closely with *Eciton*, from which it is distinct in the form of the frontal lamellæ, the form of the gaster and in not being polymorphic."

[5] *Leptanilla nordenskioldi* Holmgren (Zool. Anzeiger 33:347) is an *Eciton* (*Acamatus*) according to Emery (Gen. Insect. p. 25, 1910).

[6] Santschi says in this paper, "*Le* ♂ *du Lep. minuscula* Sant. dont la tête est également très allongée, provient des mêmes terrains et pourrait bien être celui du *L. nana*."

Leptanilla santschii, new species. Java: Buitenzorg.

Leptanilla revelierei Emery, 1870, ☿, ♀, Bull. Soc. Ent. Ital. 2:196, pl. 2, fig. 2, 7. Emery, 1876, ☿, ♀, Stettin, Ent. Zeitg. 37:74. Ern. André, 1882, ☿, ♀, Spec. Hym. Eur. 2:269, pl. 16, fig. 4, pl. 17, fig. 1. Dalla Torre, 1893, ☿, ♀, Cat. Hym. p. 72. Emery, 1904, ♀, Arch. Zool. 2:108, fig. 1-4. Emery, 1910, ☿, ♀, Gen. Insect. p. 33, fig. 8. Emery, 1916, ☿, ♀, Bull. Soc. Ent. Ital. 47:96, fig. 8, 9. Corsica: Corte. Sardinia.

Leptanilla revelierei var. *bimaculata* Emery, 1899, ☿, Bull. Soc. Ent. France p. 20, fig. Emery, 1910, ☿, Gen. Insect. p. 33. Emery 1916, ☿, Bull. Soc. Ent. Ital. 47:96. Corsica.

Leptanilla revelierei subsp. *chobauti* Emery, 1899, ☿, Bull. Soc. Ent. France, p. 20. Morocco: Tangier.

Leptanilla revelierei subsp. *sardoa* Emery, 1916, ☿, Bull. Soc. Ent. Ital. 47:97. G. Wheeler, 1928, larva, Psyche 35: 85-87, fig. Sardinia: Carloforte.

Leptanilla tenuis Santschi, 1907, ♂, Rev. Suisse Zool. 15:307, fig. 1. Emery, 1910, ♂, Gen. Insect. p. 33. Tunis: Kairouan.

Leptanilla theryi Forel, 1903, ☿, Ann. Soc. Ent. Belg. 47:252. Emery, 1904, ☿, Arch. Zool. 2:110, fig. 5, 6. Emery, 1910, ☿, Gen. Insect. p. 33, pl. fig. 8. Santschi, 1915, ♀, Bull. Soc. Hist. Nat. Afr. Nord 6:57-58, fig. 3. Eastern Algeria. Tunis: Sousse.

Leptanilla vaucheri Emery, 1899, ☿, Bull. Soc. Ent. France, p. 19, fig. Emery, 1910, ☿, Gen. Insect. p. 33. Morocco: Tangier.

Genus *Phaulomyrma* new genus

Phaulomyrma javana, new species. Java: Buitenzorg.

Phaulomyrma tanit Santschi (= *Leptanilla tanit* Santschi), 1907, ♂, Rev. Suisse Zool. 15:310, fig. 2. Emery, 1910, ♂, Gen. Insect. p. 33. Tunis: Kairouan.

THORACIC MODIFICATIONS ACCOMPANYING THE DEVELOPMENT OF SUBAPTERY AND APTERY IN THE GENUS *MONOMORIUM*[1]

BY GEORGE S. TULLOCH.

The occasional appearance of forms intermediate between the alate and the apterous castes of the Formicidæ offers some ontological evidence of early stages in the origin of castes and has an important bearing on the question of development of organic forms through continuous or saltatory variation. The differentiation into castes is a condition which has existed for a long period of time since it is clearly shown in the many beautifully preserved ants of the Baltic amber from the Lower Oligocene Tertiary.

In several genera of ants it is possible to trace all the transitional stages in the thoracic structure from that of the winged female to the wingless worker, except that the wings show no transitions, being perfectly developed in the typical female and entirely lacking in all the other forms of the series. In two genera gradational changes in the wing structure have been figured, one in the genus Monomorium (Wheeler, 17) and the other in the genus Pogonomyrmex (Tulloch, 30). The series of *P. californicus* which was given to the writer by Professor Harlow Shapley of the Harvard College Observatory exhibited various transitional stages of the wing from the completely venated type to a veinless wing sac. However, the appearance of these forms was considered to be pathological (since they only occurred in one colony) and, therefore, are perhaps not as instructive as the case noted by Dr. Wheeler in the genus Monomorium. Here it was discovered that at least two species exhibited a normal and unsuspected condition of subaptery in the female.

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[1] Contribution from the Entomological Laboratory of Harvard University, No. 336.

Before proceeding to the description of this condition of subaptery, it should be noted that an extremely unusual condition of aptery has long been recognized in Monomorium. In *Monomorium floricola, M. carbonarium* subsp. *ebeninum* and *M. minutum* subsp. *ergatogyna* Dr. Wheeler (1905) observed that the females had a thoracic structure typical of winged forms, yet they showed no indication of ever having borne wings. Thus we have a case of aptery unaccompanied by the usual fusion of sclerites and by huge diminution in size of the thorax. Forel describes *M. andrei* of Oran as having both winged and ergatoid females as well as the Indian *M. shurri* and *M. dichroum,* but as he fails to explain the thoracic structure of the ergatoid and the winged female, it is impossible to judge whether the apterous condition here is similar to the case cited by Dr. Wheeler.

In two Australian species, *M. rothsteini* and *M.* (*Notomyrmex*) *subapterum,* the males show no differences in the size and development of the wings, which in both species are large and of the usual structure, but the females exhibit differences in the size of the thorax and wings. The wing of *rothsteini* measures 6.8-7 mm., while that of *subapterum* is only 3 mm., and its thorax is also much reduced in size. A somewhat similar case was found in the female of the related species *M.* (*Notomyrmex*) *rubriceps.* In a specimen of an incompletely deälated female the size of the remaining hind wing indicated that all the wings were very much reduced previous to deälation, and probably represented a more advanced condition of subaptery than the female of *subapterum.* It should be noted that in the case of *subapterum* several specimens of the female were available for study, each exhibiting the subapterous condition of the wing. In the case of *rubriceps* only a single specimen of the female illustrates the subapterous condition, while in five other specimens from the same nest all the intermediate stages between the subapterous and the apterous condition are represented. In the case of *subapterum* the condition of subaptery is evidently normal, while in *rubriceps* it is, perhaps, abnormal. However, whatever the case may be, the female of *rubriceps* represents a new condition of subaptery which had been hitherto unknown until described by Dr. Wheeler.

The specimens of *M. rubriceps,* six in number, were found to contain an interesting series of intermediate forms between the subapterous condition represented by the female mentioned above and the apterous condition exhibited by the worker. Dr. Wheeler first noted this series and figured the modifications existing in the notal regions of the thorax. Since the pleural regions exhibit various equally interesting morphological modifications from the winged to the apterous condition, and since they may represent phylogenetic stages in the origin of castes,

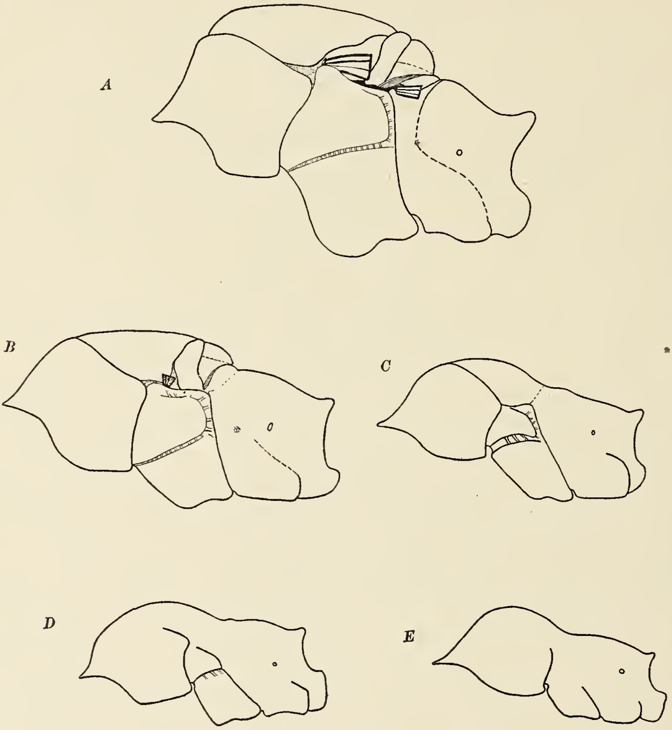

Fig. 1. Thoracic modifications in *Monomorium.*

the following description is offered. The specimens examined are all from the collection of Dr. Wheeler, through whose kindness the writer is enabled to describe them.

The subapterous female of this particular species measures 6.5 mm., has well-developed ocelli, and its thorax (Fig. A), although somewhat reduced, is of the same general composition as its close relative, *M. subapterum.* The stumps of wings are present except on the hind right side, where the entire wing is retained. It is much reduced in size and may be considered as vestigial. The other wings have been lost by deälation. The structure of the pleural region of the thorax is not unlike that of other Myrmicinæ, and since it is not the purpose of this paper to discuss the morphology of these forms, but rather to indicate the annectant stages between the alate and the apterous castes, a discussion of the different sclerites is omitted. The second stage (Fig. B) is one in which the hind wings have entirely disappeared, yet the stumps of the fore wings are present. The transition to this stage has been accompanied by a reduction in size of the thorax and by the fusion of the pleuron and notum in the regions formerly occupied by the hind wings. A further step in the series (Fig. C), indicated that the wings have totally disappeared, and the thorax has become greatly reduced in size. Fig. D represents another stage illustrating a simplification of structure and a reduction in size. Fig. E represents the true worker and is characterized by the presence of an enlarged pronotum, which appears to be a fairly constant character of the worker caste among most genera of Myrmicinæ.

The evidence derived from the series of Pogonomyrmex and this series of Monomorium may have an important bearing on the question of the production of organic forms through continuous or saltatory variation. The gradation of the intermediate forms is so continuous that one is almost forced to accept the explanation of the production of organic forms through continuous variation as the more logical of the two. The appearance of intermediate forms would seem to suggest at once that the origin of castes could not have come about as a saltatory variation or mutation. It is very possible that the explanation involving continuous variation may be incorrect, and one must turn to other hypotheses to answer this question. When one considers the influence of nutritional factors upon the production of abnormal forms (especially among the arthropods), it is quite possible that the suggestion made by LaMeere (1909) considering nutritional factors as influencing the origin of castes among the ants may be of greater significance than has been hitherto suspected.

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ANT-LIKE SPIDERS OF THE GENUS MYRMARACHNE FROM THE PHILIPPINES

BY NATHAN BANKS

In the collection of Arachnida of the Philippine Islands in the Museum of Comparative Zoölogy are a number of specimens of the interesting ant-like genus Myrmarachne. Peckham described four species and the types are here, Karsch described one, and Chamberlin one species. The large species, *M. maxillosus* Koch, known from various parts of the Malay region, also occurs in the collection.

In this paper I shall treat only of the males, believing that we know too little as yet to place the females properly; in several cases, however, there are females with males to which they evidently belong. I have, therefore, not treated of *M. edentulus* which Peckham based on a female; quite possibly it is the female of *M. bellicosus*. The specific characters are best illustrated in the jaws, their shape and armature. The male palpi are so nearly alike in the several species that it appears they are less useful than in most spiders; the case is similar to that of Tetragnatha.

The following synoptic table will distinguish the forms so far known; doubtless there will be fully as many more to be found in the islands. Only one of the species is from Mindanao, most of them from Luzon. Except *M. maxillosus* none of the species agree with the species known from Ceylon, Malacca, Java, or Borneo.

1. Two teeth on outer upper edge of each jaw, jaws not constricted, fang without tooth, lower outer edge of fang-groove with a row of small teeth........*bidentata*
No teeth on outer upper edge of jaw........................ 2

2. Inner upper edge of jaw with a prominent tooth before tip, and a large blunt tooth-like process at tip; jaws not constricted at base, abdomen not constricted, large dark species ....*maxillosus*
No tooth on upper inner edge of jaw before tip.... 3

3\. The jaws (seen from side) more or less plainly constricted on basal part and swollen above on apical part 4

The jaws (seen from side) not constricted on basal part, nor swollen on apical part, but even along the top 9

4\. Abdomen very plainly constricted before middle; fang evenly curved, color yellowish throughout .... *assimilis*

Abdomen not plainly constricted above, fang sinuous 5

5\. On lower outer edge of fang-groove a row of distinct teeth to near base, fang with blunt tooth near middle, jaws not much swollen toward tip .... *opaca*
On lower outer edge of fang-groove only a few small teeth, not noticeable except near tip, fang without tooth 6

6\. Jaws only a little swollen toward tip, fang but slightly sinuous; no tooth missing on lower inner edge toward tip 7

Jaws greatly swollen toward tip, fang plainly sinuous 8

7\. Color mostly dark .... *bellicosus*

Color wholly pale yellowish .... *dubius*

8\. Jaws more suddenly swollen on basal side, no prominent teeth on outer fang-grove, head more globose than usual .... *tagalica*

Jaws more gradually swollen on basal side, three prominent teeth near tip on outer fang-groove .... *mcgregori*

9\. Abdomen not constricted above, but very slender, cephalothorax very long, but slightly cut back of eyes, no tooth on fang, color iridescent above .... *iridescens*
Abdomen constricted above, and with two shields, plainly separated 10

10. Fang with one (or two) teeth 11

Fang without tooth 12

11. Fang with one long, and one very short or indistinct tooth; teeth on lower inner edge large, cephalothorax only slighted indented back of eyes .... *chapmani*

Fang with one short tooth; inner teeth on lower side small; cephalothorax deeply indented back of eyes .... *piercei*

12. Fang plainly sinuous; cephalothorax moderately indented, inner row of teeth even (not one missing), outer edge of fang-groove with row of distinct teeth .... *seriatis*

Fang evenly curved, no row of distinct teeth along outer edge of fang-groove 13

13. On lower inner edge one tooth skipped, fang not constricted near tip, nor wrinkled, cephalothorax only slightly cut behind eyes, larger species .... *bakeri*

On lower inner edge no tooth skipped, all at subequal distances apart, fang wrinkled beneath and constricted before tip, cephalothorax more deeply cut back of eyes, smaller species .... *nigella*

Myrmarachne bidentata sp. nov.

Fig. 4

Cephalothorax dark red-brown, jaws red-brown, dorsal shield of abdomen dark red-brown, rest of abdomen brown; legs yellow-brown, tarsi 3 and 4 pale and coxæ 1 very pale. Cephalothorax but little indented back of eyes, only about the height of third eyes; eyes of second row as near third as to A. S. E. and higher up. Jaws heavy, shorter than the cephalothorax, seen from side convex above and below, sides transversely wrinkled from above rather broadest on apical third, outer edge with two prominent teeth, the apical one usually more blunt than the basal, the edge between sometime slightly concave, lower inner edge with a rather large apical tooth and about three before it, outer edge of fang-groove with a faint carina and several teeth, two near tip longer and more visible from side; fang slightly sinuous, without tooth. Palpi about as long as jaws, the tibia a little shorter than tarsus. Legs of moderate length; femur swollen at base more than others, tibia 1 with six pairs of long spines. Sternum narrow, anterior coxæ nearly touching, second coxæ also swollen within. Abdomen not constricted, with one large dorsal shield, truncate before tip, and with little if any indication of a basal division.

Body.—Length 6-7 mm.

From Mt. Makeling (Baker), Malinao, Tayabas (Baker), and Sarai, Paete, Laguna (McGregor).

Myrmarachne maxillosus Koch

Several specimens from Los Banos (Baker), Malinao, Tayabas (Baker). In one specimen the anterior tibia is short and with but four pairs of spines, others have the front tibia longer (though variable) and with more spines, but the characters of the jaws are the same in all.

Myrmarachne assimilis sp. nov.

Figs. 7, 13.

Pale yellowish throughout, jaws rather darker, fang dark red-brown, except pale tip. Cephalothorax very deeply cut behind eyes, much more so than usual, thoracic part scarcely rising behind cut; eyes of second row near to and a little above the anterior laterals. Jaws longer than the cephalothorax, much constricted on basal half, so that narrowest part (seen from side of above) is about half of the widest part, a faint outer carina, and an inner one on apical part, transverse wrinkles rather faint except on inner sides; on inner lower edge five teeth at subequal distances apart on apical half, a few small ones on basal part, outer edge of fang-groove with ten or more teeth, two near tip rather larger than the others which are very small; fang gently evenly curved, not at all sinuous. Palpi with tibia a little longer than tarsus. Legs very slender, front femora but little enlarged at base, tibia 1 with five outer and four inner spines. Sternum not very narrow, about as broad between coxæ 1 as between coxæ 2. Abdomen elongate, much constricted at basal third, with two separated shields, and showing some trace of dark marks.

Body.—Length 8 mm.

From Mt. Makeling (Baker) also females probably belonging thereto, and a female from Calayan Island, (McGregor).

It is related to *M. plataleoides* Peck. from Ceylon, but the swollen part of the jaw is longer, and the tibia of palpus though elongate is not as much so as in *M. plataleoides*.

Myrmarachne opaca Karsch

Fig. 12.

Cephalothorax dark red-brown to black, the mandibles also; legs yellow brown to dark brown, often not marked; abdomen dark, nearly black. Cephalothorax quite deeply cut back of eyes, the thoracic part rising somewhat behind before sloping off to tip; eyes of second row plainly a little nearer to A. S. E. than to third row. Jaws fully as long or longer than the cephalothorax, constricted on basal half, but not as much so as in *tagalica* or *mcgregori*, about as much as in *M. bellicosus*, from above about one-half wider in widest place than at base, each edge with a carina, that on the inner side of apical part especially strong, on sides and above transversely wrinkled; lower inner edge with six or more teeth, those on apical part fairly large, but hardly at equal distances apart, lower outer edge of fang-groove marked with a long row of good-sized teeth, plainly visible from side all along to near the base; fang sinuous, and near middle with the beginning of a tooth. Palpi nearly as long as the jaws; the tibia about equal to tarsus; legs long and slender, the front tibia very long and with five pairs of spines; sternum moderately slender, plainly wider at coxa 2 than at coxa 1; abdomen rather short with one large shield above which on the anterior sides shows an indentation each side.

Body.—Length 6.5-7.5 mm.

From Manila, Los Banos (Baker); Culasi, Panay (McGregor); and Philippine Islands (J. W. Chapman). Karsch described it briefly from Samar; in 1912 I examined his type. This species is related to *M. turriformis* Badcock, but the numerous teeth on outer edge of fang-groove separates it, the sternum is also narrower than the Malayan species. *M. robustus* Peck from Burmah is very close to *M. turriformis,* and perhaps the same, but tibia of palpus a little longer.

The *M. tayabasanus* Chamb. (1925) appears to be this species; the type is not here, and the description gives nothing to show it distinct from *M. opaca;* the marks on legs vary.

Myrmarachne bellicosus Peck

Besides the type we have specimens from Serai, Paete, Laguna, (McGregor), and several marked only Luzon. The second femora usually shows a black line more or less plainly.

Myrmarachne dubius Peck

I have seen no more than the type, and doubt if it is distinct from *bellicosus,* the femur 2 shows a trace of the dark line. One of the *bellicosus* is paler than others but none approach *dubius* in the practically wholly yellow color. I fail to find anything different in the jaws; both forms have four pairs of spines under tibia 1.

Myrmarachne tagalica sp. nov.

Figs. 1, 10.

Cephalothorax reddish brown, almost black on top of head, jaws dull yellowish brown, legs yellowish brown, femora rather darker, abdomen nearly black above. Cephalothorax deeply cut behind eyes, and the side furrows also deep, behind cut rising slightly before sloping, cephalic part more globose than usual, the sides (seen from above) convex and hind corners well rounded. Jaws longer than cephalothorax, basal part much constricted, apical part greatly swollen, and the swelling starts rather suddenly, each upper edge with a carina, lower inner edge with four teeth in apical part and some small ones on basal part, outer edge of fang-groove marked by a row of small teeth, those near tip scarcely larger and not noticeable from side; fang sinuous, no tooth. Palpi short, tibia hardly as long as tarsus. Sternum not very narrow, at coxæ 1 fully one-half as wide as at coxæ 2. Legs long and slender, tibia 1 fully two-thirds as long as jaw, with four pairs of spines, and an extra one near tip. Abdomen short, not constricted, rounded above, the two shields practically united.

Body.—Length 4.5 mm.

From Butuan, Mindanao (Baker).

Myrmarachne mcgregori sp. nov.

Figs. 9, 14.

Cephalothorax red brown, clothed with appressed white hair, eyes on black spots, jaws dark red brown, legs pale yellowish brown, front pair rather darker, palpus mostly pale, abdomen black above, paler beneath. Cephalothorax deeply cut behind eyes, and the side furrows also deep, thoracic part sloping behind; eyes of second row a little nearer to A. S. E. than to third row. Jaws much longer than cephalothorax, very large, basal part constricted, apical part much swollen, but the slope rather gradual, from above not twice as broad as at base, lower inner edge with about five teeth, outer edge of fang-groove marked by a row of teeth of which several near the tip are larger and noticeable from side; fang strongly sinuous, no tooth. Palpi much shorter than jaws, tibia 1 not two-thirds as long as jaw, with four pairs of spines. Sternum narrow, not one-half as wide at coxæ 1 as at coxæ 2. Abdomen rather short, but little longer than the swollen part of jaw, evenly convex above, not constricted, but with two distinctly separated shields.

Body.—Length 3.2 mm.

From Sarai, Paete, Laguna (McGregor).

Myrmarachne chapmani sp. nov.

Figs. 6, 11.

Cephalothorax and jaws yellow-brown, black in front and around third eyes, legs yellowish; abdomen pale on basal half, beyond shining black, except extreme tip pale, anterior metatarsi slightly dark. Cephalothorax not deeply cut behind eyes, but side grooves are deep, and above the eye-region appears trilobed behind; eyes of second row about as near third row as to A. S. E. Jaws about as long as cephalothorax, straight, not constricted on basal part, from above the sides are nearly parallel, but outer somewhat convex, each edge with a carina; lower inner row of about seven large teeth, nearly evenly spaced, except near tip; outer edge of fang-groove not indicated and without teeth; fang long, scarcely sinuous, but with a very large tooth near basal third and the beginning of another near apical third. Palpi short, the tibia shorter than usual, no longer than broad. Legs short; femora, especially of leg 1, swollen at base, tibia 1 with four pairs of spines. Sternum much narrowed between coxæ 1, but moderately broad at coxæ 2. Abdomen elongate, constricted above, with two separate shields.

Body.—Length 4mm.

From Philippine Islands (J. W. Chapman), with ants.

Myrmarachne piercei sp. nov.

Fig. 2.

Cephalothorax with head black, thoracic part yellowish, base of abdomen pale, beyond dark, jaws red-brown, legs yellowish brown, metatarsi 1 dark, leg 2 pale, with a dark stripe in front of femur; leg 3 mostly brownish; leg 4 with coxæ, trochanters, and most of patellæ very pale, rest brown. Cephalothorax deeply cut back of the eyes, the thoracic part somewhat elevated behind cut; eyes of second row almost as near third row as to A. S. E. Jaws long, straight, hardly as long as the cephalothorax, not constricted above on basal part, upper edge with carina, outer side slightly convex, lower inner edge with only two or three small teeth toward tip, outer edge of fang-groove marked by a carina with a few small teeth scattered along to near base; fang slightly sinuous with a distinct tooth near basal third and beyond that wrinkled within. Palpi much shorter than jaws, the tibia little longer than broad. Sternum quite narrow, but about as much widened between coxæ 1 and 2 as behind coxæ 2. Legs moderately short, tibia 1 with four pairs of spines, one beneath on patella 1. Abdomen rather long, plainly constricted above and on sides, and with two separate shields.

Body.—Length 6.5 mm.

From Victorias and Manapla, Occ. Negros (Pierce).

A female similar to male except short jaws may be the same species.

Myrmarachne seriatis sp. nov.

Fig. 5.

Cephalothorax nearly black, clothed with fine appressed white hair; jaws red-brown; legs mostly yellow-brown, femora often dark, front femur, tibia and metatarsus mostly dark brown; abdomen black, a pale band across between shields. Cephalothorax cut quite deeply back of eyes, but posterior face of head sloping; eyes of second row a little nearer to A. S. E. than to third eyes; jaws fully as long as the cephalothorax, heavy, very thick near base (seen from side), not constricted on basal part, from above outer edge convex, broadest a little beyond middle, each upper edge with a carina, above transversely wrinkled, lower inner edge with about four rather small teeth on apical part, besides the larger and sharp apical tooth, basal part with many small teeth, outer edge of fang-groove marked by a long row of teeth, plainly visible from side; fang sinuous, without tooth, the inner edge before middle somewhat wrinkled. Palpi short, tibia moderately short. Legs not very long, leg 1 short, tibia with five pairs of spines below. Sternum moderately slender, about as wide at coxæ 1 as at coxæ 2. Abdomen moderately short, but with two distinct dorsal shields, and slightly constricted between them.

Body.—Length 4.5-5.5 mm.

From Culasi, Panay (McGregor).

Myrmarachne bakeri sp. nov.

Fig. 8.

Cephalothorax brownish yellow, eyes on black band, jaws reddish brown, legs mostly dull yellowish, femora more brown, especially front ones, metatarsi 1 dark and a broad dark band on tibia 1. Abdomen dark, nearly black above, except tip, a pale band across between the shields. Cephalothorax only slightly cut behind eyes and then sloping off behind; eyes of second row about as near to the third row as to the A. S. E. Jaws longer than the cephalothorax, not constricted on basal part, the outer edge has a carina above and is plainly convex, a large tooth on inner edge near tip, one a little behind it, then a space equal to width of jaw before the next tooth followed by two more, and several very small, scattered teeth, not noticeable from sides; fang long, slender only slightly curved except at tip. Palpi much shorter than jaws, tibia about as long as tarsus. Legs fairly long and slender, tibia 1 with six pairs of spines beneath, one under the patella 1. Sternum not very slender, almost as wide at front coxæ as at coxæ 2. Abdomen rather short, broadest toward tip, only slightly constricted above and on the sides at basal third, but with two distinctly separated shields.

Body.—Length 5-6 mm.

From Mt. Makeling (Baker).

Myrmarachne iridescens sp. nov.

Fig. 3.

Cephalothorax iridescent bronzy black; jaws red-brown; legs pale, femur 1 and metatarsus 1 and outer half of tibia dark, hind tibia and metatarsus lineate with dark; abdomen black, above iridescent. Cephalothorax very long, cut only a trifle back of eyes, the thoracic part sloping gradually, and much longer than head; second eyes about half way between third and A. S. E.; jaws only about two-thirds as long as cephalothorax, not constricted at base, from above the outer side is convex, the broadest a little before middle, each edge with carina, surface transversely wrinkled above, the inner edge produced in a sharp tooth, the lower inner edge with about five teeth, outer edge of fang-groove not marked by distinct teeth, fang but little curved. Palpi short, tibia shorter than tarsus. Legs slender, but rather short, femur 1 thick at base, tibia 1 with five pairs of spines below, patella with one spine. Sternum moderately narrow, a little narrower at coxæ 1 than at coxæ 2. Abdomen very long and slender, but not constricted above nor or on sides, and with one long shield above.

Body.—Length 4.5 mm.

From Los Banos, Luzon, Phil. Islds. (Baker). The female with the males is similar in color and structure, except in having short mandibles.

Myrmarachne nigella Simon

Described by Peckham as *S. niger,* changed to *nigella* by Simon because *Salticus niger* was preoccupied. Besides the Peckham types we have it from Manila (Feb. 1917) and Dupax, Nueva Vizcaya, Luzon.

EXPLANATION OF PLATE 11.

Fig. 1. *Myrmarachne tagalica,* jaw above.
Fig. 2. *Myrmarachne piercei,* side.
Fig. 3. *Myrmarachne iridescens,* side.
Fig. 4. *Myrmarachne bidentata,* jaw above.
Fig. 5. *Myrmarachne seriatis,* side.
Fig. 6. *Myrmarachne chapmani,* jaw above.
Fig. 7. *Myrmarachne assimilis,* side.
Fig. 8. *Myrmarachne bakeri,* jaw above.
Fig. 9. *Myrmarachne mcgregori,* side.
Fig. 10. *Myrmarachne tagalica,* side.
Fig. 11. *Myrmarachne chapmani,* side.
Fig. 12. *Myrmarachne opaca,* jaw above.
Fig. 13. *Myrmarachne assimilis,* jaw above.
Fig. 14. *Myrmarachne mcgregori,* jaw above and teeth near apex below.
Fig. 15. *Myrmarachne opaca,* side.

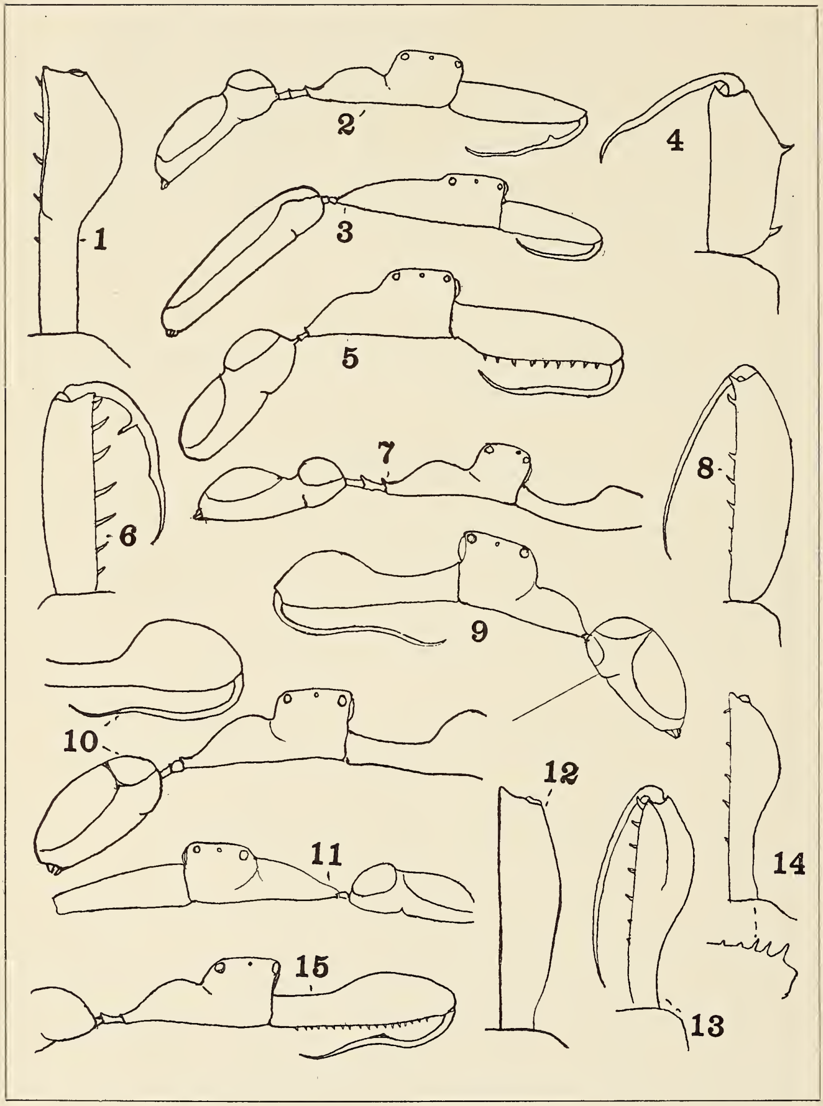

Plate 11.

Banks, Myrmarachne.

A NEW BEE OF THE GENUS COLLETES FROM PANAMA

By Myron Harmon Swenk

University of Nebraska, Lincoln, Neb.

In a lot of bees of the genus *Colletes* belonging to the British Museum, I found a well-marked new species, which may be described as follows:

Colletes isthmicus sp. nov.

♀. Length 8 mm. Black. Head nearly one-third wider than long (57 x 75), the distance between the lower orbits only slightly (about one-tenth) less than the interorbital space on the vertex (42:38). Clypeus shining, convex with a median feebly sulcate area, coarsely striate-punctate except just before the apical margin which is smoothish, slightly reflexed and feebly medially emarginate. Supraclypeus shiny, coarsely and closely punctured except on a small, median, impunctate spot. Face dullish, densely and shallowly, rather finely punctured, the foveæ short and narrow, scarcely encroaching on the vertex, but the smooth, dullish internal portion crossing the depressed sides of the vertex as an impunctate band contiguous to the orbital summits. Vertex about ocelli shiny, finely and rather closely punctured, elevated. Cheeks shiny, sparsely indistinctly punctured, thinly clothed with simple, white hairs posteriorly. Malar space minutely lined, about one-third as long as wide or nearly that (3 x 10). Pubescence of face thin, very short, minutely plumose and grayish white in color, with longer, finely plumose, erect, sparse black hairs intermixed below the antennal level, the edges of the clypeus and supraclypeus with mixed black and yellowish, simple, suberect hairs, the clypeus nearly bare, its sparse hairs like those on its margins only shorter. Vertex with mixed black and whitish, thin, erect, plumose hairs, occiput with a copious, white fringe. Antennæ short, clavate, black with the under side of the flagellum slightly tinged with brownish, joint 3 slightly longer than 2 or 4, which are subequal, the proportion of joints 2-5 being 4.5:5:4.5:4.5, the median flagellar joints one-sixth shorter than wide (5 x 6). Prothoracic spines very short but sharp, entirely concealed in the pubescence. Mesoscutum with rather coarse but not very deep punctures, separated the width of one or almost so anteriorly and laterally, on the posterior disk a distinctly defined, rather large, polished and impunctate area, the parapsidal furrows also bounded by impunctate lines. Mesoscutellum basally and medially polished and impunctate, laterally coarsely and rather closely punctured, the punctures crowded along the apical margin. Metanotum roughened by coarse, shallow, cancellate punctures. Superior face of the propodeum very broad and well defined, its apical margin strongly rimmed, divided by a few straight striæ into a few large, rectangular, shiny pits nearly as wide as long medially. Enclosure on the posterior face of the propodeum funnel-shaped, mostly smooth and polished, a few oblique striæ at extreme sides basally and indications of a short, basal median carina, the downward prolongation moderately broad at base. Surrounding areas of propodeum shiny, very coarsely reticulated. Mesopleura with coarse, round punctures about like those on mesoscutum anteriorly. Pubescence of mesopleura discally long, thin, erect, plumose and black, forming two longer and denser black tufts under and before the tegulæ, the space between these tufts with a contrasting, shorter, finely plumose, almost pollinose, snowy white hair-tuft, the mesoscutum with a short, plumose, mixed black and grayish white pubescence that is rather dense marginally but very thin discally, the pale hairs preponderating and forming an unmixed fringe along proscutal-mesoscutal suture, the mesoscutellum with copious, long, wholly black, plumose hairs with a contrasting snowy white axillary tuft of short hairs and a narrow fringe of similar hairs in the mesoscutal-mesoscutellar suture, the metanotum and propodeum with long, copious, erect, plumose, grayish white hairs, these very thinly mixed with dark ones on the sides of the posterior face of the propodeum. Tegulæ shining piceous. Wings hyaline basally, slightly darkened on the apical margin and in the marginal cell, nervures and stigma dark brown, second submarginal cell above slightly wider than the third. Anterior coxæ simple. Tarsal claws red, deeply medially toothed. Tibial spurs dark, the anterior one finely pectinate. Hind basitarsi three times as long as wide (25 x 8). Hind legs with the coxæ, trochanters and inferior base of the femora whitish-haired, the femora above and at apex black-haired, the tibial hairs almost all black, especially the long-plumose hairs on the anterior face, the basitarsi with pale yellowish hair within but black bristles externally, the intermediate legs with mostly pale hairs but black-haired on tibiæ and basitarsi externally, the anterior legs pale-haired and with yellowish hair on the tarsi. Abdomen neatly conical, polished, basal tergite impunctate, tergite 2 minutely and indistinctly punctured. Apical margins of the tergites (1-5) broadly but feebly depressed and covered with a loose, minute pile to form broad, pale yellowish fasciæ. Basal tergite with very thin, erect, white hair, tergites 2 and 3 with a minute, thin, black pile, tergites 4-6 with a longer black pile and numerous long, black bristles. Venter finely, indistinctly punctured and minutely reticulated, sternite 6 toward apex finely rugose and with crescentic, shallow, lateral fossæ on each side of the median line.

♂. Length 6-7 mm. Distinctly smaller and more slender than the ♀. Head sub-triangular, about three-tenths wider than long (50 x 65) and the face narrowing about one-fourth between the vertex and the lower orbital margins (39:20). Sculpture of clypeus, supraclypeus and face as in the ♀, but pubescence longer and more copious with the black hairs below antennal level much more numerous and the pale ones tinged with yellowish. Depressed sides of the vertex impunctate or very feebly punctured, the elevated area very slightly black-haired. Malar space of the same length as in the ♀ but much less wide so that it is nearly one-half as long as wide (3 x 6.5). Antennæ long, slender, black with the flagellum obscurely brownish beneath, joint 3 shorter than 4 or following, the proportion of joints 2-5 being 3.5:5:6.5:7.5, the median flagellar joints about one and two-fifths as long as wide (7.5 x 5.5). Mesoscutum and mesopleura much less coarsely punctured than in the ♀, and the punctures separated about twice the width of one, the mesoscutellum with the posterior punctures not crowded; otherwise the thoracic sculpture as in the ♀. Thoracic pubescence yellowish white, short and thin and very feebly intermixed with blackish on the mesoscutellum, mesoscutellar hairs long and mostly blackish, hair of metanotum, propodeum and mesopleura long and thin, the latter region with a few blackish hairs intermixed. Wings rather less darkened apically than in the ♀, otherwise similar. Tarsal claws sub-apically cleft, the apical tarsal joint sometimes reddish. Tibial spurs not obviously pectinate. Hind basitarsi proportioned as in the ♀ (21 x 7), the intermediate one about twice as long as wide (II=4.5 x 8.5). Hair of legs all pale. Abdomen elongate conical, polished, basal tergite minutely punctured, the punctures separated several times the width of one, following tergites very finely, indistinctly punctured. Apical margins of the tergites more distinctly depressed than in the ♀, the fasciæ whitish and on tergites 1-5. Pubescence of the tergum much as in the ♀. Apical margins of the sternites with a dense, narrow, apical fringe, longest laterally, forming distinct hair bands. Sternite 6 apically smooth and shining, slightly concave, medio-basally slightly elevated, without distinctive sculpture.

Type Locality—San Lorenzo, Chiriqui, Panama.

Type—A female collected by Mr. Champion. In the collection of the British Muesum.

Allotype—A male from the type lot. In the collection of the British Museum.

Remarks—This species is easily recognizable by the black hair of the mesopleura and posterior legs, impunctate first tergite, short malar space and small size, in the ♀. It is closest, probably, to *C. mexicanus* Cresson. The above measurements are of the type and allotype.

Specimens Examined—Total number 9 (2♀♀, 7♂♂), from localities as follows: Panama: San Lorenzo, 9.

NEW NEUROPTEROID INSECTS FROM THE UNITED STATES

BY NATHAN BANKS

The following notes include a synoptic table to the species of Boriomyia and the description of three new genera of Trichoptera. The new Psocidæ represents a genus new to our fauna, quite different from anything else in the country.

PSOCIDÆ

Deipnopsocus texanus sp. nov.

Figs. 1, 2.

Body yellowish to reddish brown, no distinct markings, head with sparse, short white hair, longer on the clypeus; legs pale yellowish brown, with some white hair, few bristles, front femora broad and compressed. Wings hyaline, surface with a few scattered, short, minute, rounded scales, several rows of them on margin all around wing, some of these more elongate and pointed; the veins and margin and near margin with long, stout bristles as in *D. speciophilus;* the venation very similar to that species, but three apical forks, not quite alike in the two wings, in one as figured, in the other with the three forks about equal in length, all about as long as the third fork in wing figured; the stem of cubital fork is more than twice as long as in the Peruvian species. In the hind wing the venation is very similar to the other species.

Length—1.2 mm.

From Brownsville, Texas.

HEMEROBIIDÆ

Boriomyia ultima sp. nov.

Face uniform polished dark brown; vertex pale, with a median brown dot; antennæ and palpi pale yellowish; pronotum pale, a broad, median brown stripe; rest of notum pale, side of the metanotum marked with brown; pleura mostly brown; legs pale yellow; abdomen dull yellowish. Wings hyaline; fore wings with several large brown spots, many irregular smaller marks, more or less forming oblique transverse bands, a row over each gradate series, the larger spots near middle, another row before the first gradate series, with the large spots behind, and a large spot over the cross-vein between medius and cubitus; veins pale, with scattered brown dots; margin interruptedly pale and brown. Hind wings pale; veins pale, a few gradate veins dark. Fore wings not very broad, four radial sectors, the fourth forked once before the cross-vein, no cross-vein between the first and second sectors near base.

Expanse 15 mm.

From Angora Peak, Tahoe, Calif. (Van Duzee.)

Synopsis of Species of Boriomyia of United States

1. No cross-vein between the last (third) radial sector and radius; one between first and second sectors near base; hind wings with tip and costal mark brown—subgenus—new .... *Allotomyia,* 2

   A cross-vein between last radial sector (either third or fourth) and the radius; hind wings without large brown marks 3

2. Gradate series marked with dark brown .... *speciosa*
   Gradate series not dark, but broad brown area before first gradates and beyond the second gradates.... *fidelis*

3. Face pale, with a few dark spots or dots 4

   Face uniform shining brown 6

4. A large brown spot at base of antennæ truncate below; three radial sectors, the third usually forked but once before the cross-vein 5

   No such spot, face with small dots; four radial sectors, or if three, the third forked twice before cross-vein .... *longipennis*

5\. Fore wings with numerous brown bands across; pronotum with dark brown stripe each side ... *coloradensis*
Fore wing without such bands; pronotum not plainly marked .... *pretiosa*

6\. A cross-vein between first and second radial sectors near base; wings heavily marked, usually four radial sectors or the third forked twice before the cross-vein 7

No cross-vein between first and second radial sectors near base; usually three radial sectors and the third usually forked but once before cross-vein 8

7\. Margin of fore wings heavily marked; pronotum with dark brown stripe each side .... *longifrons*

Margin of fore wings scarcely marked; pronotum not plainly marked .... *transversa*

8\. Wing surface evenly fumose; veins not spotted; three radial sectors .... *brunnea*

Wings not evenly fumose; veins dotted or spotted with dark 9

9\. Pronotum pale, unmarked; wings with only a few gradates dark .... *schwarzi*

Pronotum with lateral or median brown stripe; wings plainly spotted or banded with dark 10

10\. Pronotum with broad brown median stripe. Wings with large spots tending to form bands; no lateral stripes; four radial sectors .... *ultima*

Pronotum with brown side stripes; and often median line; usually three radial sectors 11

11\. Fore wings marked all over with dark spots in form of oblique, wavy bands, wings not especially long .... *disjuncta*

Fore wings with large dark spots mostly near outer and hind-margin, middle area scarcely marked; wings more elongate than usual .... *posticata*

LIMNEPHILIDÆ

Limnephilus hageni sp. nov.

Figs. 7, 8, 9.

Yellowish; thoracic notum brown, abdomen dull yellowish, to pale brown; legs pale, spines black, but several on front tibiæ yellow, hairs yellowish; wings yellowish, fore wing with posterior portion mostly yellowish brown, broken near middle by broad, oblique, pale area, a large brown spot near tip, and stigma mostly dark, the outer part of fourth and fifth apical cells and the first and second subapicals hyaline, base of apical cells and area before anastomosis also white hyaline, the brown contains but few pale spots.

Male genitalia related to *L. sansoni*, but the superior appendages smaller, the teeth on inner side differently arranged, the intermediate appendages black only at tip, somewhat curved, the lower appendages stouter and shorter. The female has two slender appendages very similar to those of *L. sansoni*. The species is quite a little smaller than *L. sansoni*.

Expanse 24 mm.

From Ft. Resolution, Great Slave Lake (Kennicott, 1862), Hagen had this by label of *sublunatus*, but the species Provancher sent Hagen as *sublunatus* is very different, the same as I described as *L. macgillivrayi*.

Limnephilus roberti sp. nov.

Figs. 10, 11, 12.

Yellowish, head with yellow hair, basal joint of antennæ with some black hair in front; thorax mostly with yellowish hair, but some dark ones on pronotum; abdomen more brown; legs pale yellowish, spines black, in the male the front tarsi are very long. Maxillary palpi of male with second and third joints subequal, in female the fifth is longest, plainly longer than third, the fourth somewhat shorter than second.

Wings yellowish, with fine yellowish hair, venation partly pale, many veins especially near lower apex, margined with yellowish brown spots and patches, anal margin brown, with a few pale spots, a white mark on thyridium, just before the posterior anastomosis. Fore wings rather narrow, elongate, discal cell a little longer than pedicel.

Male genitalia have very short processes, the superior lobes are very pale, and not toothed, nor darkened within. In the female the superior plate has lateral spurs and a broad median lobe which is blackened beneath on the sides.

Expanse 20 to 22 mm.

From Winnipeg Lake (Robt. Kennicott).

Limnephilus sackeni sp. nov.

Fig. 6.

Yellowish, abdomen more dull brown, spines on legs black, but a few inner ones near base of front tibiæ are yellowish; hair yellowish, some black on sides of face and under antennæ. Wings yellowish, fore wing with brown marks on plan of others of this section, the anal margin brown, streak through middle of wing, broken by the oblique hyaline spot beyond middle, region before and beyond anastomosis hyaline, surrounded with brown, which extends above to tip and below to the outer angle, stigma dark. Legs very slender, basal joint of tarsus of front legs about one-half of the tibia, but it is not equal to second plus third joint.

Male genitalia has the superior appendages rather long, reaching beyond lower appendages which are slender, the intermediate appendages are curved and much more slender than usual.

Expanse 31 mm.

From Sault de Ste. Marie River, 8 Sept. (O. Sacken.)

Acronopsyche gen. nov.

Legs slender; no spines on under side of last joint of hind tarsi; spurs 1, 3, 3,; tibia of front pair with a few spines. Basal joint of antennæ moderately elongate, beyond barely crenulate; a group of two or three macrochætæ behind each ocellus. Pronotum very small. Wings very hairy, not granulate, discal cell of fore wings extremely long, fully four times as long as pedicel; radius bent at stigma, all apical cells fairly broad at base, first fork scarcely reaches back on discal cell; cubitus disjointed at posterior anastomosis, anal cell divided as usual. In hind wing the discal cell is also elongate, and the apical cells fairly broad near base. In the male the inner spur of the hind tibia is elongate, very attenuate, about twice as long as the outer spur.

Type *A. pilosa.*

In general appearance and structure related to *Ecclisomyia*, but the spur formula and short first fork separate it. It can be included in my table (Can. Ent. 1916, p. 121) by the following modifications.

29. At least one ocellar macrochæta present 30
    No ocellar macrochætæ 31
30. Anal cell not divided; radius bent at the stigma, spurs 1, 3, 3 .... *Hylepsyche*
    Anal cell divided as usual 30a
30a. Spurs 1, 2, 4, first fork long distance back on discal cell .... *Ecclisomyia*
    Spurs 1, 3, 3, first fork scarcely back on discal cell .... *Acronopsyche*
31. Spurs 1, 3, 3, equal to No. 31 of table.
    Spurs 1, 2, 2, membrane granulate—equal to No. 36 of table.
    Spurs 1, 3, 4, equal to No. 33 of table.

Acronopsyche pilosa sp. nov.

Fig. 13.

Brown; face and rest of head with pale hair, black hair on sides of face and between antennæ, vertex with yellow hair. Basal joint of antennæ brown, with pale hair, beyond yellowish; in male the second and third joints of maxillary palpi subequal, in female the third joint is plainly longer than either the fourth or fifth; thorax with yellowish hair, abdomen pale on under side; legs pale, spines black, no spines on basal half of hind tibia, inner spur of male attenuate and elongate, about twice the outer spur. Wings very hairy, with long fringes, fore wings rather elongate, more or less irrorate with pale yellowish, and with spots on margin between tips of some of the veins, the hair between veins being largely pale, anastomosis especially behind broadly dark, stigma not especially marked, no hyaline dot on thyridium. Genital parts short.

Expanse 22 mm.

Modoc Co., California, 20 July. (Lindsey.)

SERICOSTOMATIDÆ

Neothremma gen. nov.

A Sericostomatid; the maxillary palpi of the male recurved, short, last joint with a long dense fringe on lower inner side; basal joint of antennæ elongate; ocelli present, but rather small, spurs 1, 3, 4. Venation fairly regular in both sexes, in general similar to that of Silo; the discal cell long, forks 1 and 2 back on discal cell, forks 3 and 5 also present; in the hind wing forks 1, 2 and 5 present, and the discal cell closed. Eyes not hairy.

Type *N. alicia* n. sp.

Includes apparently also *Thremma deceptiva* Bks.

Distinct from Thremma by shape of maxillary palpi of the male, and the presence of fork 1 in hind wings. From Silo to which it is possibly more related, it is separated by the ocelli, and but three spurs on middle tibiæ.

Neothremma alicia sp. nov.

Figs. 4, 5.

Pale brownish; clothed with mostly pale yellowish hair; fringe on last joint of male maxillary palpus black; yellowish hair on basal joint of antennæ, and in the male a tuft of long curved hairs near the inner tip. Legs pale, spurs pale; male genitalia yellowish; a long slender median piece bent downward beyond middle, really of two appressed pieces as tip is seen from behind to be of two parts, a pair of slender nearly straight intermediate appendages, and a large ventral piece, hairy, its tip reaching the other parts. Wings with fine yellowish hair, stigma a little darker; first fork reaching back nearly to middle of discal cell, fork 2 only a little back on discal cell, fork 3 as far back as fork 2, tenth apical cell very short.

Expanse 13 mm.

From Tolland, Colorado (G. S. Dodds).

Similar to *N. deceptiva* which was based on a female; it differs in having the first fork reaching further back on a shorter discal cell, and in that the tenth apical cell is much shorter.

HYDROPSYCHIDÆ

Dolophiliella gen. nov.

Closely related to *Dolophilus*, having ocelli, palpi, vertex, spur formula, hairy hind tibia, and general shape of male appendages as in that genus. The venation is the same, except that fork 1 is lacking in both front and hind wings. In 1909 Ulmer described a new genus, *Dolophiloides*, for a form from Central Asia in which fork 1 was absent from the hind wings. This species has gone a step further in dropping that fork in the fore wings. It might be better to consider both this and *Dolophiloides* as subgenera of *Dolophilus*.

Type *D. gabriella*.

Dolophiliella gabriella sp. nov.

Fig. 14.

Yellowish; joints of antennæ marked with brown; palpi dark brown; vertex and pronotum with pale yellowish hair; legs yellowish, hind tibia of male with much long hair behind. Wings with rather brighter yellow hair, without markings, fringe mostly gray; hind wings with mostly gray hair; a hyaline white spot behind end of discal cell in the fore wing. The discal cell is fully as long as its pedicel, fork 2 reaches to cell, forks 3 and 4 pedicellate, fork 3 with a pedicel twice as long as that to fork 4. In hind wings discal cell less than one-half the length of the third apical cell, fork 3 long pedicellate. The male genitalia has a broad, median nearly truncate projection from below; the lower appendages have the second joint nearly three times as long as the first, and enlarged at tip.

Expanse 12 mm.

From the San Gabriel Mts., Calif., June. (Grinnell.)

Nyctiophylax marginalis sp. nov.

Fig. 15.

Brown, head with pale yellowish hair, palpi brown, antennæ pale yellowish, pronotum with pale hair in the middle and brown on the margins, legs very pale, front tibiæ on outer side dark. Fore wings brown, clothed with brown and yellowish or golden hair, paler than in *N. vestitus*, around the outer margin are about eight to ten pale spots, between them the margin is darker; sometimes some of the spots are faint; hind wings brownish, with fine yellow hair, the fringe gray. In shape the wings are hardly as broad at stigma as in *N. vestitus*, the venation about the same as in that species.

Expanse 13 mm.

From Put-in-Bay, Ohio. (G. Townsend.)

Plectrocnemia pallescens sp. nov.

Fig. 3.

Pale yellowish throughout and clothed with pale yellowish hair; hair of fore wings very short, appressed, and almost golden; veins pale, sometimes tips of apical veins darker, with a dark spot on margin, pale dot between each pair, a hyaline white streak on the median vein at fork and on cross-vein just beyond and on the cross-vein from median before the second apical fork; fringe wholly pale. Venation normal, discal cell long, four or five times as long as broad, fork 1 more than one-half of its pedicel (♂) or one-third of pedicel (♀); fork 3 plainly pedicellate, fork 4 before cross-vein; in the hind wings fork 1 is very short, fork 3 present in the female, not in male.

Expanse 13 to 15 mm.

From Put-in-Bay, Ohio, August (G. Townsend); also St. Anthony Park, Minn. (Lugger.)

EXPLANATION OF PLATE 12.

Fig. 1. *Deipnopsocus texanus*, fore wing.

Fig. 2. *Deipnopsocus texanus*, hind wing, scales.

Fig. 3. *Plectrocnemia pallescens*, genitalia.

Fig. 4. *Neothremma alicia*, head and antenna.

Fig. 5. *Neothremma alicia*, genitalia.

Fig. 6. *Limnephilus sackeni*, genitalia, side.

Fig. 7. *Limnephilus hageni*, genitalia, side.

Fig. 8. *Limnephilus hageni*, female, above.

Fig. 9. *Limnephilus hageni*, male, above.

Fig. 10. *Limnephilus roberti*, male, above.

Fig. 11. *Limnephilus roberti*, female, above.

Fig. 12. *Limnephilus roberti*, genitalia, side.

Fig. 13. *Acronopsyche pilosa*, genitalia, side.

Fig. 14. *Dolophiliella gabriella*, genitalia, side.

Fig. 15. *Nyctiophylax marginalis*, genitalia, side.

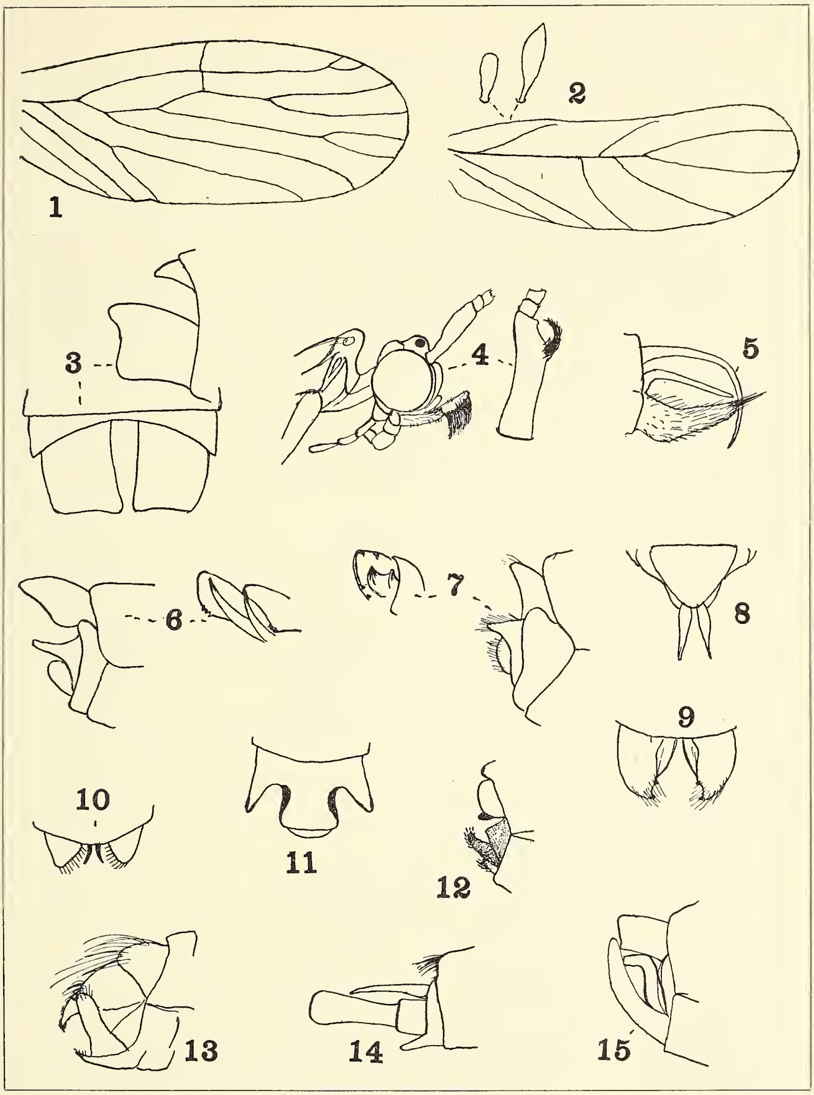

Plate 12.

Banks—Neuropteroid Insects.

A KEY TO THE BITING MOSQUITOES OF NEW ENGLAND*

By George S. Tulloch

A study of the infestation and distribution of biting mosquitoes in Massachusetts was made during the spring and summer of 1930. To facilitate the identification of the mosquitoes found, the following key[1] was constructed; it being taken from Dyar[2] and Matheson[3] and modified to include those species known to occur to New England. It is accompanied by a plate illustrating many of the taxonomic characters used in identification and by a few notes concerning mosquitoes considered to be of interest.

Table of Genera

Adults

1. Metanotum with a tuft of setæ........................*Wyeomyia*
   Metanotum without a tuft of setæ 2
2. Wings with the second marginal cell not half as long as its petiole..*Uranotænia*
   Wings with the second marginal cell more than half as long as its petiole 3
3. Scutellum rounded—not lobed ....*Anopheles*
   Scutellum not rounded—distinctly trilobed 4

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* Contribution from the Entomological Laboratory of Harvard University, No. 337.

[1] This key was based on the list given by Johnson, 1925. Fauna of New England. 15, The Diptera or two-winged flies. Boston Soc. Nat. Hist. VII.

[2] 1922—The Mosquitoes of the United States. Proc. U. S. Nat. Mus. Vol. 62, Art. 1, pp. 1-119.

[3] 1929—The Mosquitoes of North America. C. C. Thomas.

4. Cross veins tending to lie in line, or mesonotum with bare impressed discolorous lines or both.... *Theobaldia*

Cross veins normal, mesonotal integument without impressed discolorous lines 5

5. Abdomen of female blunt, with short cerci........... 6

Abdomen of female pointed, cerci exserted 7

6. Wing scales normal .... *Culex*

Wing scales distinctly large and broad.......... *Mansonia*

7. Abdomen of female with the eighth segment wholly retractile, nude; spiracular bristles present *Psorophora*

Abdomen of female with the eighth segment only partially retractile, spiracular bristles absent.. *Aedes*

Larvæ

1. Eighth segment of abdomen provided with a distinct elongate dorsal siphon or respiratory tube......... 2

Eighth segment without a distinct elongate dorsal siphon .... *Anopheles*

2. Anal segment without ventral brush .... *Wyeomyia*

Anal segment with ventral brush 3

3. Air tube without pecten .... *Mansonia*

Air tube with pecten 4

4. Air tube with several pairs of ventral tufts.......... *Culex*

Air tube with a single pair of tufts 5

5. Head elongate, elliptical .... *Uranotænia*

Head nearly circular or transverse 6

6. Air tube with tufts close to base.................... *Theobaldia*

Air tube with tufts near the middle or beyond 7

7. Anal segment ringed by the dorsal plate, with hair tufts piercing the ring .... *Psorophora*

   Anal segment not ringed by the dorsal plate or if ringed, the hair tufts posterior to the ring...... *Aedes*

TABLE TO SPECIES OF THEOBALDIA

Adults

1. Tarsi with faint whitish rings at both ends of joints *morsitans*

   Tarsal white rings, if present, basal 2

2. Scales of the wings all black or brown, no white scales *impatiens*

   Scales of the wings mixed, black or brown or white, especially along the costal margin.............. *inornata*

Larvæ

1. Pecten of the air tube produced into long hairs on the outer half 2

   Pecten not produced into long hairs on outer half *morsitans*

2. Both pairs of head hairs multiple (6) and of about equal length .... *impatiens*

   Lower head hairs of three or four long hairs; upper multiple and shorter than the lower head hair *inornata*

TABLE TO SPECIES OF ANOPHELES

Adults

1. Wings with white or yellowish white spots along costal margin .... *punctipennis*

   Wings without such marking 2

2. A bronzy or coppery spot at apex of wing.. *maculipennis*

Apex of wing uniformly dark colored 3

3. Segments of palpi white scaled at apices............*walkeri*

Segments of palpi uniformly dark scaled *quadrimaculatus*

Larvæ

1. Abdomen with six pairs of dorsal palmate tufts.. 2

Abdomen with five pairs of dorsal palmate tufts.. 3

2. Mandibles with eleven terminal teeth; six branched hairs on mandibles arranged in an outward projecting row ....*quadrimaculatus*

Mandibles with nine terminal teeth; ten branched hairs on mandibles, arranged in a forward projecting row ....*walkeri*

3. Lateral plate of the eighth abdominal segment with 22-29 (8 to 9 long) teeth ....*maculipennis*

Lateral plate of the eighth abdominal segment with 17-22 (usually 6-7 long) teeth ....*punctipennis*

TABLE TO SPECIES OF CULEX

1. Abdominal segments transversely white banded apically ....*apicalis*

Abdominal segments with white bands basally or none 2

2. Abdominal segments without basal white bands *salinarius*

Abdominal segments with basal white bands........ 3

3. Basal white band of the second abdominal segment usually not triangularly produced medianly *territans*

Basal white band of the second abdominal segment triangularly produced medianly ....*pipiens*

Larvæ

1\. Antenna with the tuft at or before the middle *territans*

Antenna with the tuft well beyond the middle........ 2

2\. Both upper and lower head hairs multiple 3

Both upper and lower head hairs not multiple....*apicalis*

3\. Air tube long and slender—7 x 1, slightly expanded before the apex ....*salinarius*

Air tube not over 5 x 1, uniformly tapering toward the apex ....*pipiens*

TABLE TO SPECIES OF AEDES

Adults

1\. Tarsi not white marked 2

Tarsal joints or some of them white marked........ 12

2\. Mesonotum with silvery or golden markings 3

Mesonotum gray, brown, or golden yellow with a single median dark longitudinal band, two narrow lines, or unmarked 6

3\. Mesonotum with two yellowish or yellowish silvery stripes on a dark ground ....*trivittatus*

Mesonotum marked with silver, rarely absent........ 4

4\. Silver in a broad or narrow line reaching scutellum or mesonotum entirely silvered (in the male).... 5

Silver on the sides of the mesonotum, the center dark *triseriatus*

5\. Both sexes with a narrow silver stripe..........*atlanticus*

Female with stripe, male mesonotum entirely silvery *dupreei*

6\. Mesonotum with central broad undivided dark band 7

Mesonotum with divided central band or none 9

7. Mesonotum with median band very broad, lateral lighter color narrow 8

Mesonotum creamy yellow at the sides........*hirsuteron*

Mesonotum golden or reddish brown at the side, median stripe sometimes divided or obsolete......*punctor*

8. Yellow lateral lines straight and narrow ....*aurifer*

These lines narrowed posteriorly, pale gray....*trichurus*

9. Mesonotum with paired brown lines........ 10

Mesonotum uniformly colored, without lines 11

10. Mesonotum yellow or gray, very variable, sometimes suffused with brown centrally, or the lines obsolete; medium-sized to rather large species, legs black, venter yellowish white ....*communis*

Legs black with bronzy reflection, venter white *implacabalis*

Mesonotum yellow, lines slender, often conjoined into a median stripe, deep black ....*diantæus*

Mesonotum gray with central brown shade, lines fine, dark, a small species ....*impiger*

11. Mesonotum uniformly dark brown, somewhat bronzy, lower mesepimeral bristles present, a medium sized species ....*intrudens*

Mesonotum uniformly brown; abdomen with continuous lateral white line, male with short palpi; mesepimeral bristles absent ....*cinerus*

12. Tarsi with white rings involving both ends of the joints 13

Tarsal white rings basal only........ 15

13. Wing-scales markedly bicolored ....*dorsalis*

Wing-scales uniformly dark, or nearly so 14

14. Mesonotum uniformly brown, or nearly so....*canadensis*

Mesonotum pale, with broad dark median stripe *atropalpus*

15\. Proboscis of the female white ringed 16
Proboscis of the female without white ring........... 17

16\. Abdomen with a longitudinal page dorsal stripe *sollicitans*
Abdomen without a dorsal stripe...........*tæniorhynchus*

17\. Tarsal pale rings broad, especially on hind legs.... 18
Tarsal pale rings narrow; mesonotum entirely brown 20

18\. Wing scales broad, inflated ....*grossbecki*
Wing scales narrow, normal 19

19\. Large, without the red tint, mesonotum usually not whitish on the sides, wing scales dark; without mesepimeral bristles ....*excruciens*
With 3-5 lower mesepimeral bristles.............*stimulans*
Mesonotum often whitish on the sides, wings often with scattered white scales. 2 lower mesepimeral bristles ....*fitchii*

20\. Terminal abdominal segments with normal pale brands ....*vexans*
Terminal abdominal segments largely pale-scaled *cantator*

Larvæ

1\. Air tube with tuft within pecten 2
Air tube with tuft beyond pecten 3

2\. Air tube with several dorsal hair tufts........*trichurus*
Air tube without several dorsal hair tufts....*atropalpus*

3\. Pecten with detached teeth outwardly 4
Pecten without detached teeth outwardly 9

4\. Air tube at least 3½ times long as wide 5
Air tube less than 3 times long as wide 6

5\. Both pairs of dorsal head hairs multiple...........*cinerus*
Both pairs of dorsal head hairs double ....*excrucians*

6.	Antennæ enlarged basally	*aurifer*
	Antennæ not enlarged basally	7
7.	Antenna as long as head	*diantæus*
	Antenna not as long as head	8
8.	Lateral abdominal hairs single beyond second	*intrudens*
	Lateral abdominal hairs multiple on 1st and 2nd, double 3-5	*vexans*
9.	Comb scales in a single row	10
	Comb scales in a triangle	11
10.	Anal segment ringed by plate	*implacabalis*
	Anal segment not ringed by plate	*triseriatus*
11.	Anal segment ringed by plate	12
	Anal segment not ringed by plate	15
12.	Upper and lower head hairs double	*punctor*
	Upper and lower head hairs single	13
13.	Anal gills at least as long as anal segment	*trivattatus*
	Anal gills shorter than anal segment	14
14.	Lateral abdominal hairs double on 3-6	*sollicitans*
	Lateral abdominal hairs triple 3-5, single on 6	*tæniorhynchus*
15.	Air tube at least 4 times as long as wide	*fitchii*
	Air tube 3 times or less as long as wide	16
16.	Head hair single	17
	Head hairs double or multiple	19
17.	Anal gills at least as long as anal segment	18
	Anal gills much shorter than anal segment	*dorsalis*

18. Scale of comb with broad apex, 4-7 stout spines *communis*

Scale of comb with single stout spine .... *impiger*

19. Both pairs of dorsal head hairs multiple 20

Both pairs of dorsal head hairs not multiple 21

20. Anal gills budlike .... *cantator*

Anal gills well developed .... *canadensis*

21. Lower head hairs double—upper 3 .... *hirsuteron*

Upper double—lower single .... *stimulans*

The following genera are each represented by a single species: *Mansonia perturbans, Uranotaenia sapphirina, Psorophora ciliata, Wyeomyia smithii.*

A large part of the study was restricted to the habits and biology of *A. sollicitans.* The eggs of this species are distributed over the salt marshes and during the summer months hatch when flooded by the waters of the tides and rains. The larvæ appear soon after the marshes are flooded and under favorable conditions develop in 7 to 12 days. Usually only the larvæ in the pools left by the peak tides (those most distant from the ocean, within 100 to 200 yards of the mainland)[4] successfully complete their development since these pools are free from larva-eating fish and are not flushed by the succeeding lower tides. In a particularly dry season the water in many of the smaller pools along the edge of the marsh evaporates before the larvæ complete their development, thereby effecting a natural means of control. Pools formed by heavy rainfall are usually small and dry out rapidly and the larvæ are destroyed.

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[4] This observation based on conditions existing along the North Shore, Massachusetts, in 1930.

Several chlorine determinations[5] of water from pools containing larvæ of *A. sollicitans* were made. The results of these determinations indicate that the larvæ can live and develop in water having a chlorine content ranging from 400 to 2900 parts per 100,000 parts of water. Since the chlorine content of open sea water contained only 2000 parts, it is evident that larvæ can developed in water having a chlorine content greater than sea water as well as in water having a chlorine content considerably less than sea water.

Several evening collections of fresh water species were made in the Charles River Valley. The collections made in late May and early June yielded *A. cinerus, A. excruciens* and *A. implacabalis* in about equal numbers. During July and August the collections contained a majority of *M. perturbans.* Of 120 specimens taken in one collection at Needham, Mass., in August, 118 were of this species, 1 of *A. punctipennis* and 1 of *C. pipiens. M. perturbans* is a difficult mosquito to control as the larvæ are not free swimming but attached to roots and stems of various aquatic plants. The adults are fierce biters but fortunately are weak flyers.

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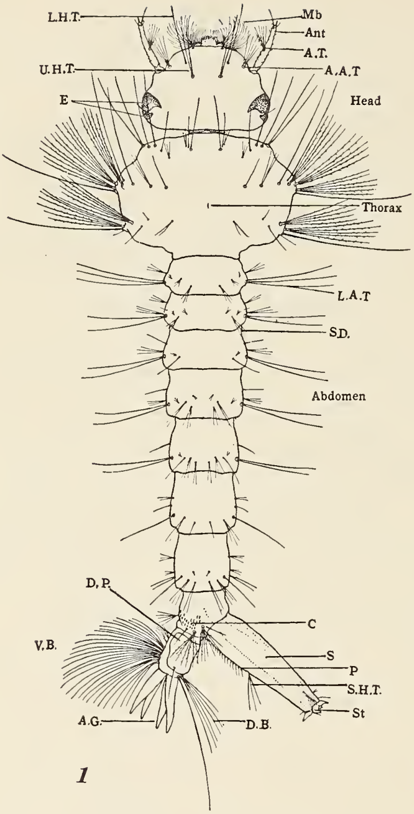
[5] These determinations were made through the courtesy of the Massachusetts State Department of Health.



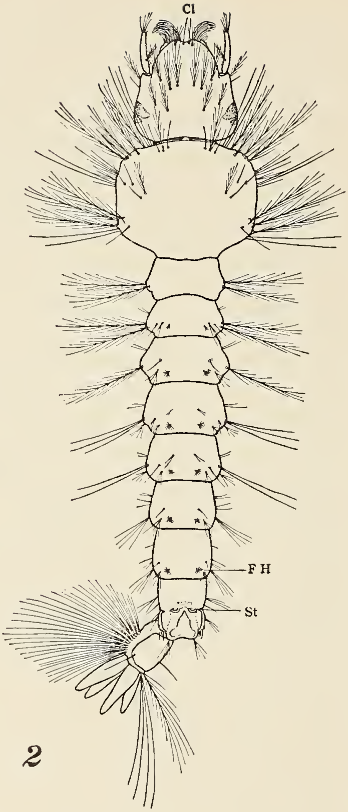


Fig. 1. Larva of *Aedes stimulans.*

Ant., antenna; A. T., antennal tuft; A. A. T., ante-antennal tuft; A. G., anal gills; C., comb; D. B., dorsal brush; D. P., dorsal plate; E., eye; L. A. T., lateral adbominal tufts; L. H. T., lower head tuft; Mb., mandible; P., pecten; S., siphon; S. D., subdorsal tuft; S. H. T., siphonal hair tuft; St., stigma; U. H. T., upper head tuft; V. B., ventral brush (after Matheson).

Fig. 2. Larva of *Anopheles punctipennis.*

Cl., clypeal hairs; F. H., float hairs; St., stigma (after Matheson).

THE INTERPRETATION OF THE WING VENATION AND TRACHEATION OF THE ODONATA AND AGNATHA.[1]

By A. V. Martynov,

Custodian, Zoological Museum of the Russian Academy of Science, Leningrad

Translated, with an introductory note, by F. M. Carpenter.*

Introduction

In 1922 Dr. A. V. Martynov read a paper before the Entomological Society of Russia on the interpretation of the veins and tracheæ in the wings of the Odonata and Agnatha (Plectoptera). His manuscript was turned over for publication in 1923 and after some delay was finally published in Russian the following year (Rev. Russe Ent., 18(4):145-174). In connection with my investigations on fossil insects, I found it necessary to consult his paper, and from the very short French summary at the end of the article, I felt sure that the text contained important data and discussions which should not be overlooked. I therefore employed Miss Olga Jahr, of the Slavic Department of the Harvard Library, to assist me with the translation of the Russian. Naturally enough, Miss Jahr was unfamiliar with the biological terms, but by working together we obtained a complete English translation without much difficulty. As the translation progressed it became more and more evident that the text was fully as important

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[1] This paper is an enlargement of the report which was read at the Russian Entomological Society, November, 1922; the manuscript was handed to the press in May, 1923.

* National Research Fellow, Harvard University.

as I anticipated, and when the task was finished, I decided to publish the entire translation of this paper in order that it might be available to other investigators of insect phylogeny. Although there are several points on which I cannot agree with Dr. Martynov, I nevertheless consider this paper one of the outstanding contributions to insect phylogeny published during the past decade.

Dr. Martynov kindly assisted me in locating several misprints which occurred in the original text, and which had naturally caused me much confusion. The twelve figures accompanying the original article are essential for a complete understanding of the problems under discussion. Unfortunately, these figures were very poorly printed, and could not be copied for reproduction here without considerable retouching. Since there is always a possibility of distorting a figure during this process I decided that it would be better not to reprint the figures at all, but to refer the reader to the original ones. While this procedure, involving the use of two publications, may be somewhat inconvenient, I believe it introduces the lesser of two "evils." —F. M. CARPENTER.

Comstock and Needham published (4) their first data on the interpretation of venation of the Odonata and Agnatha in a series of articles on the wings of insects, which appeared in 1898 and 1899; and in 1903 Needham developed (10) these ideas with more details into a large work on the venation of Odonata. The interpretation of Odonate venation which was proposed in both works mentioned above was later accepted by the majority of Odonatologists and by Handlirsch (6). According to this interpretation the nervuration of the Odonata proved to be so peculiar that it could hardly be compared even with that of the Agnatha—the very closest group.

The most characteristic features of this venational system are the following: 1, the crossing of the radial sector by the bases of M_1 and M_2, and its extension into the region between M_2 and M_3. 2, the large size of the media, with 4 branches; M_4 always leading from the base of M.

3, the curve of the cubitus (chiefly in the Anisoptera) and beyond this curve, the formation of the two branches, Cu_1 and Cu_2; formation of a triangle (or quadrilateral. 4, small size of the anal vein and its fusion with the cubitus.

It is necessary to add that according to the authors' understanding the continuation of RS to M_{1+2} is clearly a secondary vein ("bridge") and appears to be the basal part of the analogous vein indicated by Tillyard (14).

The venation of the Agnatha, as usually interpreted (Eaton, Comstock 1899, Handlirsch, Ulmer and others), is entirely different from that of the Odonata, and much more similar to that found in the more primitive Palæodictyoptera (Dictyoneuridæ). The media is simple and forks only in the distal part; RS is large and forms 4-5 branches; Cu is divided at the base, and the down curve is formed only by the lower branch; the anal veins are well developed. These differences in the interpretation of the wings of the Odonata and Agnatha are so great that the dragon-flies would on this basis be moved far off from the may-flies; but this contradicts the sum of all data in morphology and the development of these insects. If venation means anything in the explanation of phylogenetic relations of the different groups—as is unquestionably so, and the venation of the dragon-flies has been studied particularly carefully from this point of view—then either the evidence of morphology and history of development, which indicate a close relationship of the Odonata and Agnatha, are wrong; or the interpretation of the wing venation of Odonata or perhaps the Agnatha is incorrect. As the close relation between the Odonata and Agnatha is not disputed, the author began to doubt the accuracy of the usual interpretation of venation of the may-flies and partly of the dragon-flies.

It is well-known that Comstock and Needham based their interpretation of the wing venation in different groups on the study of the tracheation of the wings of nymphs and pupæ. This tracheation, it is supposed, reflects the more primitive condition of venation. The trachea RS of the Odonata (Anisoptera) turns off from R and, after crossing the bases of tracheæ M_1 and M_2, enters the region between

M_2 and M_3; treacheæ which go into these latter veins and into M_4 of the authors, join at the base into one common trunk, which enters the wing independently. Hence the conclusion that this trunk is M, that RS crosses M_1 and M_2, that the bridge is a secondary formation, that the cubitus is two-branched, etc. Among the may-flies Comstock discovered at first a type of tracheation very different from that of the dragon-flies, and nearer to the normal. From this tracheation Comstock was led to an interpretation essentially similar (if not in names) to the one of Eaton (5) and other authors. Ann Morgan (8) undertook a careful investigation of the tracheation of different species of may-fly nymphs and discovered that the tracheal stem which sends small tracheæ into the branches of Comstock's RS usually arises independently from the common tracheal wing stem. Consequently, she concluded that the system of veins which include these tracheæ do not represent RS, but M, as in the Odonata. Usually in the may-flies the trachea RS does not arise from the trachea R, as it does in dragon-flies; but in one species of *Heptagenia,* and even then only in part of this specimen, Morgan succeeded in finding a weak trachea which led off from R, crossed M and entered into the region between M_1 and M_2. Following the ontogenetic method of Comstock, Morgan concluded that the may-flies also originally had the radial sector cross the media.

Comstock, in his later work on the wings of insects (3), which represents an enlarged and somewhat changed edition of the joint work of Comstock and Needham (4), agreed with the results of Morgan and accepted, therefore, her interpretation of the wing venation of may-flies. By this interpretation the venation of the may-flies was brought (to a certain degree) up to the scheme[2] of the venation of the dragon-flies; but by the same interpretation the Ephemerid venation appeared to be extremely remote from that of the Palæodictyoptera and even the Carboniferous *Triplosobidæ* Handl. Although the latter are placed in

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[2] Only to a certain degree, because Rs of the may-flies in Morgan's paper is not this vein in the dragon-flies. In the latter Rs (of author's) corresponds to our Rs_4, and R_5 (Morgan and Comstock) of the may-flies corresponds to our Rs_3.

a special group by Handlirsch, Protephemeroidea, which combines the characteristic venational features of the more primitive *Dictyoneuridæ* and the specialized features of may-flies, nevertheless they still are Ephemerids, which preserved only the anterior branch of M of the *Dictyoneuridæ* (MA). As to the dragon-flies, Needham's interpretation aroused doubts only in its application to the Zygoptera. The trachea which supplies RS in the latter arises from M_2, not from R, and in general no tracheæ which lead from R enter into the region of M. But Comstock and Needham think that here also, the vein RS enters into the region between M_2 and M_3, and that trachea RS used to arise from R and cross the media, but later "detached" itself from R and "attached" itself to M_2. Since it is difficult to support the last supposition by definite proofs—there are none—Tillyard (15) and Rice (12) naturally expressed[3] doubts about the Zygoptera having RS. Munz, however, pointed out (9) that the conformity of the vain veins of Zygoptera and Anisoptera is so evident that it is impossible to interpret the venation of Zygoptera different from that of the Anisoptera, and accepted the old scheme of Needham.

As I approached the study of the venation of dragon-flies and may-flies I thought that if the dragon-flies and Ephemerids were Palæoptera,[4] *i. e.*, insects which never fold their wings on the back (roof-like) at rest, then not only the may-flies but also the dragon-flies should preserve the features of venation of the related Palæodictyoptera. If the venation of dragon-flies, according to the interpretation of Comstock and Needham, proves to be so unusual that it puts them in an entirely isolated group among the insects, the cause of such a situation evidently lies in the wrong interpretation of the venation by these authors and the uncertainties of the ontogenetic method. It is necessary to note that at one time Redtenbach (11) offered an entirely different interpretation of the venation of dragon-flies; attaching great importance to the alternation of con-

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[3] Citing after Munz (9).

[4] Concerning the division of the Pterygota into Paleoptera and Neoptera, see my paper (7).

cavities and convexities of the wing, the author compared their dispositions in dragon-flies and may-flies, and came to the conclusion that they are very similar in venation as well as in the alternation of concavities and convexities. Unfortunately this author, following the erroneous conception of Adolf (1) concerning the different origins of "convex" and "concave" veins in the first stage of the "fan" type of wing and the disappearance in other insects of a series of "concave" veins, came to an incorrect homologization of the veins of the two groups mentioned with those of other insects. Thus the cubitus of Ephemerids (and dragon-flies) he indicates by the number viii, which in other insects corresponds to A_1; the median by number vii, which corresponds to the cubitus, etc. Denouncing the earlier views of Adolf, Comstock and Needham also did not attach any importance to the similarity in the wing venation between the may-flies and dragon-flies, which was observed by Redtenbach.

It always seemed to me very risky to depend upon Comstock's and Needham's ontogenetic method for the explanation of the homology and evolution of venation. When we study the tracheation of nymphs and pupæ we study at the same time the ontogeny of tracheation, but not venation at all, because veins are vessel-like forms in which the blood circulates and into which nerves and usually tracheæ often enter; but there can exist veins without tracheæ. On the other hand, the thinner tracheæ which we observe in the nymphs and young imagines of dragon-flies and nymphs of may-flies go through the wing and outside of veins in great numbers and often do not connect the neighboring veins, but the ones lying far apart. As to the formation of veins, although it was previously supposed that they were formed originally by the tracheæ, more recent investigations have shown, especially in rather primitive groups [see, for example, the work of Marshall (17) on the development of the wings of the Trichoptera], that in the wing *anlage* the venation is formed before the tracheæ pierce through. Comstock and Needham supposed that the tracheation in the wing of a pupa and nymph reflects the primitive state of venation. Therefore one would suppose that in the forms with a venation which resembles especially closely the scheme of the original venation, we should expect a particularly complete parallelism of the tracheation with the venation. But this is not so. In Hydropsyche, which is a small caddis-fly with extremely primitive venation, Comstock and Needham found a complete unconformity of the tracheation with the venation, which they interpret without regard for the direction of the trachea. These authors are obliged to do the same with the Hymenoptera and Diptera. Why should we rely so blindly upon the tracheation in case of dragon-flies and Ephemerids and ignore the data of paleontology, which proves the close relation of venation in contemporary representatives of dragon-flies and may-flies with that of the Palæodictyoptera (in the case of the Ephemerids, through the Carboniferous Triplosoba Handl.) ? Such a "conception" is all the more unacceptable because the theory of Comstock and Needham encounters serious contradictions within the groups themselves. The crossing of the media which arises from R by means of the trachea RS takes place only in the Anisoptera; this does not appear in the Zygoptera, and the trachea of the corresponding vein arises from the branch M. We have no proofs that the latter condition developed from the former. As to the Anisozygoptera, in view of their very close relationship to the Agrionidæ (through the Lestinæ), one can suppose that in them the trachea RS of the authors arises from the media of the authors. A very diverse and changeable tracheation of nymphs of may-flies gives us still less right to conclude that they have such a crossing, that their complicated vein below R is M, etc.

My investigation of the relation of the venation to the tracheation has led me to the conclusion that the formation of venation occurred under the influence of causes of mechanical character; the tracheation, adapting itself to the newly formed distribution of veins, often changed in a most original way; therefore, one can judge the venation by such an "indirect" representation of it only with utmost care.

In view of these facts I decided that in investigating the venation of dragon-flies and may-flies, as well as of other groups, to turn first to the comparative study of the venation itself, at the same time constantly keeping in mind as much as possible the function of the venation, and changes which should appear in the phylogeny of the wing by the work of the separate parts of the wing and the work of its veins. Only after such investigation is it possible to approach the study of the history of tracheation, which depends upon the venation and reflects its history. This I will discuss at the end of this paper.

Let us first turn to the Palæodictyoptera. The "family" Dictyoneuridæ has the most primitive venation (figs. 1 and 2); the wings here are homonomous, hardly broadened at the base; sometimes their ends are somewhat pulled out and as if curved backwards (Stenodictya, Microdictya, Stilbocrocis, Polioptenus, et al). RS in the more primitive forms (Stenodictya, Microdictya) arises from R approximately at the middle of the wing, or a little nearer to the base; but in the majority of other forms we encounter the process of its receding towards the base. Usually RS sends 3 or 4 branches posteriorly, not counting its continuation; in some cases the second branch (counting from the base) does not reach the trunk RS, but adjoins to the first and sometimes (*Microdictya vaillanti,* Stilbocrocis, Eumecoptera) forks dichotomously. The media is divided into two branches, which we shall call M. anterior (MA) and M. posterior (MP)[5]; MA in this family, as well as in the majority of other Palæodictyoptera remains simple; MP branches in the Dictyoneuridæ, often forming three branches (Stilbocrocis, Eumecoptera, Dictyoneurula, Acanthodictyon, partly Polioptenus), in which it greatly reminds us of M in the Ephemerids. Normally the cubitus also divides not far from the base into two branches of which the first (anterior), CuA, usually remains simple as in Polioptenus and Eumecoptera (figs. 1 and 2); the posterior branch, CuP*, usually gives rise to smaller branches.

In the very primitive forms the anal veins form a comparatively homogeneous series of 3-4 veins, which gradu-

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[5] The development and configuration of the media have just the same characteristics as R. MA corresponds to the radius proper (R); MP, to the radial sector. The same was originally true of the cubitus (Cu).

* Misprinted MP in original.

ally grow smaller nearer to the base; but the more specialized A_1 is better developed, and others lose their independence, uniting either with A_2 or even together with A_1.

There is no need to discuss the other families, because their wings were already specialized in different directions from those in which the dragon-flies and Ephemerids are specialized.

All recent Agnatha differ sharply from the Palæodictyoptera, in that their fore wings are greatly enlarged at the expense of the hind pair (fig. 4), which have become completely reduced in many species (in sub-group Bætoidea Ulm.). If the hind wings are present, the fore wings are wide and approximate a triangle; then, where the hind wings tend to disappear, the fore wings take the shape in the first group (Ephemeroidea and Heptagenioidea), which corresponds more to the shape of the fore and hind wings taken together.

If the hind wings of contemporary Ephemerids differ greatly from the fore wings, this was not the case in the past. In the Ephemerids of the Permian the hind wings differed very little or not at all from the fore pair, and their form resembled very much that of the wings of Dictyoneuridæ (13). Likewise, the wings of the remarkable Carboniferous Ephemerid Triplosoba Brogn. were homonomous (fig. 3). Handlirsch placed (6) this form into a special order, Protephemeroidea, because it preserved in its venation the features of the Palæodictyoptera, particularly of the Dictyoneuridæ. Just as in Eumecoptera (fig. 2) and in many other Dictyoneuridæ, RS arises nearer to the base and sends posteriorly the usual four branches, of which (and this is very important) the second branch, i. e. RS_4, originates near RS_5, and RS_3 and RS_2, together with RS^1, form the distal group. Evidently RS_2, already forming the "inserted sector," did not reach RS_1. M, as in the Dictyoneuridæ, is divided near the base into the same two branches, MA and MP; MA also, as in the Dictyoneuridæ, remains simple, while MP is divided distally into three branches, the middle one and the two supplementary ones beside it being already changed into "inserted sectors" (Schaltsectoren). The close similarity of this MP with M in the real Ephemerids leads us to believe that M of the may-flies is really MP, and their MA is reduced and has completely vanished. Cu is divided into two simple branches, in which one can also see CuA and CuP of the Palæodictyoptera. Then come the anal veins; the long A_1 with its branches, and another long one, A_2 or A_3, with its branches. The character of the cross-veins is the same as in Ephemerids. As already mentioned the fore and hind wings in the may-flies of the Permian were alike, their shapes quite resembling those of the Dictyoneurid wings; but in all that is known to us, MA was already missing. The branching of RS is also very much like that of Triplosoba and of the contemporary Ephemerids, while here also (Protecha Sell., Protereisma Sell.) RS_4 arises near RS_5, and the rest of the branches form the distal group. The branches RS_4 and RS_2 represent "inserted sectors" as in the recent Ephemerids.

According to the interpretation of Sellards and Handlirsch, Cu is divided into two branches at the very base; the anterior of these also divides into two side branchlets and a middle "inserted" one (in Protechma); and the posterior branch gives rise to two small branches directed posteriorly. The anal region is badly preserved. On account of this poorly preserved anal region it is difficult to say how to regard the two branches of the cubitus, whether they correspond to CuA and CuP of the Palæodictyoptera or whether there is another interpretation possible. Incidentally, the anterior branch with its branchlets is very much like the cubitus of Siphluridæ, Ecdyuridæ or Leptophlebiidæ.

The fore wings of the recent may-flies, because of the division of labor between the wings (all work of production of strokes and stroking the air being transferred to the fore wings), increased their dimensions and took the shape of elongate triangles, as in many Papilionidæ; as to the hind wings, where they are developed best of all—in Ephemeroidea and Heptagenioidea—they are of an oval or round shape as in many Rhopalocera, and in other may-flies—in Bætidæ, Ephemerellidæ, and Cænidæ—they are subject to greatest reduction. The fore wings, substituting in these groups for the disappearing hind ones, grow wider in the cubital and anal region and take a shape which corresponds to the form of the fore plus hind wings in other groups, or to one wing of the homonomous group (Dictyoneuridæ, Carboniferous and Permian Ephemerids). Therefore, I think that the primitiveness of Bætoidea wings is only an apparent one and that in the past their fore wings were also probably of triangular shape. The differences in dimensions and in the shape of both pairs, in their turn also, were formed for a second time, replacing the original homonomous condition. The venation inherited from the ancestors was not effected by the change in the shape of the wings, and it remained very much like that of such may-flies of the Permian as Protereisma, Protechma, and also as Triplosoba. The homologizing of veins in these last forms with those in the Dictyoneuridæ is therefore not difficult and is correctly interpreted by Handlirsch. RS in Triplosoba also turned off (from R) at the very base, but here the place of origin (how, is another question) is still nearer to the base. But more often Rs is derived (secondarily) from the basal part of M.* The branching of RS is entirely similar to that of the Palæozoic may-flies and to that of the majority of Dictyoneuridæ, i. e., RS forms two groups: a basal branch, and another one almost always without a basal connection, the "inserted sector," Rs_4; and the distal one, including RS_3, RS_2, and RS_1, the sector RS_2 having already lost its true origin ("Schaltsector"). In the hind wings, because of their reduction, the branches of RS are very seldom preserved, as in Palingenia; usually only RS_5 and RS_4, and naturally RS_1, are preserved, but RS_3 and RS_2 retreat towards the edge and are reduced. M corresponds to MP in the Triplosobidæ and Dictyneuridæ, and forms the usual three branches. The branches of M in the hind wings are reduced also, and usually are simple (fig. 10). At the base of the fore wings, M approaches R almost to contact, and weakening, disappears; in the hind wings M often fuses at the base with R. Into this narrow path RS is directed and usually diverges from M, but often ends here as an "inserted sector," i. e., it weakens and disappears, being joined basally with R and M by means of the usual cross-veins. In the hind wings,

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* Misprinted M_1 in original.

RS arises either from R or oftener from M. As well known, RS and M are tracheated in the may-flies in the majority of cases from one main trunk, which turns away from the side trachea (in the body), independently from R. This condition and perhaps also the fact that RS oftener "turns away" from M, gave Anne Morgan the motive to assert that the complicated vein which Comstock originally (4) indicated as RS, is actually M. We shall return below to the explanation of this moving off of RS from M, but now let us turn to the following veins.

Cu arises near M and soon divides into two main branches; Cu_1 and Cu_2, with an inserted middle branch which joins at the base either to Cu_1 or Cu_2 ("inserted sector"). In all Ephemeroidea (Palingeniidæ, Ephemeridæ, Polymitarcidæ, Potamantidæ), Cu_2 forms a downward curve similar to the curve of the cubitus in dragon-flies. By means of its projecting angle, this curve approaches and often completely fuses with A_1. The cross-veins disappear between the very origins of Cu_1 and Cu_2; on account of this, in my mind, they correspond morphologically as well as physiologically to the triangle of the dragon-flies (Anisoptera). In Heptagenoidea and Bætoidea this curve is absent (except in Bætisca, Oniscigaster), or it is expressed very faintly. The basal bifurcation and the general configuration of the origin of the cubitus in Ephemeroidea are certainly secondary if compared to, e. g., their condition in Dictyoneuridæ. The condition in Siphluridæ (and perhaps in the Ephemerids of the Permian) is therefore less changed.[6] The peculiar condition in Ephemeroidea originated in the receding of the furcation point towards the base (this is a very common condition among the Palæodictyoptera, and in Ephemerids it unquestionably took place in RS), and by forming the curve in Cu_2. This connection with A_1, just as that in the dragon-flies, has unquestionably mechanical advantages, although the method itself and the original causes of the curve in Cu_2 are not clear to us. It is difficult to say yet if one can see in our Cu_1 and

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[6] However, it is possible that in some Siphlonuridæ the curve of Cu_2 was lost secondarily; the condition in Oniscigaster is especially suggestive of this.

Cu_2 of the Ephemerids CuA and CuP. The similarity with the dragon-flies seems to confirm it, but their palæontological data do not assert this with certainty, and I indicate these branches so far by different symbols.

In groups with the curve of Cu_2 present A_1 also has a more or less considerable curvature. Often the descending segment of Cu fuses entirely with the original of A_1, a condition which we encounter in some Palingeniidæ (Anagenesia, Plethogenesia), or otherwise disappears (Campsurus, Polymitarcys, et al). Ordinarily A_1 forms distally a series of branches directed posteriorly. It usually also has an upward curvature. A_2 arises either in the middle of A_1 and A_3, or very close to A_1; usually it curves backwards soon after, and becomes short, and only in Bætiscidæ does it run parallel to the straight A_1. A_3 is still shorter, but often has more branches; in Bætisca its first branch is parallel to A_2. From the distal part of these (A_3) lead a few weak anal veins, but more often the latter lose their independence, and come in contact with A_3 in different ways.

In groups which have the tendency to a final reduction of the hind wings, the cubito-anal regions of the fore wings grow, take the place of the disappearing hind wings in function, and correspondingly elongate and distribute the anal branches in accordance with the mechanical needs (Cænidæ, Bætidæ, Leptophlebiidæ). The anal veins preserve the more original bow-shaped form in the hind wings, but quickly weaken towards the base.

Now let us turn to the question of concave and convex veins, and to their relation to the veins in the wings of may-flies. In 1880 Adolf noted the fact that in the wings of may-flies the concave ones, like valleys, alternate with the convex, as longitudinal ridges. In the bottom of valleys and on the peaks of ridges are the adjoining longitudinal veins. Adolf regarded this alternation as very important. According to his understanding the "convex" and the "concave" veins have entirely different origins, significance and destinations. He thought that the original wings differed in the possession of a more regular alternation of the numerous convex and concave veins and that the wings were similar to a fan. Redtenbach compared fully the distribution of these veins in the may-flies and dragon-flies, and found a complete correspondence. Later it was shown (2) that the indicated representation of Adolf was incorrect and perhaps this was the cause of Comstock's and Needham's paying little attention to the valuable comparisons of Redtenbach. The plaiting and alternative distribution of veins along the bottoms and tops has great mechanical value. The wings of the may-fly have attained a very high specialization. The membrane is extremely thin and delicate, and its veins have already adopted an extraordinary mechanical function and acquired the corresponding structure (ribs, absence of blood, dry structure) and their distribution also corresponds to the mechanical requirements. If this thin membrane were spread over the veins entirely in one plane, then at the stroke of the wings upon the air, being so delicate and unable to stretch, it would break and inevitably tear. The plaiting gives the membrane flexible, elastic qualities. At the sharp resistance of air on the stroke of the wings, the latter can stretch sufficiently because of the plaiting at all necessary points. In the formation of this plaiting the closely lying veins, as in similar cases (Arthoptera), were distributed, some on the bottom, others on top, and their course, even in their details, was affected by the plaiting; the fundamental character of the latter, in its turn, was conditioned by the original distribution of veins. In that way the continual reciprocal action of these two structures took place in the course of evolution. The concave position among the main veins includes Sc, RS, Cu and A_2, and then a series of distal branches, which alternate with the convex greater part of the distal sectors, Cuad[7], Mad, RS_4, the RS_3 concave, RS_2 convex; among the smaller distal sectors, the larger ones also alternate. In the more primitive Palingeniidæ, Ephemeridæ, Ecdyuridæ and the ones near to them, which retain rich, thick venation in their wing, the greater part of the distal sectors, Cuad[7], Mad, RS_4, the branches between RS_2 and RS_3 as well as these branches

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[7] Cu additional or M additional; in this way we shall designate the middle branches of Cu and M.

themselves weaken at their origin and appear to be tied to the neighboring veins only through common cross-veins; and already have no real basal part of their own, nor any origin. Such absence of the origin is unquestionably a secondary condition. In Palingenia and in some Ephemera, RS_4 arises normally from the trunk RS, but in others its origin disappears. The same seems to be the case with other sectors. In the specialized Bætoidea this process went still further, and in Bætidæ all the longitudinal veins except the main ones (Sc, R,* RS,* RS_5, M_1, Cu_1, A_1, A_2, A_3), lost their origins and became "independents," Woodworth (16) and the distal ones became shorter and shorter and deteriorated into a series of small veins along the edge, like the measurements on a ruler. How can one explain such a change? It can be satisfactorily explained through mechanical and practical means. The longitudinal veins lose their origins where they enter by means of their bases into the space between the branches of the forking vein, which forms a sharp angle, for example, RS or M. Such a vein is of course always "convex" if the dichtomating one is concave, and vice versa. Because the part of support rests always upon the branching vein, the mechanical meaning of the basal part of the intervening vein diminishes and becomes insignificant; consequently the basal part of such a vein weakens, becomes thinner and disappears entirely. The economy of material requires the disappearance of the unnecessary part of the vein. Everyone knows that in the more specialized and (so to speak) "mechanized" wings, as those of the Bætidæ, all superfluous veins disappear, and the remaining ones tend to keep the intervals between themselves equal. If the origins of the "inserted sectors" remained, this would be an injurious accumulation of veins in different places. The disappearance of the base also requires the alternative distribution of veins in different planes. If the vein is "concave," and the "inserted" vein, e. g., RS_4, is "convex," then near the union with RS the short and weak part of the base would have a broken-up aspect (from the convex side to the concave). The mechanical meaning of this broken-up part is insignificant, therefore it

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* Misprinted R_1, RSc in original.

would unquestionably weaken and finally disappear. Such was, according to my understanding, the way in which the "inserted sectors" of the German authors were formed.[8] Now, the origin of RS sometimes from M, more seldom from R, or its "free" origin becomes clear to us. Entering into the oblique angle between the convex R and M, the concave RS unquestionably had to become a "Schaltsector," which we quite often find in the typical species of Hexagenia, in some Siphlurus and others. The approach of the base of RS to one of the neighboring veins, e. g., to M, together with some small changes in the direction of the joining cross-vein (the cross-veins are certainly preserved) easily give the appearance that RS arose from M.

The appearance of the alternation of the convex and concave vein with its result—the change of convex veins into "inserted sectors" [9]—had been acquired by the ancestors of may-flies and dragon-flies very long ago. This appearance was well expressed not only in the may-flies of the Permian, but also in the Carboniferous Triplosobidæ, as becomes clear from their possession of a series of "inserted sectors." The dragon-flies of the Mesozoic do not differ in this respect from the recent ones. The Carboniferous "Protodonata," at least some of them, also acquired this alternation. The plaiting was already indicated in the Palæodictyoptera and Megasecoptera but it was very seldom that the branches actually turned into inserted sectors, and according to the branches we can judge with certainty about this

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[8] Woodworth, on the contrary, sees in the "independent" veins of the may-flies primitive structures which illustrate the process of the formation of the longitudinal veins of insects. The "independent" veins are supposed to receive their origins from the marginal vein, as growths of the latter to the inside; these growths are pulled out towards the base and finally fuse with one of the main trunks. The media, according to Woodworth, was formed as an independent vein also, only the anal veins having a different origin, and growing from the base. We have no need to stop to discuss this fantastic theory; it contradicts all data of paleontology and comparative systematics (the condition in Bætoidea is unquestionably secondary!), and is impossible from a morphological aspect. (One cannot imagine the growth of veins in the membrane.)

[9] I do not exclude the possibility that some (short) intercalary veins of dragon-flies could develop as illustrated by Comstock (1918): as a result of the formation of plaiting.

plaiting. Such was the situation acquired, e. g., in *Camplyoptera eatoni* Brongn., a species referred by Handlirsch to the Megasecoptera. In the drawing by Handlirsch the character of the intercalary sectors is very clear. Furthermore, according to Handlirsch's drawing the change of some longitudinal veins into intercalary sectors had begun in Lycocercus and in Epithethe. In other Palæodictyoptera we do not notice this. In groups rich with longitudinal veins as the Spilapteridæ, Lamproptilidæ, Polycreagridæ, the plaiting was already suggested, but it never came to a formation of inserted sectors. The plaiting, together with the forming of inserted branches, is a very important mechanical improvement, which allowed lightening of the wing a great deal without loss of its firmness and elasticity.

Leaving aside for awhile the question of the origin of the peculiarities of tracheation in may-flies, which we will consider together with the tracheation of dragon-flies, let us turn to the venation of dragon-flies. The peculiarities of dragon-flies enumerated at the very beginning of this article, are, as stated, rather the peculiarities of interpretation, which result from the nature and insufficiency of the method employed ("method of ontogeny"), and not at all from the actual venation. Putting aside these hypothetical considerations, let us compare the wings of dragon-flies with those of may-flies and Palæodictyoptera.

First of all one should note that in form as well as in the general distribution of the main longitudinal veins and in the smaller reduction of the anal area, the Anisoptera show a great deal more primitive features than the Zygoptera, whose wings were subject to very great changes; one could say that in the Anisozygoptera everything in general is much closer to the Zygoptera, and as a matter of fact merges into them in their more primitive Liassic representatives (Archithemidæ, Heterophlebiidæ); they still partly resemble the Anisoptera in their form, configuration of the anal area, and in general distribution of the main veins.

In this collective Liassic complex the triangle (e. g., in Heterophlebiidæ) begins to take form, but further development was reserved only for such groups in which the triangle succeeded in acquiring its typical aspect,—and these were the groups that formed the Anisoptera; others, where the "attempts" did not lead to the form of a typical triangle, died out. From here by way of another evolutionary path of the Zygoptera, were derived the majority of the known Anisozygoptera, which often cannot be told apart from the Zygoptera.

Unquestionable Zygoptera and Anisoptera are known only as far back as the Jurassic. The form of the wings in the Anisoptera and still more in the primitive Archithemidæ, resembles very much that of the wings of the Dictyoneuridæ, the most primitive of the Palæodictyoptera, also the Spilapteridæ, Triplosobidæ and may-flies of the Permian. If these dragon-flies have remained unchanged in their original form and homonomous nature of wings, we have also the right to expect a general plan of the distribution of veins, because the one and the other are bound together by function. This we actually find takes place. In Diastatomma (Archithemidæ) no nodus is to be found and Sc has the same aspect and same relation to R as it has in the majority of Dictyoneuridæ and Spilapteridæ. The next longitudinal vein after R gives rise to 3 or 4 branches; their method of origin and general distribution repeats that in a series of Dictyoneuridæ and Spilapteridæ (e. g., in Stenodictya, Polioptenus, Acanthodictyon, Eumecoptera and others), and still more of Triplosoba and the Agnatha. The resemblance of the Triplosobidæ in the distribution of the branches of RS, especially to the Anisoptera, and to the recent may-flies is so striking and obvious, that we can compare vein by vein without difficulty. In the dragon-flies we usually find in the region of RS two groups, the basal, —formed by the *first* concave branch, as in may-flies ($RS_5=M_3$ of authors); and the *second* convex and also usually "inserted" branch (RS_4=1 Morgan); and the distal group, formed by the concave RS_3 the weak convex and sometimes almost disappearing inserted RS_2, and lastly the concave continuation of RS (as in may-flies and Triplosoba). After this complicated RS follows the simple vein which is divided from it at the very arculus, and which is indicated by Odonatologists as M_4, but which represents M. It is still impossible to say whether this M corresponds to MA or MP of Triplosoba, and that is why we shall indicate it simply by the letter M. At its base M turns sharply towards R (as in may-flies) and almost fuses with it, but not entirely: by looking from above (partly), and in a cross-section the partition between the two veins is still distinct. The origin of RS from this turning-point of M, which sometimes has the form of a cross-vein, is not clear to us. RS arises here from the base of M just as in may-flies and one certainly should look upon such a manner of origin as a secondary appearance, even if this tendency was acquired very long ago, for it was already present in the dragon-flies of the Liassic and Jurassic. After this vein follows Cu (CuP) which forms in the Anisoptera and Anisozygoptera, soon after its origin, a more or less sharp curve or projection posteriorly, as in the suborder Ephemeroidea. This curve is still entirely distinct in the Agrionidæ, which appear to be the continuation of the Anisozygoptera, and dissappears only in the species of Calopterygidæ (by the "straightening" of Cu and A).

Now, if we compare the relation of the longitudinal veins to the convexities and concavities in dragon-flies to that in may-flies, we will ascertain the identity of their distribution, which was well explained by Redtenbacher. This circumstance, certainly, proves once more the correctness of our comparison of RS in dragon-flies (=M of the authors) to RS in may-flies, etc. Cu ($Cu+Cu_1$ of the authors) is concave, as in the may-flies, and the next vein after it, which consists of the "anal bridge"$+Cu_2$ of the authors, forms the same kind of projection and is just as "convex" as in Ephemeroidea Ulm. This vein is unquestionably A_1, and Cu_1 of the authors is Cu_2, and to be even more exact, it is CuP. In the majority of the Anisoptera, A_1 comes into contact with Cu after the projection, but such contact, which often changes into fusion, is also frequent in the Ephemeroidea. On the other hand, in the majority of Zygoptera and Anisozygoptera and many other Anisoptera (compare Fig. 6, wing of fossil *Heterophlebia dislocata,* with Fig. 7, hind wing of *Phyllopetalia apicalis* Seyls), A_1 does not come in contact with Cu and runs independently and almost parallel to Cu. In its general appearance of A_1 (Cu_2 of the authors) of the dragon-flies, especially such as the Gomphidæ or Anisozygoptera, corresponds entirely to A_1 of may-flies, analogously forming an arch towards the front and analogously sending a certain number of weak branches posteriorly. Next follows in the may-flies the concave A_2, then the convex A_3. But even if these veins did exist for a long time in the dragon-flies, they are fused now with A_1 at the base, and in the majority of cases this region has suffered great reduction. Usually we still find in the hind wings of the Libellulidæ two longitudinal veins, still quite distinct, which arise from A_1. As we find the suggestion of a fusion of the two longitudinal veins with A_1 in the "Protodonata" also, the conception of the composite nature of A becomes possible.

We did not finish the investigation of Cu and the triangle. The triangle represents a frame which presses apart and at the same time strengthens Cu and M. The perfection of this frame in the Anisoptera evidently becomes an acquisition of importance and use in the mechanism of the wing. We find the formation of the triangle in the Archithemidæ and Heterophlebiidæ in *statu nascendi.* Its forms here were rather diverse, sometimes different in the fore and hind wings, and in general these triangles did not correspond entirely to the triangles of the Anisoptera. These groups with the aberrant triangle died out, and only the groups with the normal triangle were developed and became preserved up to the present time. In the series of Anisozygoptera-Zygoptera no triangle was formed, but in connection with this the original form of the wing is also not preserved, the venation, changed greatly in the anal area, became reduced, Sc became shorter, etc. But originally, as we notice in the Lestinæ and in the related Anisozygoptera, the distinct projection of Cu (and A_1) was here also. The same kind of projection is also clearly expressed in the very conservative group Ephemeroidea Ulm. The triangular area between the bases of Cu_2 and Cu_1 in the families of this suborder also closely resemble the triangle in the dragon-flies, only its external side in the former is represented not only by one straight vein, but by two cross-veins (between Cu_1 and Cuad, Cu_2 and Cuad), which are seldom placed opposite each other. The "inserted sector" Cuad is also often found in the Anisoptera; it is also well represented in the fossil Heterophlebiidæ[10] by a longitudinal and usually uneven vein anterior of Cu. All these comparisons lead to the conclusion that in the dragon-flies, Cu_1 of the authors is not at all Cu_1, but that it corresponds to Cu_2 of the may-flies. Cu_1 of the may-flies does not exist any longer in the dragon-flies.* It is very possible that Cu_1 of the may-flies is CuA_1, but at present we cannot ascertain this.

The top side of the triangle was formed, according to Needham, by a cross-vein between Cu and M, slanting distally[11]. This is contrary to certain facts. In *Neurothemis oculata* Fab., for instance, and even more in *Aeschnidium*, the region of the triangle, as well as other areas, is occupied by a thick net and between M from one side, and Cu and the top side of the triangle from the other side, is distributed a thick series of short cross-veins. It is absurd to attribute the formation of the upper side by an inclination of a cross-vein. The outside as well as the upper side very likely was crystalized, as it were, directly from the network (certainly of very fundamental origin) under pressure of mechanical causes. Furthermore, this vein exists in order to join the basal part of Cu with M. If it came into that position by the slanting of a cross-vein (between Cu and M) one would not understand how it could pass by M and terminate on the exterior side of the triangle, a short distance down from M; this condition one encounters sometimes in the Libellulidæ and we find it in Heterophlebia, where it goes to the exterior side and is almost parallel to M (hind wing, *H. dislocata*). Such diversity points to the diverse nature of the formation of this vein. As soon as this wing-structure, which was derived from the configuration of the venation and of the wing form and for the working of its parts, acquired the formation of a triangular frame, its two sides (the interior side is formed by the downward projec-

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[10] E. g., *Heterophlebia dislocata* (Handlirsch, l. cit., pl. 42, fig. 3).

[11] Needham, l. cit., p. 717, fig. 12.

* At the request of Dr. Martynov, the following sentences, which were in the original, have been omitted: "In the Protodonata (Meganeura, Boltonites, Typidæ) we also usually find the simple anterior branch CuA_1, and the branch CuP joined to the anal group. This seems to point to the conclusion that Cu_2 of the dragon-flies is CuP, and that CuA disappears in them."

tion of Cu) begin to form themselves from the veins existing there, no matter which ones. It seems to be not an impossible idea that the upper side in some groups could be the remains of the original part of Cu_1. Cu_1, as in the may-flies, had to be concave, and this top side is concave, changing at the end into a sharply convex M. The fact that its end does not reach M would therefore be comprehensible. On this theory I do not insist because I cannot offer any definite facts of proof.

In the Zygoptera the true triangle does not exist, but in the Agrionidæ—and they form the main part of the Zygoptera—a structure was formed which in its function, to a certain degree, replaces the triangle. This is the "quadrilateral," which hereafter takes the form of a narrow triangle. It is very certain that such a structure as it is represented in the Lestinæ, for instance, does exist, and is indicated by the fact that from the Anisozygoptera up to the present time only such a form as (*Epiophlebia suprestes* Selys) was preserved, where the "quadrilateral" has a form identical with that in the Lestinæ. Where the projection of Cu was not fixed by the formation at this place of the frame of a triangle, or quadrilateral of the type of Lestinæ, there the existence of this projection, and below the projection of A_1, lost its mechanical significance. More than that, this projection because of the functioning of this vein would be entirely without purpose and even harmful. It is not surprising, therefore, that in the Calopterygidæ, where the "quadrilateral" did not adopt the form as in the Lestinæ and Epiophlebia, Cu tended to straighten itself out in diverse ways; a tendency which reached its maximum development in Calopteryx and related forms.

Preceding the above discussion, I compared the venation of the dragon-flies with the venation of the Carboniferous Protephemeroidea (Trilolsoba) and through them to the Dictyoneuridæ. I referred little to the Protodonata because the evolution of their wings was along different lines from the dragon-flies. It is true that in part of them two branches of M are represented as well as the two branches of Cu, which do not exist in the Odonata; but in other respects they are more specialized and go further than the dragon-flies from such groups as the Dictyoneuridæ. One can say that the primitive net of their wing was used for the formation of secondary longitudinal sectors, which imitate and take the position of the original ones. In contrast to what was as a rule expressed in the evolution of the Palæodictyoptera, may-flies, and dragon-flies, Rs did not expand, but decreased. In these the distribution of branches of RS and also M_1 and Cu is more pronounced than in the Odonata, and departs from the distribution which we find in the Dictyoneuridæ and Protephemeroidea. In this respect the Odonata have preserved more of the primitive features. The one-sided and extreme specialization of the wing venation of the Protodonata, with the loss of some fundamental features of their ancestors, were probably one of the main causes which brought about the rapid extinction of the group.

From the base of the Odonata there separated off, probably some time before the adoption of the main features of the recent venation, one more group known to us through a single representative from the Liassic—*Protomyrmelon brunonis* Geinitz. The wing venation of this form was figured by Handlirsch on Pl. 42, Fig. 14, and is reproduced here in Fig. 8. Some superficial resemblances with the Zygoptera, and at the same time some singularities of venation, lead the author to isolate the species in a separate suborder, Archizygoptera. Sc is very much shortened and Rs and M very strongly distorted, so it is difficult to understand their distribution. Handlirsch represented Cu as two-branched; below it came the anal. If Cu is actually composed of two branches, then this fact, together with the peculiar structure of RS and M, would be sufficient for us to place this form into a separate order by itself. But one should note that the base of the wing is not well preserved in the fossil.

Now let us look briefly at the tracheation of the wings of the may-flies and dragon-flies. Such an inquiry is natural. If our interpretation of the venation of the dragon-flies and may-flies is correct, how can we explain, then, the way the trachea of RS runs in the anisoptera, where the trachea which arises from R is opposite the nodus, crosses RS_1 and RS_3 and enters into the vein RS_4, extending, and often a great deal, from its base? How can we explain the almost regular absence of the trachea in RS_4 of may-flies, and also of a series of distal branches chiefly convex, as in Agnatha, Odonata, etc? Let us try briefly to throw some light on the question; and let us start with the may-flies.

A characteristic feature of the tracheation of the *anlage* of the nymphal wing[12] appears to be its exceptional diversity in different groups and its marked instability, which is shown in a very great individual variation. By studying the tracheation in different groups and comparing it with the venation, we observe in the diversity a definite correlation with the peculiarities of venation. I base this statement upon the work of Morgan, who gave a series of illustrations of the tracheæ of nymphs of different may-flies, as well as on my observations. Only in some of the more primitive forms and then only in the early stages of the development of the wing *anlage,* do we encounter, as shown by Morgan, in Chiratonetes, for example, the normal full tracheation, with the penetration of the tracheæ into all longitudinal veins through their bases. In the later stages of development of the same Chiratonetes the part of the trachea which goes into RS_1 ($=M_1$ Morgan) disappeared and instead of this a series of small tracheæ was directed into the vein RS_1 from the neighboring, stronger trachea R. A quite full tracheation exists according to Morgan in Heptigenia sp. (P. 5, Fig. 3), but here the tracheation in RS_1 and also in some other small branches has already disappeared. I repeat, we seldom encounter normal tracheation. In most of the may-flies we usually encounter a regular alternating of veins in which the tracheæ normally penetrate through the bases with veins which have no such tracheæ, and which are tracheated by numerous small branches from tracheæ of the neighboring veins (see e. g., Fig. 11, which illustrates the course of tracheation as in species of Heptigenia Ulmer). Almost always the vein (with a few known exceptions in Chiratonetes and Heptigenia) which is tracheated

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[12] If the tracheoles are distinguished with difficulty in the wings of the imagines of dragon-flies, then it is still more difficult in the may-flies. However, the characteristic features of the venation and tracheation of the adults are already indicated in the nymphs, and for that reason we shall investigate the imagines instead of the nymphs.

by such means and which was one of the first to lose its own trachea, is RS_4 (=1 Morgan); that is the vein which has no normal tracheation in Odonata, where it receives the trachea either from RS_3 (Zygoptera) or from R (Anisoptera). Furthermore, the convex vein between RS_4 and RS_1 is tracheated (almost exclusively) in the same way. Tracheæ which go into M and R are often very weak also, or even vanish entirely (especially in M), and in such a way these veins adopt a secondary tracheation from the branches of the neighboring trunks. The intercalary vein in Cu_1 is similarly tracheated, sometimes A_1 also. If we compare such characteristics of tracheation with the characteristics of venation, then without effort we shall notice the fact that the first veins to lose their own trachea and begin to be tracheated by small branches from neighboring trunks are all veins which were made "inserted" (independent, intercalary, Shaltsectors, etc.), —that is, which lost their origins. Such veins as far as known are almost always convex veins. Furthermore, in the more primitive species groups as Bætoidea, but also Siphloneuridæ and a few Ephemeridæ, the tracheæ which go into M and R, that is already into the main but exclusively convex veins, are weakened and eventually disappear. We have said above that because of this loss and even by the weakening, of trachea as in the case of R and M, which penetrate into the vein through the base, this vein begins to be tracheated by small branches from the neighboring tracheal lines. The tracheation of such "inserted" veins is, however, very diverse, because branches penetrate into it not only from neighboring systems but also from trunks which lie further away anteriorly and posteriorly. Such small branches must quite often go a long way around before they come into the necessary vein. Quite often some small tracheal branches, which are derived from the neighboring trunks as well as the trunks placed further away, become a great deal stronger than others, and accept the chief burden of tracheation; in such cases one or the other part, and sometimes most of the small tracheal branches, are subject to reduction. Finally, not rarely there are cases when only one trachea receives the repossession and tracheates almost entirely a given vein (a certain part of the small branches or neighboring trunks nevertheless remain). The methods of tracheation, as it was noted above, are very diverse in general and subject in particular to a strong individual variation. The one or the other vein is tracheated sometimes only by small branches, sometimes also by larger ones. The latter penetrate either from the nearer or from the further lying trunks, etc. Evidently a series of causes not considered here (that is, certain circumstances), influence the distribution of smaller branches. Sometimes, however, the one or the other method of tracheation is understandable. In a number of forms, as noted, the trachea RS does not continue into the distal branch RS_1, but turns off into RS_3, and RS_1 is tracheated by small branches. This we will understand if we remember that alongside RS there runs the trachea trunk R, which can supply RS_1 with branches. However, when R disappears, the trachea Rs1 is usually preserved. Morgan, seeking for an analogy with the dragon-flies, noted that in one species of Heptigenia and only in part of these specimens, the tracheæ which supply RS_3 (=RS? Morgan) separate not only from the trunk RS, as usual, but also from R. Desiring to see in this the analogy with the Odonata, Morgan concluded that this vein is Rs, and that here we have a preservation of the crossing of the tracheæ and veins, which sometimes took place in the may-flies and now in dragon-flies.[13] It is not necessary to say that such a conclusion, which is now supported by Comstock (3), has not enough foundation. In all may-flies the concave RS_3 is tracheated in a normal way from a concave trunk RS (=M_1 Morgan and Comstock), as it should be, and only in part of the specimens of Heptigenia studied the strongest trachea appears to be a branch of R. Taking into consideration the unusually great amount of variation in general, and the capriciousness of the tracheæ, can one attach such great significance to this exception, and conclude that this condition once existed in all may-flies, i. e., that in all may-flies RS takes root in the region of the media? Evidently such a con-

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[13] Only in the Anisoptera. Morgan says that the crossing was unquestionably present in the Zygoptera, but that is pure hypothesis which has no supporting facts and is more than doubtful.

clusion is very daring and was prompted by the wish to find a full analogy. However, Morgan is wrong in supposing that by such an interpretation a full analogy with the dragon-flies is established, because RS of the may-flies is a concave vein and corresponds completely to a concave vein in the dragon-flies, i. e., to RS_3; but not to the convex vein, RS_4, which almost always has the character of a "Schaltsector," and which, according to the understanding of the authors is a branch of R,, i. e., RS. To this vein there entirely corresponds in the may-flies another convex vein, also always inserted, which Morgan indicated as I and Comstock as IRS (intercalary). If one attaches importance to such exceptional cases of the entering tracheal trunks, then we lose any support of the theory of the establishment of homology of the veins. According to the illustration of Morgan (Pl. 5, fig. 7) in *Epeorus humeralis*, the vein 1 is supported in the distal part by one trachea from M_2. Why in such a case should we not consider vein 1 (that is, RS_4) to be only the branch of M_2 (that is, RS_5) and its basal part as a bridge? In Blasturus, according to the same author (Pl. 6, fig. 27), the middle (interia) vein of the media is tracheated by one treachea which separates from RS_5 (=M_2 Morgan). Why not suppose that the crossing once existed here, and not consider that this vein is a branch of RS_5, etc.? Such a supposition is not more unlikely than the one assumed by Morgan.

I have already noted above the fundamental nature of the relationship between the tracheation and the character of the venation. *Those veins which have lost the normal method of origin from other veins and become "inserted sectors," that is, after weakening at the base, have lost the base itself, those veins have lost the normal mode of tracheation and acquired a secondary tracheation.* Such veins are the convex branches and also some small secondary, distal, concave branches. It is true that not everywhere the convex vein-branches changed into "inserted sectors"; there are exceptions, though very seldom. Thus in Palingenia, RS_4 in the fore wings[14] originates nor-

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[14] In the hind wing this vein is already a typical inserted sector.

mally and has not yet changed into a typically inserted sector. Nevertheless, here this vein takes a definite convex position and forms at its base a projection towards the concave vein R. This is sufficient for the secondary tracheation to be adopted. The main convex veins, R and M, had orginally and have still in many species their own tracheal trunks, which penetrate into them; but in the other weaker tracheæ and in the more specialized groups, as in Bætoidea, for example, where the membrane is very fine, all superfluous veins are discarded and in the remaining ones the alternaton of convexities and concavities is sharply expressed up to the very base, where the main convex veins, R and M, lose their own tracheæ.

The indicated relation becomes clear to us, if we look at it from an historical point of view. There was certainly once a time when the alternation of convex and concave veins was only suggested. There was still[15] no inserted sectors, and the present convex RS_4 and RS_2 of recent types had a normal origin from R. Because of the absence of plaiting of the wings and the diversity in the methods of origin of the different veins receiving the trachea normally (that is, through the base from larger trachea of other veins of which they were branches), this position of the tracheation is approximately preserved at the present time, as mentioned above, in a great many primitive forms, and also in the earliest stages of development of the wing *anlage* in nymphs. As the wings "mechanized" more and more, that is, as the membrane became finer, the veins adopted an alternation of convex and concave positions, the basal part of the veins at the time of the change from the concave position (e. g., of R to RS_4) weakened and finally was obliterated. The normal tracheation through the base into the convex vein became more and more difficult, and then became impossible, when the vein

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[15] By this I do not mean to say that all, even the smallest irregular distal veins, were originally normal branches which arose from other veins. Small branches were formed at their places from the primitive network, were unstable, irregular, diverse and as a rule gave rise to no (secondary) alternation of convexities and concavities. Now, as before, they are tracheated by small branches probably in very diverse ways. These supplementary, secondary veins I do not consider here.

lost its base. This condition was carried over into the nymph, where in general there was at once laid down the foundation of imaginal venation. Such convex veins had to acquire a small tracheal supply by some other means. The small tracheoles in may-flies and dragon-flies (in nymphs and young imagines) frequently separate from the longitudinal trunks, and by means of the cross-veins usually reach the neighboring trunks. When the basal tracheal trunks began to weaken the small side branches of the neighboring trunks began to strengthen in their place, and finally to replace them completely in function. Because of causes which we cannot consider further, one or the other branches strengthened to the disadvantage of the others; and sometimes the tracheation, chiefly in one trachea which arose either from a neighboring or a remote trunk, appeared to be the most preferable. Since the strengthening of some of the small tracheæ depends upon a thousand small causes, because of their multitude and original similarity, even in the development of one individual, it is natural that the secondary tracheation had to be a very diverse and variable one. Under such conditions in the interpretation of the venation one should not attach any importance to the fact that in a certain species a vein receives its secondary tracheæ from neighboring trunks and not from the side where it should be. Such appears to me the origin of the secondary tracheation of may-flies; and if this idea is correct for the may-flies, then it is also correct and entirely applicable to the dragon-flies.

In dragon-flies the whole character of the tracheation of the wing in its relation to the venation maintains in general the same character as in the may-flies, since the dragon-flies have much less diversity and much more stability in tracheation than the may-flies. The tracheation of R is preserved everywhere, which is comprehensible to a certain degree if we consider the shortening of the subcosta in the dragon-flies. The tracheation of M is also preserved, although in the Zygoptera it is sometimes greatly weakened. The convex RS_2, RS_4 and A_1 obtain a secondary tracheation by small branches from the neighboring tracheæ; the cross-tracheæ are of course supplied by the small supplementary distal, longitudinal veins. The media in the Zygoptera is supplied by its own trachea as well as, to a greater or less extent, by the small branches of the neighboring veins. RS_2, together with a series of other veins in the region of Rs and M, are supplied by small tracheoles (see fig. 9), but in Zygoptera the vein RS_4 is tracheated in this way at its basal part, while in its distal part usually (but with exceptions) by one fairly large branch which arises from RS_3 (fig. 9). In the Anisoptera, this same RS_4 receives its trachea from R_1, and even the basal part of this vein (the "bridge") is tracheated chiefly by the branch of the tracheæ directed posteriorly. Comstock and Needham conclude from this fact that the vein RS_4 is actually RS, which takes root in the region of the media; and they extend this conclusion to the Zygoptera, in which this type of tracheation of RS_4 was never observed. From my historical point of view, such a tracheation of RS_4, and in particular the difference in both suborders, becomes generally clear. The convex branches of RS and also A_1 for the same reasons as in may-flies lost their original and normal mode of receiving tracheæ and acquired a secondary tracheation at the expense of the ever-increasing small branches from the neighboring trunks, which used to enter here before. Such a method of tracheation was preserved in the basal part of RS_4 in Zygoptera, but in the greater distal half one treachea which separated from RS_3 became predominant. This acquisition of predominance by one or several branches in dragon-flies as well as in may-flies, is often found in the distal longitudinal veins, and there is nothing surprising that one of the tracheæ strengthens at the expense of the other in RS_4. Originally, when the present-day type of tracheation was only beginning to evolve, the greater diversity probably took place here, as in the may-flies. Having lost its tracheation, Rs_4 received at first the tracheoles from the neighboring trunks as well as from R, and in the same group some tracheal branches obtained predominance; and in other groups, other branches, etc. The tracheation of RS_4 in the Anisoptera from R was at last established (why, is another question); in Zygoptera, partly from RS and partly by the mere preservation of an earlier means of supply by small tracheoles (in the basal half). It is difficult to say why the tracheation of

RS_4 by the branch from R or RS_3 (almost) was established, but I think that the formation of a stable point of supply at the nodus had great influence upon the process of acquiring such a tracheation. In the Anisoptera the point of origin of the branch in RS_4 from the trachea R is just opposite the nodus. In the region of the nodus the wing is certainly stronger, is much less able to bend, and is much less exposed to occasional deformation at its distal point. The trachea which arises from this place in R is naturally more protected at its base and therefore more able to be strengthened and preserved than other more distally lying branches from the neighboring trunks. In the Zygoptera RS_4 is supplied by an entirely different trachea; this is from RS_3, but here also the place of origin of the trachea is opposite the nodus, though a little more distal. However, one should bear in mind that in the evolution of the Zygoptera, there took place migration of the nodus towards the base, so that the separation of the point of origin of RS_4 and the nodus becomes clear. The difference between these suborders in the tracheation of RS_4 proves my supposition about the original diversity and the probable variability of the growing secondary tracheation in the dragon-fly. It would be strange if in both suborders, which are so different on the basis of their venation, there should have been established a similarity of RS_4.

Unquestionably the tracheation is also secondary. This tracheation in general is similar in both suborders, but there are a few which are somewhat inconsistent. The tracheation of the wings of dragon-flies differs in general from that of the may-flies in its stability; but the stability is not so great as one would think and one encounters in the Anisoptera, a variation of even a serious character. I did not investigate these questions specifically; I shall mention only four young nymphs of Æschna sp., which were taken together in the fall of 1923 in a little pond near Lakhta; in one of these the tracheæ appeared to be anormalous in the following features: in the left fore wing the treachea R behind the nodus gives rise to a strong trunk, which at once separates again into three branches, entering into RS_4, RS_3 and RS_1. Only RS_5 is tracheated here from the trachea of the media. In the right hind wing the trachea which supplies our M (M_4 of the authors), appears to be free up to the very base, and arises only very near the trachea RS (fig. 12). The last variation is especially interesting as indicating that the origin of the trachea M from the general trunk $Rs_{+}M$ is perhaps the result of a secondary fusion of the base of the trachea M with the base of RS.

And so the investigation of the tracheation of the wings of dragon-flies and may-flies from a functional and historical point of view leads us to the conclusion that the peculiarities were developed in connection with the acquisition of the characteristic features of these groups, the alternation of convex and concave veins, and usually the change of convex ones into "inserted sectors." Such features are characteristic of these two recent groups and the related fossils, Triblosoba, Protodonata (in part), some Megasecoptera and evidently some Palæodictyoptera.

The study of the relation of the jugal areas to the remaining part of the wing lead me in another work (7) to the conclusion that the *Insecta Pterygota* probably separated during the Lower Carboniferous into several branches which went along different lines of evolution, the Paleoptera (Palæodictyoptera, Megasecoptera, Agnatha, with their Carboniferous relatives) and the Neoptera (the remainder of the Pterygota, which at rest fold their wings roof-like over their abdomens). My study of the venation and the tracheation of the wings of may-flies and dragon-flies proves this conclusion, because according to the wings both these groups are similar in many ways to the Dictyoneuridæ, Triblosoba, and the typical members of the Paleoptera.

In conclusion, I would like to discuss one more question. How can one explain that out of the once rich and diverse group of Paleoptera, there are now existing only the Agnatha and the Odonata, the other groups having died out? I think that in a discussion of this question we should not forget the structure of such an important organ as the wing.

Of course the wings of recent dragon-flies are much more perfect than those of their remote ancestors, which were like the Dictyoneuridæ. They have lost most of those veins of their ancestors which were unnecessary from a mechanical point of view (among the even the main branches of M and Cu); they have changed their form (may-flies) and have acquired (dragon-flies) such important mechanical structures as the triangle and the parts adjacent to it, that they have in general become greatly mechanized; but by this means we hardly can explain the persistence of these two groups, because the wings of many extinct groups had also attained that mechanical perfection, particularly the Megasecoptera, Protodonata, and many groups and families of the Palæodictyoptera. The Megasecoptera, as well as the other groups mentioned, advanced very far, but nevertheless died out early. Evidently all this explanation is insufficient and something else is needed. Comparing the wings of may-flies and dragon-flies with the wings of the most primitive forms, e. g., Dictyoneuridæ from one side, and from the other side the Megasecoptera, Protodonata and more specialized Palæodictyoptera, we find, between the one and the other, distinct differences. In the Megasecoptera the venation is so much reduced that their wings resemble those of the Dictyoneuridæ only slightly.

In the Protodonata the number of longitudinal veins, on the contrary, has increased greatly, but the relative dimensions of the systems of Rs, M and Cu, and the distribution of their branches have greatly departed from that which we have seen in the Dictyoneuridæ. Similar changes in dimension and distribution of branches are encountered in many Palæodictyoptera. Dragon-flies (especially Anisoptera) and may-flies, on the contrary, differ in that, disregarding the various specializations, they preserved the original relative dimensions of the systems of the main veins and the distribution of branches (especially Rs!). The Anisoptera preserved their primitive form of wing. Such preservation of the fundamental primitive features was the reason why the specialization of the wings of dragon-flies and may-flies did not become fatal for them, as in the case of the former groups. *A too rapid specialization, with the loss of the original primitive features, as we have in the Megasecoptera, Protodonata, etc., inevitably narrows greatly the potentiality of further evolutionary modifications, and leads such groups to an end of development and* *consequently to extinction.*

And so this study of the venation of the two recent orders, the Agnatha and the Odonata, which to my mind represent the branches which separated early from the more primitive forms of the very similar Dictyoneuridæ, and which have nothing in common with the Neuroptera and Plectoptera[16], leads me to the conclusion that such characteristic features of the venation and the distribution of veins (in particular RS, partly M) of the Dictyoneuridæ were preserved better in the dragon-flies and may-flies than in many Palæodictyoptera or Megasecoptera, in which the venation was too specialized or too reduced. May, 1923.

P. S. My work was already in the press of the Russian Entomological Review when the July number of Psyche (30: 1923, nos. 3-4) appeared, with an article by Aug. Lameere on "The Wing Veins of Insects." In this small but very valuable article, the author discusses chiefly the venation of the Palæodictyoptera, the dragon-flies and the may-flies, and in many respects comes to the very same conclusion on the question of the interpretation of the venation as I have.

In the treatment of RS in the dragon-flies and the may-flies we agree perfectly, aside from terminology. According to Lameere, also, the media of may-flies corresponds to the posterior branch (our MP), in Triblosoba, etc., and the media of the dragon-flies according to the author is MA (my terminology). From a comparison of the Protodonata, I now entirely share this interpretation, according to which the dragon-flies lost MP. In the treatment of the cubitus we do not agree in everything, because the assertion of Lameere that the may-flies, as well as the dragon-flies, have lost CuA, is to my mind not entirely proven. I will not discuss here the venation of the other groups, and will note only that the conception of the author that there is a close relation between the Hemiptera and the Palæondictyoptera appears to me unlikely. According to my understanding of the venation of Eugeron, it is constructed entirely after the type of the Palæodictyoptera, and is far from the type

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[16] The Plecoptera have to be included according to my understanding into the super-order Orthopteroidea. A similar view has been taken by Lameere (1917).

of the Hemiptera. Eugereon, together with several other forms, represents only one on the branches of the Palæodictyoptera, and one can hardly connect it with the Hemiptera, which represents an entirely different trunk and must be referred to my group Neoptera; the latter separated very early from the division Paleoptera, to which one should assign Eugeron Dorhn. To all these questions I hope to return. Fall, 1924.

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EXPLANATION OF FIGURES

Fig. 1. Wing (hind?) of *Polioptenus elegans* Goldenberg.

Fig. 2. Fore wing of *Eumecoptera laxa* Gold.

Fig. 3. Wing of *Triplosoba pulchella* Brongn.

Fig. 4. Wings of *Hexagenia bilineata* Say.

Fig. 5. Fore wing of *Gomphus descriptus.*

Fig. 6. Basal part of hind wing of *Heterophlebia dislocata* Brodie and Westw.

Fig. 7. Base of hind wing of *Phylopetalia apicalis* Selys.

Fig. 8. Wing of *Protomyrmeleon brunonis* Geintz.

Fig. 9. Tracheation of wing of nymph of *Lestes rectangularis* Say.

Fig. 10. Hind wing of *Palingenia longicauda* Oliv., after Eaton (5).

Fig. 11. Tracheation of the *anlage* of the fore wing in the adult nymph of a member of the Hexagenioidea Ulm. (original).

Fig. 12. Anormalous tracheation in the hind wing *anlage* of a nymph of *Æschna sp.* (original).

Figures 1, 2, 3, 6, and 8 after Handlirsch (6); Fig. 4 after Needham (8); Figs. 5, 7, and 9 after Needham (10).

ON THE VARIATION AND ABUNDANCE OF *SIREX NITIDUS* HARRIS

By Charles W. Johnson

Boston Society of Natural History

Dr. Frederic T. Lewis has obtained a large and interesting series of a horntail referable to *Sirex nitidus* Harris, at his summer place at Randolph, N. H. On July 29, 1930, Dr. Lewis sent me 18 males and 5 females; on August 3, 24 males and 25 females; on August 7, 9 males and 17 females; on August 10, 5 males and 4 females; on August 22 to 29, 6 males and 15 females; in all, 62 males and 68 females, a total of 130. Having but one male and three females of this species after twenty-six years collecting in New England, this large number came as a great surprise. The series is especially interesting in showing a remarkable range of variation. The smallest male measures 13 mm., the largest 25 mm., and the smallest female is 12 mm. and the largest 24 mm. This measurement does not include the ovipositor. Between the two extremes there is a complete gradation in size. There is also a great variation in the color of the two sexes, which together with the problem of distribution make the species of the genus Sirex difficult to define.

In determining this species there are many obstacles. It does not agree with *S. cyaneus* Fabr. as defined by either Bradley[1] or Waterston[2], but is closer to *S. noctilio* Fabr. as redescribed by Waterston. It differs, however, from that species in having all the femora of the male bright yellow not "darkened," the posterior tibiæ and the first three joints of the tarsi black. The female has the same form of cornus and length of ovipostor as *S. noctilio,* but

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[1] J. C. Bradley, Journ. Ent. and Zool., vol. 5, p. 19, 1913.
[2] James Waterston, Bull. Ent. Research, vol. 5, p. 221, 1928.

the "tergites II-VIII" are not "dull black," but of a deep blue color, smooth and highly polished, as described by Harris[3] under *Urocerus nitidus*.

The type came from Dublin, N. H., near Mt. Monadnock, about one hundred miles south of Randolph. It seems evident that this is the prevailing form of this region and that it represents the *S. nitidus* Harris. I have also received a male from Mr. Dwight Blaney, who collected it on Ironbound Island near Bar Harbor, Maine. The males vary considerably in color. Three and often four of the basal segments and the eighth segment of the abdomen are dark blue. One has the base of the eighth only narrowly bluish, and a second specimen has the same segment with only a narrow apical margin of yellow. Many specimens have on the three or four yellow segments dorsal spots of blue, and the seventh segment is often widely margined with blue. As in *S. noctilio* the first transverse brachial vein may be either complete or incomplete, but this character is of little value. In 100 specimens, 60 had the vein complete and in 40 it was incomplete; in addition two specimens had the vein complete in one wing and incomplete in the other.

The specimens came from a Balsam fir (*Abies balsamea*) which had been cut down during the summer of 1929. On September 3 Dr. Lewis sent a section of the tree 11 inches long, with a diameter of 4¾ inches, from which 41 specimens had emerged. With the *Sirex nitidus* were taken three males of *Ibalia ensiger* Nort. This species like *I. maculipennis* Hald. is probably parasitic on Sirex and other wood borers.

While collecting on Nantucket, Mass., Sept. 9, 1929, I obtained an interesting specimen associated with *Sirex edwardsii*, a male in which all except the first and second segments of the abdomen are yellow. If the third and fourth joints of the antennæ were not reddish I should be inclined to refer it to *S. nigricornis* without question, and perhaps this may prove to be the case. All of the many male specimens of *S. edwardsii* taken have only the fifth and sixth segments of the abdomen yellow.

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[3] T. W. Harris. Insects of Massachusetts Injurious to Vegetation, p. 391, 1841.

A BOT FLY FROM THE WHITE-FOOTED MOUSE

By Charles W. Johnson

Boston Society of Natural History

In July, 1930, Dr. Langdon Frothingham presented to the collection of the Boston Society of Natural History a bot fly—*Cuterebra* (*Bogeria*) *fontinella* Clark, obtained from a White-footed Mouse (*Peromyscus leucopus noveboracensis* Fischer). The following note was furnished by Dr. Frothingham: "The larva of the bot fly, which formed a large swelling on the thigh of the mouse, left its host August 26, 1929, was placed in a small jar of damp earth, and almost immediately buried itself in the earth. It was left in my closed summer cottage at Pocasset over the winter. The earth was dampened twice in the fall, September and October, and again in June and July. The fly emerged on July 15, 1930."

The fly is 15 mm. in length and represents the smallest of our species of Cuterebra. It agrees in every respect with *C. fontinella* Clark as defined by E. E. Austin,[1] but not with *Bogeria fontinella* Clark as described by Townsend.[2] The standing of Bogeria even as a subgenus is questionable. The chief character, "arista bare," used by Austin having proved to be erroneous, Townsend took up a second character, "antennal pit," used by Austin to separate Bogeria from Rogenhofera. This character when confined to Cuterebra has evidently no generic value.

This is the first record to my knowledge of this bot fly having been actually obtained from the White-footed Mouse, although the larvæ of Cuterebra have been found in this Mouse at Sandwich, Mass., by Willard Reed; at Wareham, Mass., by Outram Bangs; and at Bedford, Mass.,

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[1] Annals and magazine of Nat. History, ser. 6, vol. 15, 1895.

[2] Insecutor Inscitiæ Menstruus, vol. 5, p. 27, 1919.

by J. Miller. Riley and Howard[3] record Cuterebra larvæ from a mouse—*Sitomys californicus* at West Creek, California. Larvæ of this genus have also been found in the Meadow Mouse at Provincetown, Mass. I remember that while living in Florida I obtained Cuterebra larvæ from the large wood rat.

The life history of the Cuterebrinæ is quite different from the other subcutaneous bots. The flies appear from May to July and deposit their eggs, the larvæ maturing quite rapidly, leaving their hosts in August and September, and passing the winter in the ground as pupæ.

The abundance of bots on the Barren-ground Caribou (*Rangifer caribou* Gmelin) in Labrador is well illustrated by a skin recently tanned for Mr. Francis Richardson. A piece 7 x 10 inches presented to the Museum shows over 200 perforations, the number in the entire skin far exceeding 1000. About one-third of these entirely perforated the skin, the others represented scars of older perforations that had healed. Judging from the antlers the caribou was probably about eight years old. The bot fly in all probability is *Oedemagena tarandi* Linn., although a similar species *O. terrænovæ* Knab, is found in Newfoundland infesting *Rangifer terrænovæ* Bangs.

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[3] Insect Life, vol. 6, p. 47, 1893.

THE WALKING-STICK, *MONOMERA BLATCHLEYI* RACE *ATLANTICA* DAVIS IN EASTERN MASSACHUSETTS

By Charles W. Johnson

Boston Society of Natural History

In 1926 I received from Mr. A. W. Higgins a female walking-stick, taken at Rock, Mass., August 10. It was referred to *Monomera blatchleyi* Caudell in the Bulletin of the Boston Society of Natural History for January, 1930, but should have been referred to the race *atlantica* Davis. As this was the most northeastern record for this interesting form, I was desirous of obtaining additional material and if possible securing a male. I therefore asked Mr. Higgins to be on the lookout for it this year.

The results of his work were a surprise. On August 10-15 he collected 19 specimens, on the 21st 40, and on the 27th 17, a total of 76 specimens, all females. I kept the 40 specimens alive for several days. On the 23rd there were 55 eggs in the glass jar, and on the 25th 57. The eggs, which look like little seeds, are 2.5 mm. long. Mr. Higgins found about 60 per cent of the specimens on goldenrod. Most of the specimens were a bright green, some having a more or less prominent yellow or reddish lateral stripe, two were of a dark grayish color, three were reddish brown, and two were laterally reddish, this color extending over the ventral surface except for a narrow median stripe of green. They vary in length from 65 to 80 mm.

The most interesting feature connected with this insect is the apparent absence of males. Mr. William T. Davis had some forty-six females when comparing this form with the typical *blatchleyi*, and many more have come under his observation. Are we dealing with a parthenogenetic species, the males appearing only at intervals?

NOTES ON AMERICAN NEMESTRINIDAE

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Most of the following notes have been in manuscript for a number of years, pending their inclusion in a revision of the American representatives of this family. The recent discovery of some of these flies in Yucatan prompts their publication in the present form.

Subfamily **Nemestrininae**

The subfamily Nemestrininae should, in my opinion, comprise all nemestrinids with an elongate, slender, hard proboscis, the labium usually provided with narrow labella. All the North and Central American species belong to one genus, Neorhynchocephalus.

Neorhynchocephalus Lichtwardt

Neorhynchocephalus Lichtwardt, 1909 (July), Deutsch. Ent. Zeitschr., p. 512 (based upon two species: *Rhynchocephalus sackeni* Williston, 1880, and *R. volaticus* Williston, 1883); 1910, *Loc. cit.*, p. 592.

Rhynchocephalus subgenus *Nemestrinopsis* Cockerell, 1910 (October), Bull. Amer. Mus. Nat. Hist., XXVIII, p. 285 (type by original designation: *Rhynchocephalus volaticus* Williston, 1883).

This genus, which is exclusively American, may be defined as follows:

Medium-sized flies, densely pilose, often with narrow hair-bands on the abdomen; the integument black, dark brown, or reddish yellow. Head broad and short, flattened hemispherical. Face flattened or slightly concave. Frons flattened; linear or more or less narrowed beneath the ocellar triangle in the male (the eyes almost holoptic in certain species) ; very broad in the female, often occupying about one-third of the width of the head. Eyes bare. Proboscis elongate, stylet-like, slender, usually directed downward and backward, more rarely slanting forward; terminal labella long and slender, slightly flattened. Palpi short, very slender. Antennæ short; the two basal segments subequal, transverse; the third subcircular, flattened with a terminal, three-segmented, bare arista. Ovipositor of female long, sabre-shaped, composed of two slender, curved valves. Wing: alula broad; apical half never with a network of cross-veinlets; branches of third and fourth longitudinal veins long, running parallel with the hind margin; third and fourth veins never coalescing before the margin; first and second submarginal cells separated by a cross-vein (Cockerell's outer radio-medial) ; costa as a rule enclosing the hind margin of the wing completely and usually reached by the fifth longitudinal (or apical portion of diagonal vein), which thus divides the third and fifth posterior cells; base of fourth posterior cell removed from the anal cell and situated at or slightly beyond the lower basal corner of the discal cell; anterior cross-vein absent, the fourth longitudinal vein usually reaching the third some distance basad of the latter's branching.

Genotype, by present designation: *Rhynchocephalus volaticus* Williston, 1883.

Lichtwardt (1907, Zeitschr. Syst. Hym. Dipt., VII, p. 451) first pointed out that, in the genotype of Rhynchocephalus Fischer (*R. tauscheri* Fischer), the upper branch of the fifth longitudinal vein does not reach the hind margin of the wing. He later (1909) proposed a new genus, Neorhynchocephalus, for the Nearctic *R. sackeni* and *R. volaticus,* in which the hind margin is thickened into a vein, reached by the diagonal vein. Neorhynchocephalus was more fully characterized by Lichtwardt in 1910.[1] About the same time and quite independently from Lichtwardt, Cockerell also noticed that the diagonal vein extends to the hind margin in *R. volaticus*, while such is not the case in typical Rhynchocephalus. He therefore placed *R. volaticus* in a new subgenus Nemestrinopsis. It would seem, however, that he wished to retain *R. sackeni* Williston and *R. subnitens* Cockerell in Rhynchocephalus, proper, although this is not clear from his paper.

The distinction between Rhynchocephalus and Neorhynchocephalus is entirely based upon two peculiarities of the venation. The first of these, *viz.*, the development of the costa along the hind margin and its connection with the diagonal vein, is probably too slight and variable to be of generic value. At any rate, in some of the specimens of *N. sackeni* which I have examined, certain stretches of the hind margin are not visibly thickened into a vein, and the margin is not fully reached by the diagonal vein, the third and fifth posterior cells being incompletely divided. The second feature, *viz.*, the contraction of the base of the fourth posterior cell, appears to be more reliable: it is present in 40 specimens of Neorhynchocephalus, belonging to the four known species. As a rule, the cell is briefly stalked at the base; but sometimes it is narrowly sessile on the second basal cell. I have seen only one specimen in which it was narrowly sessile on the anal cell, but even this condition is very different from that of *Rhynchocephalus tauscheri* Fischer, in which the base of the fourth posterior cell touches the anal cell over a long stretch, its lower margin running nearly parallel with the lower margin of the discal cell.

Contrary to Lichtwardt's statement, the shape of the frons in the male is not of generic significance. He writes that in Neorhynchocephalus the eyes touch each other on the vertex in the male; while the male of Rhynchocephalus has the eyes distinctly separated by the ocelli. In fact, the males of both genera have the eyes separated on the vertex itself by the ocellar triangle; below this the frons may be more or less narrowed. In *N. volaticus* and *N. sackeni* the frons is very much narrowed and linear, so that the eyes seem to touch each other. In two males of *N. vitripennis* (Wiedemann) the frons is moderately narrowed, the eyes being distinctly separated.

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[1] The Zoological Record lists Neorhynchocephalus as dating from this 1910 paper; but the genus was validly established a year before.

Quite possibly Neorhynchocephalus should not be given generic rank, and rather be regarded as at most of subgeneric value. While it is not represented in the Old World, so far as we know, it does not contain all the New World species. Lichtwardt has described *Rhynchocephalus mendozanus* (1910, Deutsch. Ent. Zeitschr., p. 594; ♀ ♂), from Argentina, which he says has the venation of *R. tauscheri*, except "dass sich Cubitus und Media in einem Schnittpunkte trennen."

The four known species of Neorhynchocephalus may be separated as follows:

1. Two branches of fourth longitudinal vein united before the costa, the second posterior cell closed and with a long apical stalk. Black, with dense, rather short, pale yellowish pile; the abdomen not distinctly banded nor spotted. Length, 6 to 10 mm.....*N. sackeni* (Williston).

Two branches of fourth longitudinal vein ending freely in the costa, some distance from each other, the second posterior cell not stalked at the apex ....2.

2. North and Central American species. Tibiæ and tarsi darker than the femora, especially those of the hind legs. Body covered with pale yellowish pile; the abdominal tergites with more or less distinct, white, apical fringes, and with small tufts of black hair on the sides; tergites often spotted with yellowish red. Frons linear in the male, the eyes nearly touching over some length below the ocellar triangle. Length, 8.5 to 14 mm. ....*N. volaticus* (Williston).

South American species. Legs uniformly pale colored, dirty yellow to reddish-yellow. Abdominal tergites without distinct, white, apical fringes, but on the sides with more prominent tufts of hair, which are partly black..3.

3. Head, thorax and legs densely covered with long bright sulphur-yellow pile. Wings distinctly infuscated at the extreme base. Length, 8 to 10 mm. (Male unknown to me)................................*N. sulphureus* (Wiedemann).

Head, thorax and legs covered with pale yellowish pile. Wings subhyaline throughout, at most slightly yellowish at the base. Male: frons narrowed beneath the ocelli, but the eyes separated by about half the basal width of the ocellar triangle. Length, 8 to 11 mm. ....*N. vitripennis* (Wiedemann).

Neorhynchocephalus volaticus (Williston)

Rhynchocephalus volaticus Williston, 1883, Canad. Entom., XV, pp. 70 and 71, fig. 4 (♀; Florida); 1886, Trans. Amer. Ent. Soc., XIII, p. 293 (♀); 1888, "Synopsis North American Diptera," p. 33, fig. C. W. Johnson, 1895, Proc. Ac. Nat. Sci. Phila., XLVII, p. 325. Williston, 1901, "Biologia Centr.-Amer.," Dipt., I, p. 269. Aldrich, 1905, "Cat. North Amer. Dipt.," p. 219. Cockerell, 1908, Trans. Amer. Ent. Soc., XXXIV, p. 250. Williston, 1908, "Manual of North American Diptera," 3d Ed., p. 186, fig. 68. Kertész, 1909, "Cat. Dipt.," IV, p. 30.

Neorhynchocephalus volaticus Lichtwardt, 1909, Deutsch. Ent. Zeitschr., p. 512; 1910, *Loc. cit.*, p. 593, fig. 2. C. W. Johnson, 1913, Bull. Amer. Mus. Nat. Hist., XXXII, p. 54. F. M. Hull, 1923, Ent. News, XXXIV, p. 275 (♀ ♂).

Rhynchocephalus (*Nemestrinopsis*) *volaticus,* Cockerell, 1910, Bull. Amer. Mus. Nat. Hist., XXVIII, pp. 285 and 286.

Rhynchocephalus species, Osten Sacken, 1886, "Biologia Centr.-Amer.," Dipt., I, p. 73 (♀).

Specimens Examined.—Florida: one female (holotype) and two other females, without more definite locality (Riley Coll.—U. S. Nat. Mus.); St. Augustine, one male (C. W. Johnson Coll.); Georgiana, one female (Whitfeld Coll.—U. S. Nat. Mus.). Texas: one female and one male, without more definite locality; Cotula, one female, May 12, 1906 (J. C. Crawford Coll.—U. S. Nat. Mus.); two males, labelled "Neucest" (Marlatt Coll.—U. S. Nat. Mus.); Raymondville, one female and one male (F. M. Hull Coll.). Mississippi: Agricultural College near Starkville, several females and males (E. K. Dickey, W. E. Anderson, and F. M. Hull Coll.). Kansas: Bourbon Co., 800 ft., one female (R. H. Beamer Coll.); Sumner Co., 1189 ft., one female (R. H. Beamer Coll.); Lawrence, one female (C. H. Curran Coll.); Douglas Co., one male (W. J. Brown Coll.). Mexico: Presidio River, Villa Union, Sinaloa, one female (A. Kusche Coll. U. S. Nat. Mus.3; Venodio [? Fenochio, Sinaloa], one female (A. Kusche Coll.—U. S. Nat. Mus.); State of Colima, one female (L. Conradt Coll.—U. S. Nat. Mus.); Mexico City, one female (Juan Muller Coll.—U. S. Nat. Mus.); Matamoros, Morelos, one female (W. L. Tower Coll.); Altamira Farms, four males (M. E. Hoag Coll.—Ac. N. Sci. Phila.). Yucatan: Chichen Itza, three females, and six males, taken in the dry forest, from June 6 to 10, 1929; the species is evidently common in this locality, although difficult to find and to collect; it is on the wing during the warmest and sunniest hours of the day, when it hovers in the bushes, some 2 to 10 ft. above the ground, poising on a spot for many minutes, while producing a characteristic, high-pitched noise; after a while it may rest on the tip of a dry branch.

There are also reliable, published records of *N. volaticus* from Kingsville, Texas; West Point, Mississippi; Chilpancingo, Guerrero; Mazatlan, Sinaloa; Vera Cruz, Mexico; and San Geronimo, Guatemala.

Neorhynchocephalus sackeni (Williston)

Rhynchocephalus sackeni Williston, 1880, Trans. Conn. Ac. Sci., IV, 4, p. 243, fig. (♀; Olympia, Washington State); 1883, Canad. Entom., XV, pp. 70 and 71 (♂); 1894, Ent. News, V, p. 47. Snow, 1903, Kansas Univ. Sci. Bull., II, 5, p. 214. Hine, 1904, Canad. Entom., XXXVI, pp. 86 and 90. Aldrich, 1905, "Cat. North Amer. Dipt.," p. 219. Cockerell, 1908, Trans. Amer. Ent. Soc., XXXIV, p. 249, Pl. XVI, figs. 1 and 3. Kertész, 1909, "Cat. Dipt.," IV, p. 30. Cockerell, 1910, Bull. Amer. Mus. Nat. Hist., XXVIII, p. 286. Schaeffer, 1912, Jl.

New York Ent. Soc., XX, p. 296. Cole and Lovett, 1921, Proc. Calif. Ac. Sci., (4) XI, p. 239.

Neorhynchocephalus sackeni Lichtwardt, 1909, Deutsch. Ent. Zeitschr., p. 512; 1910, *Loc. cit.*, p. 593 (♀ ♂).

Rhynchocephalus clausus F. Brauer, 1883, "Offenes Schreiben als Antwort auf H. B. Osten-Sacken's 'Critical Review,'" Wien, p. 8. Not of Osten Sacken, 1877.

Rhynchocephalus subnitens Cockerell, 1908, Trans. Amer. Ent. Soc., XXXIV, p. 250 (♀; Clark Co., Kansas); 1910, Bull. Amer. Mus. Nat. Hist., XXVIII, p. 286. Schaeffer, 1912, Jl. New York Ent. Soc., XX, p. 296.

Neorhynchocephalus subnitens Lichtwardt, 1910, Deutsch. Ent. Zeitschr., p. 593.

SPECIMENS EXAMINED.—Southern Illinois, one female (C. Robertson Coll.—U. S. Nat. Mus.). Kansas: Clark Co., one female (F. H. Snow Coll.). New Mexico: West Canyon Camp, Koehler, one female and one male (W. R. Walton Coll.—U. S. Nat. Mus.). Arizona: Huachuca Mountains one male (C. Schaeffer Coll.). Colorado: one female and seven males, without more definite locality (U. S. Nat. Mus. and Zool. Inst. Halle a. S.); Fort Collins, one male (in Coll. Johnson). Utah: Mill Creek, one male (L. P. Rockwood Coll.); Salt Lake City, one female (E. C. Titus Coll.— M. C. Z. Cambridge). Idaho: Grangeville, one female (J. M. Aldrich Coll.); Whitebird, one male (J. M. Aldrich Coll.). California: Goose Lake, Medoc Co., one male (Holleman Coll.—U. S. Nat. Mus.). Oregon: Mt. Angel, one female and three males (F. Epper Coll.—U. S. Nat. Mus.); Forest Grove, one female (M. C. Lane Coll.); Lewisburg, one female (J. C. Chamberlin Coll.). Washington State: one female and one male, without more definite locality (H. K. Morrison Coll.—U. S. Nat. Mus.); Yakima River, two females (M. C. Z. Cambridge); Rock Lake, one female (U. S. Nat. Mus.). British Columbia: Vernon, one male (J. S. Hine Coll.).

There are reliable, published records of *N. sackeni* from Morton Co., Kansas; Colorado Springs, Colorado; Mary's Peak, Oregon; Corvallis, Oregon; and Union Co., Oregon.

Professor Cockerell informs me that two females and one male have been taken at Boulder, Colorado.

After examining a large number of Neorhynchocephalus, I am unable to regard any of the characters given for *subnitens* as of specific or even varietal value. Cockerell described *subnitens* as follows: "Smaller than *R. sackeni* Will.; length of wing just over 8 mm. (over 9½ in *sackeni*); pubescence paler, with a sort of greenish gray tint; abdomen less hairy, the bases of segments 2-4 broadly exposed, shining black; ovipositor shorter, with a stronger, more even curvature; eyes apparently lighter and redder; ultimate branches of cubitus (bounding second posterior cell of Williston) uniting a very short distance before margin of wing (a considerable distance in *sackeni*)." The difference in the venation especially is unimportant, considering the variability exhibited by most species of Nemestrinidae. In the series of *N. sackeni* which I have studied, hardly two specimens are alike in this respect and often the right wing differs considerably from the left. For instance, the third submarginal cell may be petiolate at the base or broadly or narrowly connected with the first submarginal. In one female, from Salt Lake City, the left wing is fairly normal, but in the right wing the third submarginal cell is subdivided at about its basal quarter by a supplementary cross-vein. A somewhat similar abnormal division of the third submarginal cell in one wing is present in a female from Grangeville, Idaho, in a female from Forest Grove, Oregon, and in a male from Colorado; but the cross-vein is placed at a varying distance from the tip of the cell. A male from Colorado, in V. v. Röder's collection (Zoological Institute of the University at Halle a. S.), is even more aberrant: while the right wing is normal, in the left wing both the second and third submarginal cells are subdivided by cross-veins, placed a short distance from each other near the middle of the cells; in addition this left wing has a supplementary cross-vein about the middle of the fifth posterior cell, uniting the lower border of the fourth posterior cell with the hind margin. Cockerell also has figured the closed third submarginal cell of the right wing of a male from Colorado. The length of the apical stalk connecting the closed second posterior cell with the margin is very variable and often different in both wings; in one case the cell being closed at the margin in the left wing and very short-petiolate in the right; at the base this cell may either touch the fifth posterior cell or be removed some distance above it. The fourth posterior cell is either stalked at the base, or sessile, or narrowly connected with the second basal cell. The anal cell is as a rule open on the hind margin; but in one male from the Huachuca Mountains, Arizona, it is distinctly closed. I may also add that in a letter, dated November 2, 1929, Professor Cockerell has expressed doubts as to the validity of his *R. subnitens.* He now thinks it may have been only a variation.

Neorhynchocephalus sulphureus (Wiedemann)

Nemestrina sulphurea Wiedemann, 1830, "Aussereurop. Zweifl. Insekt.," II, p. 631 (no sex given; Minas Geraes, Brazil). Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 149.

Nemestrinus sulphureus Kertész, 1909, "Cat. Dipt.," IV, p. 25.

Neorhynchocephalus sulphureus Lichtwardt, 1910, Deutsch. Ent. Zeitschr., p. 594 (♀ ♂).

Specimens Examined.—Two females from northern Argentina: Mistol Paso near Icano, Chaco de Santiago del Estero (E. R. Wagner—Paris Museum).

Lichtwardt saw Wiedemann's types in the Vienna Museum and he says that they are male and female. He also studied three specimens of which he does not give the sex and the locality, in the Berlin Museum, and a female from Asuncion, Paraguay, in the Budapest Museum.

The two specimens from Argentina, though otherwise very similar, differ considerably in size; in one the wing is 8 mm. long; in the other 11 mm. The fourth posterior cell is short-stalked at the base in the larger one and very long-stalked in the smaller one.

Neorhynchocephalus vitripennis (Wiedemann)

Nemestrina vitripennis Wiedemann, 1830, "Aussereurop. Zweifl. Insekt.," II, p. 631 (♀; Brazil).

Prosœca vitripennis Schiner, 1868, "Novara Reise," Zool., II, Abt. vol. B, Dipt., p. 112. Kertész, 1909, "Cat. Dipt.," IV, p. 29.

Nemestrina vitreipennis Hunter, 1901, Trans. Amer. Ent. Soc., XXVII, p. 149.

Neorhynchocephalus vitripennis Lichtwardt, 1910, Deutsch. Ent. Zeitschr., p. 594 (♀).

Specimens Examined.—Two males. One, merely labelled "Bras.," in V. v. Röder's collection at the Zoological Institute of the University of Halle a. S., is a very old faded specimen, on a short pin, and may have been one of Wiedemann's cotypes. The other is labelled "Chapada," a locality in the southern part of the State of Matto Grosso, Brazil. This appears to be the first definite locality for the species. Lichtwardt only saw Wiedemann's cotypes at the Berlin and Vienna Museums.

Both males I have seen agree in having a well-developed, though narrowed frons below the ocellar triangles; their venation is practically identical. The specimen from Chapada is the larger, its wing being 10.5 mm. long; that of the other specimen measures 8.5 mm.

Subfamily **Hirmoneurinae**

The Hirmoneurinae should contain all nemestrinids with a well-developed, but short and broad proboscis, the labium ending in large, fleshy labella. The alula of the wing is always broad and the ovipositor of the female is telescope-shaped, consisting of several narrow segments capable of retraction within one another. In North America, this subfamily is represented by two genera, *Hirmoneura* Meigen and *Hyrmophlaeba* Rondani.

Hyrmophlaeba brevirostris (Macquart)

Hirmoneura brevirostris Macquart, 1845, Mém. Soc. Sci. Lille, (1844), p. 233, Pl. XX, figs. 1-1*a*; 1846, "Dipt. Exot.," Suppl. 1, p. 101, Pl. XX, figs. 1 and 1*a* (♂;

Merida). Osten Sacken, 1877, Bull. U. S. Geol. Geogr. Surv. Terr., III, p. 224; 1878, Smithson. Miscell. Coll., No. 270, p. 85. Williston, 1883, Canad. Entom., XV, p. 70. Aldrich, 1905, "Cat. North Amer. Dipt.," p. 218. Cockerell, 1908, Trans. Amer. Ent. Soc., XXXIV, pp. 251 and 252, Pl. XVI, fig. 2; 1910, Bull. Amer. Mus. Nat. Hist., XXVIII, p. 286.

Hermoneura brevirostris Kertész, 1909, "Cat. Dipt.," IV, p. 25.

Hyrmophlaeba brevirostris Rondani, 1863, Arch. per la Zoologia, Modena, III, 1, p. 51. Lichtwardt, 1910, Deutsch. Ent. Zeitschr., pp. 580 and 591. J. Bequaert, 1920, Jl. New York Ent. Soc., XXVII, (1919), p. 306.

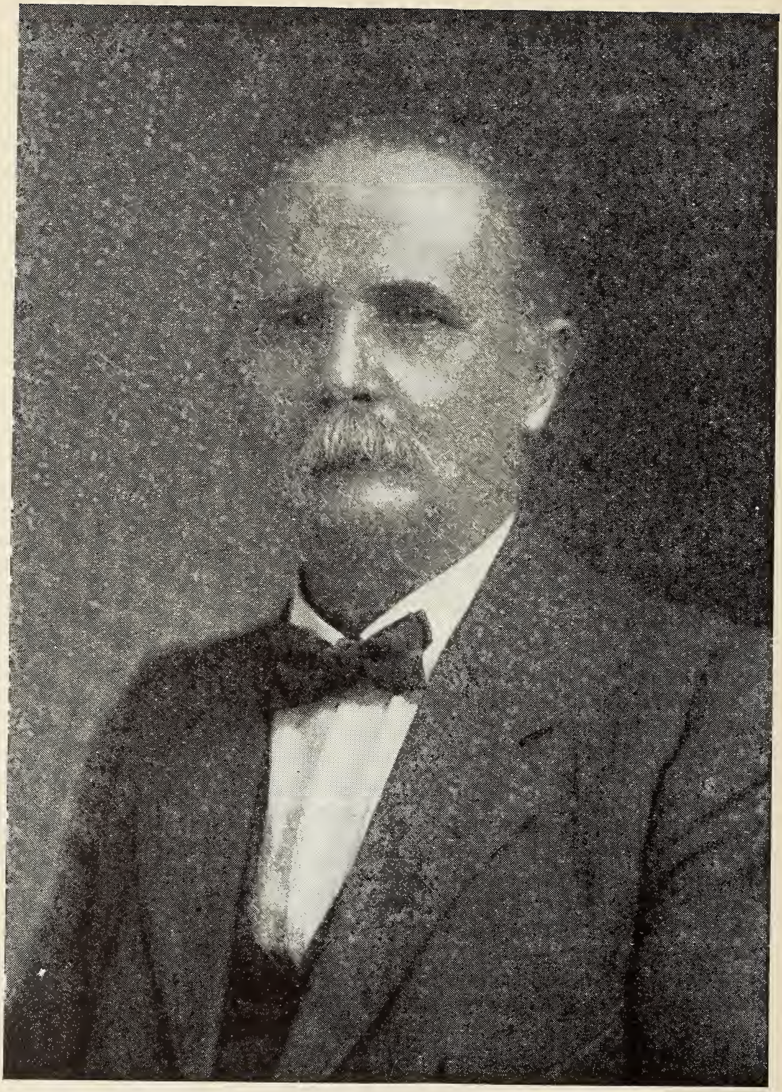
This species, originally described from the State of Yucatan, has been reported from Mexico by Lichtwardt. I have seen two specimens from Guatemala: El Rancho, one female (J. S. Hine Coll.), and Gualan (in the eastern part), one male (C. C. Dean Coll.—U. S. Nat. Mus.).

Since no adequate description of this insect has ever been given, the following notes may help to recognize it.

Female.—Integument of the body uniformly black, entirely covered with ashy gray pruinosity. Antennæ dark brown, the basal segments paler, the arista black. Proboscis and legs pale reddish-yellow, the tibiae dirty white. Body moderately hairy all over. Ocellar triangle and upper part of face with black pilosity; lower part of face and outer orbits with white hairs; two basal segments of antennae with very long and dense, spreading, black hairs, forming fringes above and below. Thorax densely covered with rather long, pure white hairs. Abdomen: first tergite with similar long white pilosity; the succeeding tergites evidently rubbed off in the specimen seen, since they bear only sparse, black and gray hairs, forming small tufts on the sides; sternites covered with silvery white pile. Legs with white hairs, mixed with a few black hairs on tibiæ and tarsi. Head large, hemispherical in profile, about as broad as high, slightly wider than the thorax. Frons extremely narrow, less than one-quarter the width of an eye at its broadest point (just above the antennae); inner orbits diverging both in the upper and lower portion, the frons being narrowest about midway between vertex and antennae, where the eyes are barely separated. Ocellar protuberance flattened, forming a much lengthened triangle, not distinctly separated by a groove from the inner orbits. Anterior ocellus about twice as far from the posterior ocelli as these are apart. Eyes very densely covered with long, gray pile. Antennae small, crowded together between the inner orbits; basal segment much longer than the second; third segment flattened, pear-shaped, a little larger than the second. Arista about the length of the combined second and third antennal segments. Body slender and narrow. Dorsum of thorax about as broad as long, the transverse suture distinctly marked on the sides, broadly interrupted in the middle. Scutellum semi-oval, cushion-shaped, with distinctly swollen posterior margin separated from the remainder of the scutellum by a slight groove. Abdomen elongate, oval, ending in an ovipositor composed of several gradually narrowed segments, capable of being telescoped into one another. Legs slender, the femora not swollen. Wing long and slender, slightly over three times as long as wide, a little shorter than the body and much longer than the abdomen; entirely hyaline. Costa distinctly developed along the entire hind margin of the wing and reached by the diagonal vein. The cross-vein separating the first and second submarginal cells reaches the third longitudinal beyond its branching. Three submarginal cells; the third briefly truncate at the base and closed at the apex, which is connected by a long stalk with the costa; the two branches of the third longitudinal vein fused over more than their apical quarter. Anal cell broadly open.

Length (to apex of tergite 4), 10.5 mm.; length of wing, 10 mm.; width of wing, 2.5 mm.

Male.—Differs little from the female, except in the usual sexual peculiarities. Eyes densely pilose, holoptic. In the specimen I have seen, the color of integument and pilosity and the venation of the wing were the same as in the female. The pilosity was, however, much better preserved, the entire abdomen being clothed, like the rest of the body, with long, whitish-gray hairs.



GEORGE DIMMOCK

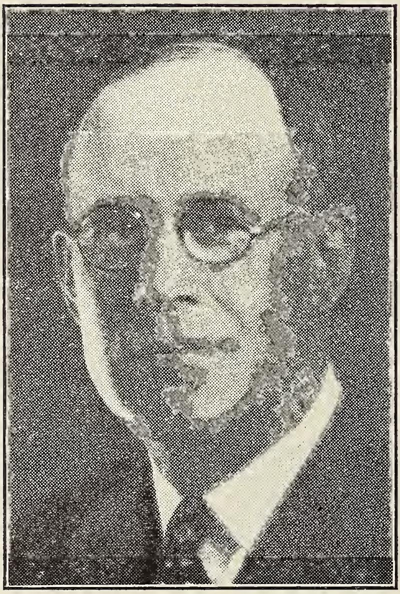
Born May 17, 1852. Died May 17, 1930.

George Dimmock, one of the founders of the Cambridge Entomological Club, died in his home town, Springfield, Mass., on his birthday at the age of 78 years. His interest in Natural History began early, and as a boy he made collections of insects and took part in the work of the local museum, of which he was curator in 1872, until he moved to Cambridge as a student at Harvard College, from which he was graduated in 1877. In 1879 he went to Germany and studied with Rudolph Leuckart at the University at Leipzig, from which he received the degree of Doctor of Philosophy. Later he went to Paris, where he studied with H. Lacaze-Duthiers at the zoological laboratory at Banyuls in Southern France. A paper on the mouth-parts of the Mosquito and other Diptera, part of his work at Leipzig, was privately printed in 1881.

Returning to this country, he settled in Cambridge, and took an active part in the work of the Entomological Club, being one of the editors of its journal, Psyche, from 1880 to 1890, at times taking entire charge and paying part of the expense of publication. Numerous short articles by him on various entomological subjects were published in Psyche at this time.

His entomological work began with the Coleoptera, and his principal work always was with this group. Short papers on the Coleoptera and Lepidoptera of the neighborhood of Springfield were privately printed from 1870 to 1873. Later he gave much attention to coleopterous larvæ, and a paper on this subject in connection with F. Knab, was published by the Springfield Museum in 1904. The specimens on which this paper was based were given to the National Museum at Washington. About this time he visited Cuba and made studies of the Cuban Coccinellidæ, which were published (in Spanish) by the Cuban Agricultural Station in 1906.

In 1890 his hearing began to fail and by 1900 he could hardly hear anything. By this time he became much interested in the history of the Dimmock family and in genealogy in general, to which he devoted much of his time, but continued to help in the entomological work of the Springfield Museum and among the Springfield teachers and school-children. —J. H. Emerton.



Louis William Swett

LOUIS WILLIAM SWETT

The friends of Louis W. Swett were greatly shocked to learn of his untimely death. He was killed by lightning at his summer home on Baker Island, Salem Harbor, Massachusetts, July 21, 1930.

Mr. Swett was born at Riverside, California, October 2, 1880, and came East with his parents when about ten years of age. He attended the Hopkinton School, Boston, where he prepared for Harvard, and was a student from 1900-1902.

I first met Mr. Swett in 1903, when he was interested in Lepidoptera as a whole, but later he specialized on the Geometridæ, describing many new species. He gave his first collection of Geometridæ to the Museum of Comparative Zoology at Harvard in 1912, when his business did not give him sufficient time to devote to it. Later, however, with his friend Mr. S. E. Cassino, he made a second collection, and jointly they published "The Lepidopterist." He was a member of the Boston Society of Natural History, the Cambridge Entomological Club, of which he was president in 1911, Pi Eta Society of Harvard, etc.

Mr. Swett was proprietor of a large dry goods store at Lexington, Mass., known as "The Modern Shop," and also had a store at Somerville, Mass. He is survived by his wife, daughter and mother, to whom we extend our sincere sympathy.

—C. W. JOHNSON.

CAMBRIDGE ENTOMOLOGICAL CLUB

A regular meeting of the Club is held on the second Tuesday of each month (July, August and September excepted) at 7.45 p. m. in Room J, basement of the Peabody Museum, Divinity Ave., Cambridge. Entomologists visiting Boston are cordially invited to attend.

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PSYCHE

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NOTES ON HIPPOBOSCIDAE

2. The Subfamily Hippoboscinae

By J. Bequaert

Department of Tropical Medicine,
Harvard University Medical School

Although much has been written concerning some of the common species of Hippobosca that infest equines and cattle, no comprehensive and critical account of the genus as a whole has been published thus far. The present attempt at filling this gap cannot be more than preliminary, especially with regard to the synonymy adopted for the many names proposed in this group. In no case have I had access to the types on which these names were based.

The genus Hippobosca occupies an isolated position in the family Hippoboscidæ, forming a subfamily of its own, which was first defined by Speiser (1908, Zeitschr. Wiss. Insektenbiol., IV, p. 445).

Subfamily **Hippoboscinae**

Head rounded posteriorly, entirely free from the anterior margin of the thorax. Antennal pits completely enclosed by a continuous rim, containing the small, subglobular antennæ, which have no dorsal prolongation. No ocelli. Pronotum well developed dorsally, visible between the head and the mesonotum. Humeral angles rounded off, not projecting. Claws simple, but apparently bidentate, without supplementary tooth between the sharp apex and the broad, flattened "heel" of the base. Wings always well developed and functional throughout adult life; six distinct longitudinal veins and a vestigial seventh vein between the fifth ($M_{3+}Cu_1$) and sixth (An); two cross-veins, the anterior (r-m) and the anterior basal (m-cu or M_3); second basal cell very long; no closed anal cell; membrane bare, but rilled with numerous delicate, more or less parallel wrinkles, extending from the region of distinct veins toward the hind margin.

The subfamily contains only one genus.

Hippobosca Linnæus

Hippobosca Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (type: *Hippobosca equina* Linnæus, 1758, designated by Latreille, 1810, Considér. Génér. Crust. Arachn. Ins., pp. 407 and 444).

Hippobosca subgenus *Nirmomyia* Nitzsch, 1818, in Germar's Mag. d. Entom., III, p. 309 (monotypic for *Hippobosca equina* Linnæus, 1758).

Zoomyia Bigot, 1885, Ann. Soc. Ent. France, (6) V, pp. 227 and 234 (tentatively proposed as a substitute for *Hippobosca;* type by present designation: *Hippobosca equina* Linnæus, 1758).

Attention may be called to the remarkable structure of the pulvilli and empodium, which in this genus offer excellent specific characters.

The genus Hippobosca is indigenous throughout the continental areas of the Old World. All of the eight species, which I recognize as valid, are found in Africa; four of them extend also into the Oriental Region and two have entered Europe. Much of the present distribution of *H. equina, H. camelina, H. maculata,* and *H. capensis* is undoubtedly artificial and due to the spreading of their domestic hosts by man. I have tried to trace the probable original home of these species, but the conclusions I have reached are far from satisfactory.[1] None of the species appear to have become naturalized in the New World, where their occurrence is very accidental.

With one exception, the species of Hippobosca are ectoparasites of mammals, mainly of Ungulates and Carnivora. *H. struthionis,* however, is a normal parasite of the ostrich. Since the Ungulates and Carnivora were more numerous and more widely distributed in Mesozoic times than nowadays, it is safe to assume that Hippobosca has had a long geological past and may have been at one time cosmopolitan. The few living species are perhaps only the remnants of a large group of parasitic flies, which may have been as numerous in species as the living Hippoboscidæ of birds.

The Hippoboscæ are fairly good fliers. The gravid female leaves the host and deposits the full-grown larva in cracks of walls, in holes of trees, or on the ground. Patton, for instance, observed a female of *H. capensis* leave a dog, fly onto a wall and, after running along it, rapidly disappear into a crack. The fly remained there a few minutes; as it emerged, it was caught, and, on examining the crack, a larva was found a little distance inside (Patton and Evans, 1929, "Insects, Ticks, etc., of Medical and Veterinary Importance," I, p. 404).[2]

Host specificity is not very pronounced among the Hippoboscidæ which retain the wings throughout adult life, and this statement applies particularly to Hippobosca. Only the species of the ostrich seems to be restricted to a single host-species. *H. fulva, H. hirsuta* and *H. camelina* also have a narrow range of normal hosts. The other species have nowadays a variety of usual hosts; but in some cases this may be an artificial condition, due to the influence of man. Spreading of certain species by man beyond their

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[1] There is a voluminous literature dealing with the ancestors of domestic animals. After consulting a number of publications, I have found what appears to be the most reliable information in Keller, Conrad, 1902. "Die Abstammung der altesten Haustiere," (Zurich), 232 pp.

[2] I have not found any evidence that the puparia of Hippobosca are ever placed among the fur or feathers of the host, as Theobald (1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92) has claimed.

original home may perhaps explain partly why more than one species of Hippobosca infest nowadays domestic equines and cattle. I have attempted to distinguish in a table between the "normal" and the "facultative" or "accidental" hosts, in so far as feasible.

	Normal Hosts	Facultative and Accidental (Acc.) Hosts
H. equina	domestic equines	cattle (Acc.: dog, rabbit, camel, birds)
H. capensis	domestic dog, lion, leopard, hyena, cheetah, civet, fox, serval	duiker, dik-dik (Acc.: mule)
H. fulva	hartebeest	
H. maculata	domestic equines and cattle	camel, dromedary
H. rufipes	domestic equines	domestic cattle, wildebeest, eland, giraffe (Acc.: ? ostrich)
H. hirsuta	waterbuck and allied antelopes	
H. struthionis	ostrich	
H. camelina	camel, dromedary	horse (? Acc.)

The following alphabetical list of 36 names will serve as an index to the synonymy here adopted:

albo-maculata Macquart=*rufipes* v. Olfers.
albonotata Rondani=*rufipes* v. Olfers.
bactriana Rondani=*camelina* Leach.
bengalensis Ormerod=*maculata* Leach.
bipartita Macquart=*maculata* Leach.
calopsis Bigot=*maculata* Leach.
cameli Leach=*camelina* Leach.
8. *camelina* Leach. A valid species.
camelopardalis Roubaud=*rufipes* v. Olfers.
canina Rondani=*capensis* v. Olfers.

2. *capensis* v. Olfers. A valid species.
chinensis Giglioli=*capensis* v. Olfers.
cunicosa Thalhammer=*capensis* v. Olfers.
dromedarina Speiser=*camelina* Leach.
egyptiaca Macquart=*maculata* Leach.
equi Macquart=*equina* Linnæus.
1. *equina* Linnæus. A valid species.
fossulata Macquart=*maculata* Leach.
francilloni Leach=*capensis* v. Olfers.
3. *fulva* Austen. A valid species.
6. *hirsuta* Austen. A valid species.
laticornis Macquart=*capensis* v. Olfers.
longipennis Fabricius=probably *capensis* v. Olfers.
4. *maculata* Leach. A valid species.
maculata Macquart=*rufipes* v. Olfers.
marginata v. d. Wulp=*rufipes* v. Olfers.
massaica Speiser=*struthionis* Janson.
neavei Austen=*hirsuta* Austen.
orientalis Macquart=*capensis* v. Olfers.
5. *rufipes* v. Olfers. A valid species.
sivæ Bigot=*maculata* Leach.
7. *struthionis* Janson. A valid species.
sudanica Bigot=*maculata* Leach.
taurina Rondani=*equina* Linnæus.
variegata Wiedemann=*maculata* Leach.
wahlenbergiana Jænnicke=*rufipes* v. Olfers.

KEY TO SPECIES OF HIPPOBOSCA

I have studied specimens of the seven valid species separated by the subjoined key, which I have attempted to base mainly upon reliable structural characters. I have found that the coloration, although often helpful, is rather variable in certain species, and I do not regard it as of specific value when no differences in structure can be discovered.

Hippobosca fulva Austen appears to be distinct from the other seven. I have not seen it, and the characters given in the description do not allow of its being included in my key.

1. Second longitudinal vein (R_{2+3}) long, reaching the costa much beyond the tip of the first longitudinal (R_1) and apicad of the anterior cross-vein; the last section of the costa at most three times the length of the penultimate section. Base of third longitudinal vein (R_{4+5}) bare. One pair of vertical bristles. Two pad-like pulvilli at the sides of the bristle-like empodium, one much larger than the other.................................... 2

   Second longitudinal vein short, reaching the costa together with or close to the tip of the first longitudinal; the last section of the costa equal to at least five times the distance between the tip of the first and that of the second longitudinal veins 3

2. Apical lobes of the fronto-clypeus regularly and sharply triangular, their inner margins nearly straight. Scutellum as a rule wholly ivory-white; wing veins mostly pale testaceous, with some darker stretches. Smaller, the wing 5 to 6 mm. long..............................*H. capensis*

   Apical lobes of the fronto-clypeus irregularly and broadly triangular, their inner margins curved. Scutellum fuscous to ferruginous on the sides, yellowish white in center, rarely more extensively yellowish; wing veins as a rule rufous to dark brown. Larger, the wing 6 to 8.5 mm. long ....*H. equina*

3. Base of third longitudinal vein setulose over some length on the upper side. One pair of vertical bristles. Only one pulvillus well developed, the other rudimentary 4

   Base of third longitudinal vein bare 6

4. Second longitudinal vein very short, forming an oblique cross-vein which ends in the first longitudinal and runs from opposite or apicad of the upper tip of the anterior basal cross-vein to basad of the anterior cross-vein. Scutellum as a rule with three ivory-white spots, the largest in the center; bristles of head and thorax pale. Large, the wing 7 to 8 mm. long ....*H. maculata*

   Second longitudinal vein much longer and more oblique, ending in the costa close to or at the tip of the first longitudinal and running from basad of the upper tip of the anterior basal cross-vein to opposite or basad of the anterior cross-vein 5

5. Vertex distinctly narrower at the occiput than at the fronto-clypeus in both sexes. Scutellum very wide and nearly rectangular, with a median, rufous, and two lateral, ivory-white spots. Legs bright reddish; bristles of head and thorax brownish black. Larger, the wing 7 to 9 mm. long ....*H. rufipes*

Vertex about as wide at the occiput as at the fronto-clypeus. Scutellum narrower and less rectangular, with a median, ivory-white spot. Legs rufous-yellow; bristles of head and thorax pale. Smaller, the wing 6.5 to 8 mm. long ....*H. hirsuta*

6. Two pairs of vertical bristles. Sclerotized upper plate of vertex (or vertical triangle) about as long as wide at the occiput, much shorter than the medio-vertex, the latter considerably narrowed in the middle by the very broad inner orbital plates. Apical lobes of fronto-clypeus broadly separated by a semi-elliptical notch. Second longitudinal vein ending in the tip of the first, opposite the anterior cross-vein. Anterior basal cross-vein very oblique and nearly its own length from the anterior cross-vein. Scutellum semi-elliptical in outline, its posterior margin distinctly convex and slightly projecting in the middle. No pad-like pulvilli; the bristle-like empodium bare, except at the base. Larger, the wing 9 to 10 mm. long ....*H. camelina*

One pair of vertical bristles. Sclerotized upper plate of vertex longer than wide at the occiput, as a rule longer than the medio-vertex, the latter moderately narrowed by the inner orbital plates. Apical lobes of the fronto-clypeus separated by a narrow notch. Second longitudinal vein reaching the costa close to the tip of the first and apicad of the anterior cross-vein. Anterior basal cross-vein short, almost vertical upon the fourth longitudinal and more than twice its own length from the anterior cross-vein. Scutellum subrectangular, broadly truncate at the apical margin, not projecting in the middle. Two pad-like pulvilli; the empodium feathered. Smaller, the wing 7 to 7.5 mm. long ....*H. struthionis*

1. **Hippobosca equina** Linnæus

Hippobosca equina Linnæus, 1758, "Syst. Nat.," 10th Ed., I, p. 607 (no sex given; Europe and North America). Austen, 1906, "Illustr. Brit. Blood-Suck. Flies," p. 63, Pl. XXXI. Newstead, Dutton and Todd, 1907, Ann. Trop. Med. Paras., I, p. 90, figs. 17 (♀) and 18 (puparium). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 49, Pl. IV, figs. 3 and 4 (♀ ♂).

Hippobosca equi Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638, Pl. XXIV, fig. 8 (error for *H. equina*).

Hippobosca taurina Rondani, 1879, Boll. Soc. Ent. Italiana, XI, pp. 24 and 25 (no sex given; off cattle in central Italy).

Specimens Examined.—Sweden: (Ljungh). Germany: Berlin. Spain: Montanegos (Cevera); Escurial; Iviza, Baleares (W. M. Wheeler). France: Banyuls-sur-Mer, Pyr. Or., off a dog (G. Dimmock). Sardinia: (Krausse). Turkey: Reshadie (H. R. Hagan). Egypt: (S. H. Scudder). New Caledonia: Plum Farm (T. D. A. Cockerell). Belgian Congo: Kitobola, two males, 1913 (Rovere). Philippines: Manila (M. J. Myers).

Distribution.—This common species is known in England as the "forest-fly," after the New Forest in Hampshire, where it is particularly abundant. It may have been at first restricted to southern Europe and western Central Asia; but nowadays it is found throughout Europe (as far north as Lapland, and also in the British Isles), Northern Africa (as far south as Biskra), the Canary Islands, Madeira, the Azores, the Senegal, the Anglo-Egyptian Sudan, Egypt, Palestine, Asia Minor, India, the Sunda Islands, the Philippines, Celebes, Fiji, the New Hebrides and New Caledonia (introduced about 1890). It has been seen on freshly imported horses in Australia, but it does not seem to have become established there. Linnæus (1758) mentioned North America as part of the habitat and Loew [1864, Amer. Jl. Sci. Arts, (2) XXXVII, p. 318] included it among the species of Diptera common to Europe and America. It is doubtful, however, whether either Linnæus or Loew actually saw American specimens. Loew's record may have been based upon the earlier statement by W. Kirby (1837, Fauna Boreali-Americana, IV, p. 317; see Bethune, 1881, Canad. Entom., XIII, p. 169), who listed *H. equina* among the insects of Boreal America, without, however, mentioning a definite locality. Notwithstanding certain discrepancies, Kirby's description seems to have been based upon a specimen of true *equina;* but whether or not it came from North America is open to question. In any case, no other entomologist seems to have reported this fly from a New World locality, and I have never seen an authentic American specimen in any collection. Moreover, it is somewhat of a mystery why this fly has not become established in America, since it must have been brought over repeatedly from the Old World.

Newstead, Dutton and Todd (1907) state that they saw a few examples of *H. equina* on cattle, shipped at Las Palmas, Canary Islands, while on board ship on their way to the Belgian Congo. But the two specimens which I have seen from Kitobola are the only ones actually taken in tropical Africa, where *H. equina* seems to be replaced by *H. maculata.* Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1140) includes the Cape Colony in the range of the species, but no specimens have since been taken in South Africa.

HOSTS.—*H. equina* is usually found on equines (horses, mules and donkeys), sometimes also on cattle and more rarely on dogs, rabbits, or camels. Accidentally it may stray to birds. Massonat (1909, Ann. Université Lyon, N. S., CXXVIII, p. 242) saw specimens from owls (*Tyto flammea*) and from a kite (*Milvus regalis*), and Schuurmans-Stekhoven captured one on a pigeon. It is of interest that this species has never been taken on the wild equines of Africa.

The predilection which *H. equina* shows for horses makes it very probable that this insect was originally a specific parasite of one of the wild horses from which the domestic races have been derived. According to C. Keller (1902), the ancestor of the heavy races of horses was a wild equine which lived in Europe during the Pleistocene (*Equus caballus* Linnæus) and even survived until historic times. The lighter races, on the other hand, had an Asiatic origin and were most probably derived from *Equus przewalskii* Poliakoff, a wild equine of Central Asia, of which a few specimens may be living yet in a feral state in Dzungaria. I am inclined to the view that both these ancestral species were infested with *H. equina,* although, of course, this is a mere hypothesis. It may yet be possible to find the insect on the living *E. przewalskii.*

AFFINITIES.—*H. equina* and *H. capensis* appear to be very closely allied, although there can be no doubt that they are specifically distinct. After a very careful study, I have found that the only structural difference, which seems to be entirely reliable, is found in the shape of the fronto-clypeus. I had thought at first that the wing venation afforded some additional distinctive features. The relative distance from the tip of the second longitudinal vein to that of the first and third longitudinals appears to be highly variable. The length of the anterior basal cross-vein (or second basal cross-vein; *m-cu* or M_3) is perhaps more reliable: in *H. capensis* this cross-vein is fairly straight and, as a rule, about as long as the distance from its tip to the anterior cross-vein (*r-m*) ; in *H. equina* it is more curved and generally much longer than the distance from its tip to the anterior cross-vein.

In one male of *H. equina,* from Sardinia, the left wing has a double anterior cross-vein, enclosing a small supernumerary cell; the right wing is normal.

A further specific character may perhaps be found in the size and shape of the sclerotized upper plate of the vertex (vertical triangle). In all the 29 specimens of *H. equina* examined, this plate occupies about the upper third of the vertex, being at most half the length of the medio-vertex (or frontalia) ; it is almost semi-circular in outline and much wider at the occiput than long on the middle line. In most of the specimens of *H. capensis* seen, this upper vertical plate is much more extensive, being over half the length of the medio-vertex, sometimes occupying nearly half of the vertex; it is rather semi-elliptical and only a little wider at the occiput than long on the middle line. Unfortunately I have seen several specimens of *H. capensis* which in the shape of the vertex do not appreciably differ from *H. equina.* Nevertheless, this character may be of specific value, even though its variability prevents its being used in a key.

The color peculiarities of the scutellum and of the venation, which have been generally used as specific characters, I have found to be extremely variable and wholly unreliable in these two species. I have seen specimens of *H. equina* colored almost exactly like *H. capensis,* and I am certain that the two have often been confused in collections.

2. **Hippobosca capensis** v. Olfers

Hippobosca capensis v. Olfers, 1816, "De Vegetativis et Animatis Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen).

Hippobosca francilloni Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 8, Pl. XXVI, figs. 8-10 (no sex given; without locality). Theobald, 1906, 2d Rept. Wellcome Res. Lab. Khartoum, p. 92, figs. 51 and 53*C*; Pl. X, fig. 1 (♀).

Hippobosca orientalis Macquart, 1842, Mém. Soc. Sci. Lille, p. 432, Pl. XXXVI, fig. 6; 1843, "Dipt. Exot.," II, 3, p. 275, Pl. XXXVI, fig. 6 [called *Hippobosca laticornis* in the Explanation of Plates, p. 294] (no sex given; East Indies).

Ornithomyia chinensis Giglioli, 1864, Quart. Jl. Micr. Sci., N. S., IV, p. 23, Pl. 1*B,* figs. 10 and 11 (no sex given; China; supposedly off *Turdus obscurus*).

Hippobosca canina Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 164 (no sex given; Italy, Southern Europe, Persia, South and East Africa).

Hippobosca cunicosa "Madarasz," Thalhammer, 1899, "Fauna Regni Hungarici, Diptera," p. 69 (without description).

Hippobosca longipennis Fabricius, 1805, "Syst. Antliat.," p. 338 (no sex given, Tranquebar), is probably also *H. capensis* v. Olfers. The very brief description is as follows: "H. alis obtusis corpore duplo longioribus, corpore ferrugineo immaculato. Minor *H. equina.* Caput et thorax ferruginea, immaculata. Abdomen brevissimum; segmento primo transverso, carinato. Alæ longissimæ, albæ. Forte mera *H. equina* varietas." Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 332) claims to have recognized this species in a specimen at the Genoa Museum, collected by Fea (1885) at Mandalay, Burma. He states that the wing venation is as in *H. equina,* but otherwise mentions only color characters. Later (1908, Zeitschr. Wiss. Insektenbiol., IV, pp. 301 and 443) Speiser regarded it as a typically Oriental species, differing from all others in the absence of pale markings. The only specimen he saw was about the size of *H. capensis* (wing 6.5 mm. long). I hesitate, however, to change the name of this well-known species until Fabricius' type can be critically studied.

SPECIMENS EXAMINED.—Tunis: Kairouan (F. Santschi). Egypt: Bab-el-Wadi, Assuan (Nasarey); Lower Egypt (Nasarey); Luxor (G. Allen), off *Vulpes vulpes egyptiaca* (Desmarest). Kenya Colony: Hills west of Mt. Kenya, off a spotted hyena, *Crocuta crocuta fisi* Heller, July 3, 1909 (G. M. Allen); Sabaki (L. Bayer); Campi Kiboko (L. Bayer); Kerio River (L. Bayer); Tsavo River (L. Bayer); Magadi Railway (C. M. Woodhouse). Tanganyika Territory: Saranda near Dodoma, off a serval, *Felis capensis hindei* Wroughton (A. Loveridge); Tabora, off a lion, *Felis leo* Linnæus (J. Rodhain); between Tabora and Kigoma (Stamper); 25 miles east of Ikoma, numerous specimens off a lion, and one male off a young leopard, *Felis pardus suahelicus* Neumann (J. P. Chapin); Dodoma, on man (A. Loveridge). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Japan: Kamagawa (J. T. Gulick). China: Wuchang (C. M. A. Wassell); Kao-Ghiao

(J. Hervé-Bazin); Suifu, Sze-Chuen (D. C. Graham); Soochow (N. Gist Gee); Nanking, off dogs (C. S. Low); Penniu (C. Y. Wong). India: Koolloo (M. M. Carleton). Tonkin.

DISTRIBUTION.—*H. capensis* is common in many parts of the Mediterranean Subregion (Italy, Sicily, Macedonia, Crimea, Asia Minor, Palestine, Cyprus, Egypt, Cyrenaica, Tunis, Algeria), throughout the Sudan (as far as Northern Nigeria), in East and South Africa (Eritrea, Kenya Colony, Tanganyika Territory, Zanzibar, Transvaal, Cape Province, Southwest Africa), Transcaspia, Turkestan, Persia, India, Ceylon, China, Korea, and Japan. It has also been found in Bukowina, Hungary and Poland; and there is one record from Germany (Berlin), where the insect was certainly an accidental introduction. It has never been reported from the Malay Archipelago, and it appears to be absent from the West African Subregion. There is, as yet, no record from within the boundaries of the Belgian Congo, although I should expect it to occur in Upper Katanga.

I have seen a specimen of *H. capensis*, from the Canadian National Collection, labelled Okanogan Falls, British Columbia, May 20, 1913 (E. M. Anderson), without indication of a host.

HOSTS.—*H. capensis* was most probably originally a parasite of wild Carnivora in East and South Africa and in the Oriental Region. There are positive records of its having been found in the wild state, in East Africa, on lion, *Felis leo* Linnæus; striped and spotted hyena, *Hyæna hyæna* (Linnæus) and *Crocuta crocuta* (Erxleben); leopard, *Felis pardus* Linnæus; cheetah, *Acinonyx jubatus* (Schreber); civet cat, *Civettictis civetta* (Schreber); serval, *Felis capensis* Forster; and fox, *Vulpes vulpes* (Linnæus). Unfortunately there appears to be no record from any of the Indian wild Carnivora. It is nowadays most commonly found on domestic dogs, especially on the pariah dogs of India, which are said to be fairly swarming with "louse-flies." It has also been taken occasionally on some of the smaller antelopes, such as the duiker, *Cephalophus grimmia*

(Linnæus) (according to A. Loveridge, 1923, Proc. Zool. Soc. London, p. 734), and the dikdik, *Rhynchotragus kirkii cavendishi* (Thomas) (according to Speiser, 1915, Ark. f. Zool., IX, No. 13, p. 3). Waterston (1918, Bull. Ent. Res., IX, p. 155) mentions having taken it on a mule. Very rarely it strays to man, but I have not found any evidence that it actually bites human beings. Giglioli's record of "*O. chinensis*" from a bird (*Turdus obscurus*) seems rather open to question. Speiser (1905, Zeitschr. Syst. Hym. Dipt., V, p. 349), who examined Giglioli's type, found that his *O. chinensis* was a *H. capensis*.

The innumerable races of domestic dogs are certainly of polyphyletic origin. C. Keller (1902) traces them to at least six wild species of jackals and wolves. The pariah dog of Northern Africa and Southern Asia he derives from the common jackal of those regions, *Canis aureus* Linnæus, which quite possibly may have been one of the original hosts of *H. capensis,* from which the insect passed onto the pariah dog.

AFFINITIES.—These have been discussed under *H. equina.*

3. **Hippobosca fulva** Austen

Hippobosca fulva Austen, 1912, Bull. Ent. Res., III, p. 417 [♀; off hartebeest, *Alcelaphus lichtensteini* (Peters); Nawalia, Northeastern Rhodesia].

H. fulva is known only from the type-locality. To judge from Austen's description, it appears to be closely related to *H. capensis,* with which it agrees in size (wing 5 mm. long) and in the pale straw-yellow scutellum. The remainder of the thorax, however, is deep tawny and devoid of markings, while the veins of the wing are uniformly ochraceous. The main structural difference seems to be found in the venation: "third longitudinal vein straight and much closer to second longitudinal vein and costa than in case of *H. capensis* v. Olfers, so that the submarginal cell is conspicuously narrower than in the species mentioned."

4. **Hippobosca maculata** Leach

Hippobosca maculata Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 7, Pl. XXVI, figs. 11-13 (no sex given; East Indies). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 173, Pl. XIII, fig. 99 (♀). Schuurmans-Stekhoven, 1926, Parasitology, XVIII, p. 36, figs. I-V; Pl. IV, figs. 1-2 (♀ ♂, larva, puparium and biology).

Hippobosca variegata Wiedemann, 1830, "Aussereurop. Zweifl. Ins.," II, p. 603 (no sex given; Bengal and Tranquebar).

Hippobosca bipartita Macquart, 1842, Mém. Soc. Sci. Lille, p. 432; 1843, "Dipt. Exot.," II, 3, p. 275 (no sex given; Pondichéry, India).

Hippobosca egyptiaca Macquart, 1842, Mém. Soc. Sci. Lille, p. 431, Pl. XXXVI, fig. 5; 1843, "Dipt. Exot.," II, 3, p. 274 (♂; Egypt) [also spelled *aegyptiaca*, p. 274; and *oegyptiaca*, in Explanation of Plates, p. 294].

Hippobosca fossulata Macquart, 1842, Mém. Soc. Sci. Lille, p. 433; 1843, "Dipt. Exot.," II, 3, p. 276 (no sex given; Brazil or Chile). Speiser, 1904, Ann. Mus. Civ. Genova, XLI, p. 333.

Hippobosca sudanica Bigot, 1884, Ann. Soc. Ent. France, (6) IV, Bull. Séances, p. lix (♀; off horses; eastern Sudan).

Hippobosca sivæ Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 235 (no sex given; East Indies).

Hippobosca calopsis Bigot, 1885, Ann. Soc. Ent. France, (6) V, p. 236 (no sex given; Ceylon).

Hippobosca aegyptiaca var. *bengalensis* Ormerod, 1895, The Veterinary Record (August); 1896, Indian Mus. Notes, IV, 2, p. 80 (no sex given; off horses; Bengal).

Specimens Examined.—Uganda: Turkana, Morongole, Northeastern district (Dr. H. Owen). Belgian Congo: Loka, off cattle, May 9, 1909 (Bovone). French West

Africa: Upper Volta River, off horse (E. Roubaud). Abyssinia: Darai, Harar Province (Barnum Brown). Zanzibar: (W. M. Aders). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Mauritius (D. de Charmoy). Madagascar: Tananarive (Lamberton); Mandritsara (F. R. Wulsin). India: Sohawa, Shilum (H. E. Cross); Calcutta. Southern Arabia: Aden, common on oxen, May 9, 1927 (J. Bequaert). Philippines: Alabang (M. B. Mitzmain).

DISTRIBUTION.—*H. maculata* is at present found over a very large area, but much of this is undoubtedly due to accidental introduction by man. In the Oriental Region, it is known from Persia, India, Ceylon, the Sunda Islands, and the Philippines. It also occurs in Arabia. In Africa it is very widely distributed, although much more common in the eastern parts than in the West and the South. There are records from Egypt, the Anglo-Egyptian Sudan, Eritrea, Abyssinia, the French Sudan, Sierra Leone, French Guinea, the Gold Coast, Northern and Southern Nigeria, northern Cameroon, French Equatorial Africa, Uganda, the Belgian Congo, Kenya Colony, Somaliland, Zanzibar, Portuguese East Africa, Transvaal, Madagascar, Mauritius and the Seychelles. It has not been reported from northwestern Africa nor from south of the Orange River, so that it appears to be mainly a tropical insect.

HOSTS.—Nowadays *H. maculata* occurs most commonly on domestic cattle and equines (horses, donkeys and mules), sometimes also on camels. There are no reliable records of its having been found on wild animals. The specimens taken by Neave in the Luangwa Valley, Rhodesia, off a waterbuck, *Kobus ellipsiprymnus* Ogilby, and which he listed as *H. maculata* (1911, Bull. Ent. Res., I, 4, p. 313), were evidently part of the material on which *H. hirsuta* Austen was based. According to Austen (1909) *H. maculata* occasionally bites man.

The decided preference of *H. maculata* for cattle makes it extremely probable that it was originally a specific parasite of one of the wild ancestors of this domestic animal. The origin of the domestic races of cattle has given rise to endless discussions. The most sensible view appears to be that expressed by C. Keller (1902), who admits two ancestors. The usual, larger type of cattle, now prevalent in Europe and America, was derived most likely from a wild species of Central Europe, the urus or "Ur," *Bos primigenius* Bojanus, which survived in the feral state until the beginning of the seventeenth century of our era. The more stubby, zebu type, usually kept in Eastern Africa, Southern Asia and Malaysia, had probably as ancestor the banteng, *Bos sondaicus* Schlegel and Muller, of the Oriental Region, still living in the wild state in some of the islands of the Malay Archipelago. The distribution of *H. maculata* corresponds surprisingly well with that of the zebu type of domestic cattle, so that one may suppose that the insect was originally an ectoparasite of the wild banteng. It would be of great interest to discover the fly on *Bos sondaicus* in the wild state.

It must be mentioned that no hippoboscid flies have ever been found on the water buffalo of Southern Asia nor on any of the African wild buffaloes. These animals are only remotely related to the domestic races of cattle.

AFFINITIES.—*H. maculata, H. rufipes* and *H. hirsuta* form a group of closely allied species, which differ from all the other members of the genus in having a row of setæ on the base of the third longitudinal vein and only one well-developed pulvillus. They also agree in most other peculiarities, except those mentioned in the key. The differences which separate them may appear slight, yet they are undoubtedly of specific value. I suspect that, before man contributed to extend their geographic and host range, every one of these species was confined to a rather small territory and to one or a few related hosts. *H. maculata* was probably then a parasite of wild cattle in the Oriental Region. *H. rufipes* lived on the wild equines of South Africa. *H. hirsuta* was restricted to the large antelopes of tropical Africa, as it is even nowadays.

H. maculata is rather variable in color, so that it has been fair game to the "splitters," as may be seen from the above list of synonyms. I hardly believe that any of these names are worth retaining, even for varieties, and certainly none of them represent geographical races. Speiser (1900, Ann. Mus. Civ. Genova, XL, p. 560) states that in typical *H. maculata* the ground color of the thorax is black, while in the var. *aegyptiaca* Macquart it is reddish brown. It remains to be shown whether the reddish and black forms are geographically segregated. If they occur together, they may well be due to the age of the specimens, or even to their state of preservation.

I cannot regard *H. fossulata* Macquart as anything but a slight variation of *H. maculata.* Speiser (1904, Ann. Mus. Civ. Genova, XLI, p. 333) claims to have recognized *fossulata* in a specimen at the Vienna Museum, supposedly taken by Thorey in Surinam in 1859. This specimen differed from typical *H. maculata* only in having a chestnut-brown (not black) thorax, the three spots of the scutum mesonoti not connected, and the fore and middle legs with only the apex of the femora and two rings of the tibiæ brownish black. These variations, however, are readily matched in a series of *H. maculata.* Macquart was uncertain about the locality of his specimen. If the specimen seen by Speiser actually came from Surinam, it must have been introduced there with cattle from the Old World.

5. **Hippobosca rufipes** v. Olfers

Hippobosca rufipes v. Olfers, 1816, "De Vegetativis et Animatis Corporibus in Corpor. Anim. Reper. Comm.," I, p. 101 (not seen; type said to have been found on an ostrich at the Cape of Good Hope, by Lichtenstein). Austen, 1909, "Illustr. African Blood-Suck. Flies," p. 176, Pl. XIII, fig. 100 (♀).

Hippobosca albo-maculata Macquart, 1855, "Dipt. Exot.," Suppl. V, p. 128 (no sex given: "de l'Océanie, Cap des Aiguilles"; like the other Diptera described by Macquart in 1855 as coming from the "Cap des Aiguilles," this insect was obtained at Cape Aguilhas, South Africa).

Hippobosca albonotata Rondani, 1863, Arch. Zool. Anat. Fisiol., Modena, III, 1, p. 92 (no sex given; Caffraria).

Hippobosca maculata Macquart, 1835, "Hist. Nat. Ins. Dipt.," II, p. 638 (no sex given; Cape of Good Hope). Not *H. maculata* Leach.

Hippobosca wahlenbergiana Jaennicke, 1867, Abh. Senckenberg. Naturf. Ges., VI, p. 406, Pl. XLIV, fig. 13 (♀; Caffraria).

Hippobosca marginata "Macquart" van der Wulp, 1894, Tijdschr. v. Entom., XXXVII, Versl., p. lxvi (as a synonym of *H. rufipes* v. Olfers).

Hippobosca camelopardalis Roubaud, 1925, Bull. Soc. Path. Exot., Paris, XVIII, p. 466, fig. 1 (♀; off giraffe; between Tabora and Tibu, Tanganyika Territory).

SPECIMENS EXAMINED.—Belgian Congo: Boma, off a mule (J. Rodhain); Uele District (J. Rodhain); Matadi (J. Ghesquière); Elisabethville, off mules imported from South Africa, June 26, 1912 (J. Bequaert); Biano Plateau, July 11, 1923 (Nockermans); Kapiri, July, 1912 (Leplae). Tanganyika Territory: 25 miles east of Ikoma, off eland, *Taurotragus oryx pattersonianus* Lydekker (J. P. Chapin). Southwest Africa: Walfish Bay (Michael Bequaert); Aroab (W. S. Brooks); Windhoek. Cape Province: Windsorton, off cattle (H. Brauns); Kimberley (C. P. Lounsbury). Portuguese East Africa: Lourenzo Marques (C. W. Howard). Orange Free State: Jacobsdal (M. C. Mossol). Transvaal: Pretoria (R. Van Saceghem).

DISTRIBUTION.—This species was originally a South African insect, being now very common in the Cape Province, Basutoland, Southwest Africa, Orange Free State, Transvaal, Bechuanaland, and Natal. It is also found in Zululand and Southern Rhodesia. Its extension northward into Tanganyika Territory and the Belgian Congo may have been partly due to man. Wellman (1908, Bull. Soc. Ent. France, p. 77) has reported it from Benguella (Bihé and Chiyaka), and Austen (1909) from Angola (Bembe Mines, 7° 22′ S.). Walker (1849, "List Dipt. Brit. Mus.," IV, p. 1141) has listed it from the Congo. In recent years it seems to be spreading rapidly beyond its original area.

Hosts.—*H. rufipes* is nowadays primarily an ectoparasite of domestic equines (horses, mules, and donkeys). Although the type was said to have been obtained off an ostrich, it is more probable that the original host was one of the South African wild equines, *Hippotigris quagga* (Gmelin) or *H. zebra* (Linnæus), both of them formerly common in Cape Colony. There is, however, no record of hippoboscids having ever been taken on these animals. *H. rufipes* is also found at times on cattle and will occasionally settle on dogs or on man. Bedford (1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782) mentions having taken it on the blue wildebeest, *Connochoetes taurinus* (Burchell), in the Northern Transvaal. The finding of this parasite on the East African eland, by Dr. J. P. Chapin, is also of special interest.

H. camelopardalis Roubaud was taken on giraffe, *Giraffa camelopardalis* (Linnæus), in Tanganyika Territory, by my friend, Dr. J. Rodhain. It appears to be identical with *H. rufipes*, to judge from the excellent figure and the brief description; the latter, however, does not mention any of the morphological characters here used to separate the species of Hippobosca.

It was believed at one time by Sir Arnold Theiler that *H. rufipes*, as well as *H. maculata* Leach, were the carriers of a trypanosome (*T. theileri*) found in the blood of cattle in the Transvaal. But the possibility of infection from other sources was not excluded in Theiler's experiments. Moreover, *Trypanosoma theileri* is found all over the world, even in regions where cattle never are infested with hippoboscids, so that the role of these flies as transmitters is most improbable. Nöller's recent work seems to indicate that certain tabanids are the normal carriers of *T. theileri*.

Affinities.—These have been discussed under *H. maculata.*

6. **Hippobosca hirsuta** Austen

Hippobosca hirsuta Austen, 1911, Bull. Ent. Res., II, p. 169, fig. 1*a* (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; Mohokya, Toro Plains and northeast shore of

Lake Ruisamba; both localities in Uganda). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311 and 322. Kinghorn, Yorke and Lloyd, 1913, Ann. Trop. Med. Paras., VII, p. 297.

Hippobosca hirsuta var. *neavei* Austen, 1911, Bull. Ent. Res., II, p. 171, fig. 1*b* (♀ ♂; off waterbuck, *Kobus defassa* Rüppell; junction of the Mpamadzi and Luangwa Rivers, Upper Luangwa River, and Mid Luangwa River; all in Northeastern Rhodesia). S. A. Neave, 1912, *Loc. cit.*, III, pp. 311, 314 and 315.

Specimens Examined.—Belgian Congo: Rutshuru Plains, off waterbuck, *Kobus defassa* Rüppell, March 24, 1927 (H. Coolidge and C. Whitman); Western shore of Lake Edward, off the same host (H. Leboutte); Aka, Uẹle District, off the same host (J. Rodhain).

Distribution.—This species is known from Uganda and the adjoining northeastern regions of the Belgian Congo. The var. *neavei* occurs in Northeastern Rhodesia and Nyasaland.

Hosts.—*H. hirsuta* seems to be a specific parasite of waterbucks and allied antelopes. The host list includes, at present, *Kobus defassa* Rüppell, *Kobus ellipsiprymnus* Ogilby and *Adenota vardoni* (Livingstone).

Austen's var. *neavei* differs from the typical form only in the shape of the median, straw-yellow spot of the scutellum, which is small and more or less triangular, with apex of triangle resting on hind margin; instead of being large, rounded in front and flattened behind. In the few specimens which I have seen, the spot of the scutellum is of the typical form.

Affinities.—These have been discussed under *H. maculata.*

7. **Hippobosca struthionis** O. E. Janson

Hippobosca struthionis O. E. Janson, in E. Ormerod, 1889, "Notes and Descriptions of a few Injurious Farm and Fruit Insects of South Africa," p. 56, fig. 23 (no sex given; off ostriches; Mt. Steward, Cape Province, South Africa). Ormerod, 1890, Agri, Jl., Cape Town, II, p. 293. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 259 (♀ ♂); 1909, "Illustr. African Blood-Suck. Flies," p. 171, Pl. XIII, fig. 98 (♀). Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 1, p. 5. S. A. Neave, 1912, Bull, Ent. Res., III, pp. 311, 317, and 320. Bedford, 1927, 11th and 12th Repts. Dir. Vet. Res. South Africa, I, p. 782.

Hippobosca struthionis var. *massaica* Speiser, 1909, in Sjöstedt, "Wiss. Ergebn. Schwed. Zool. Exp. Kilimandjaro," II, Abt. 10, 3, p. 30 (off *Struthio camelus massaicus* Neumann; Tanganyika Territory near Mt. Kilimanjaro).

SPECIMENS EXAMINED.—Cape Province: many specimens without definite locality (C. P. Lounsbury); Willowmore, numerous specimens off ostriches, *Struthio camelus australis* Gurney (H. Brauns). Southwest Africa: Aroab (W. S. Brooks).

DISTRIBUTION.—*H. struthionis* has been recorded from the Cape Province of South Africa, Transvaal, Tanganyika Territory, and Kenya Colony. It probably occurs over the entire range of *Struthio camelus* Linnæus, which nowadays extends over the Arabian-Syrian desert, the Sudan, and parts of East and South Africa (see Reichenow, 1900, Die Vögel Afrikas, I, pp. 5-13). Even within historic times, however, this bird was more widely distributed in Africa than at present. In former geologic periods, the Struthionidæ covered also much of Central Asia and Southern Europe, as shown by fossil remains.

HOSTS.—This fly is a strictly specific parasite of the ostrich, all the living forms or races of which are now regarded as belonging to a single species. The parasite is unusually abundant on its host in South Africa.

AFFINITIES.—In many particulars *H. struthionis* occupies an isolated position in the genus and it is probably not related in any way to the other living species. In general appearance it is more like the usual bird hippoboscid flies than like the other Hippoboscæ. The legs are unusually long and slender, and the empodium is unique.

8. **Hippobosca camelina** Leach

Hippobosca camelina Leach, 1817, "Gen. Spec. Eprobosci. Ins.," p. 10, Pl. XXVII, figs. 11-14 [called *Hippobosca cameli* in the Explanation of Plates, p. 20] (no sex given; Egypt). Dufour, 1858, Ann. Soc. Ent. France, (3) VI, Bull. Séances, p. ciii (described as a new species, from Southern Algeria). Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176. Austen, 1903, Ann. Mag. Nat. Hist., (7) XII, p. 257. Theobald, 1906, 2d Rept. Wellcome Res. Labor. Khartoum, p. 92, figs. 48, 50, and 53; Pl. X, fig. 2.

Hippobosca bactriana Rondani, 1878, Ann. Mus. Civ. Genova, XII, p. 165 (no sex given; Persia and Massaua, Eritrea).

Hippobosca dromedarina Speiser, 1902, Zeitschr. Syst. Hym. Dipt., II, p. 176 (new name for the North African parasite of dromedaries, which Rondani called *H. camelina*).

SPECIMENS EXAMINED.—Palestine: Petra (W. M. Mann). Arabia: Akaba, off camel (W. M. Mann); Aden, off *Camelus dromedarius* Linnæus, May 9, 1927 (J. Bequaert). Somaliland: Berbera (A. D. Smith). Kenya Colony: Archers Post, Northern Guaso Nyero River, November 3, 1911 (R. B. Woosnam). Egypt: Lisht (A. Hrdlicka). Tunis: Djerba (A. Weiss).

DISTRIBUTION.—This parasite is found throughout North Africa, Egypt, Syria, Palestine, Asia Minor, Persia, Afghanistan, Arabia, the Sudan (as far west as Mauretania and the Senegal), and northeastern Africa (as far south as Kenya Colony). All of this territory is probably part of its original distribution. It has been introduced recently by man into Southwest Africa. Massonat (1909, Ann. Université Lyon, N. S. CXXVIII, p. 248) mentions a specimen of *H. camelina* collected off a horse in the Camargue, Southern France, the only record of the species, so far as I know, from the European shore of the Mediterranean.

HOSTS.—*H. camelina* is the specific parasite of the two-humped camel, *Camelus bactrianus* Linnæus, and of the one-humped dromedary, *Camelus dromedarius* Linnæus, which are now generally regarded as two domestic races of one single species. The ancestral form is found even now in the wild state in some of the deserts of Central Asia (Gobi, River Ob; western Mongolia). This wild ancestor had formerly a much wider distribution (see Keller, 1902).

AFFINITIES.—*H. camelina* is not closely allied to any other species of Hippobosca. The two pairs of vertical bristles and the complete abortion of the pulvilli are aberrant features not found elsewhere in the genus.

Rondani (1878) and Speiser (1902) have attempted to draw a specific distinction between the flies found on the camel and those from the dromedary, the supposed differences being entirely based upon color characters. After examining many specimens from different localities, I have reached the same conclusion as Austen (1903), that these two forms cannot be separated even as varieties. In coloration *H. camelina* is very variable, even in a lot taken from the same host in one locality. The variation affects the markings of the thorax, as well as the color of the hair on the fronto-clypeus and at the tip of the abdomen. Moreover, since the camel and the dromedary are only races obtained in domestication from a common ancestor, one could hardly expect specific or sub-specific differences in their parasites.

REARING THE LARVÆ OF *DERMATOBIA HOMINIS* LINN., IN MAN

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The following article presents some observations on the development of the larvæ of *Dermatobia hominis* when reared in man, and on the effects of an infestation of these larvæ upon the host. The results of studies on other phases of the interesting life-history and habits of this species of parasitic diptera will be presented in later reports.

In October, 1929, while seated at the edge of a small stream near Summit, Canal Zone, I captured a fly which was hovering about and which had several times alighted on my right knee. This fly proved to be a species of *Limnophora*, not a blood-sucker, and a number of eggs were found attached to her abdomen. An examination of these showed them to be eggs of *Dermatobia hominis*. Many of them had developed to the larval stage, the operculum at the hatching end being open and the minute larva inside of each being active and ready to leave its shell when a suitable host was provided.

Through the acquiring of these eggs a good opportunity was afforded for studying the development of the larval stage of *D. hominis* with man as the host, and in view of this it was decided to allow two of the larvæ to enter the skin of my arm.

October 9. At 4 P. M., about six hours after capturing the egg-bearing fly, the glass tube in which it was confined was unstoppered and inverted on the skin of my left forearm. The tube, which was about four inches long and one inch in diameter, allowed room for considerable movement on the part of the fly. The latter was quite active and would not rest on the skin except very momentarily, but kept up a continual dashing about in the tube. The larvæ were all protruding from the egg shells, but the swift movements of the fly seemed to prevent them from remaining on the skin for a sufficient length of time to allow them to crawl from the shells. This continued for about five minutes, and it was then noticed, with the aid of a hand lens, that as the fly dashed against the side of the tube one of the larvæ was left hanging to the glass. About one minute later this was repeated and a second larva was left crawling about on the inside of the tube. The fly was then removed and the two small larvæ inside the tube were picked up on the point of a needle and gently placed on my left forearm at about the upper third of the median flexor region. Since there were no abrasions of the skin at this area, an opportunity was given for observing the entrance of the larvæ into unbroken skin.

The two larvæ were placed in the skin slightly less than an inch apart, and each remained at exactly the site where it was placed. Neither of them could be detected as having moved even a quarter of an inch. They remained so motionless that at first it was feared that they had been injured by the needle in transferring them from the tube to my arm. After watching them closely with a 10 X lens for a few minutes, however, a few faint contractions could be seen, and it was also noted that the anterior, or larger, end of each larva seemed to be sinking very slowly into the skin. This large end of each larva seemed to be about one-third, horizontally, pressed into the skin, and was evidently securing traction through the use of the oral hooks and dermal spines, while the posterior end exerted a progressive forward motion. The larvæ were lying nearly parallel with the skin, and with but a slight arching near the posterior end, so that their position in relation to the skin surface was thus very oblique, and the penetration was at first beneath just the outer part of the skin.

One of the larvæ had practically all of its large anterior part imbedded in the skin in about thirty minutes. It was then able to obtain sufficient purchase with its spines, so that rapid progress was made and the posterior end was soon inside. At the end of 42 minutes from the time this larva was placed on my arm it was completely out of sight in the skin and could not be seen even with the aid of a lens. There was absolutely no sensation caused by the entrance of this larva until after the first thirty minutes. Then, as the posterior end was being drawn inside, a sharp pricking, which lasted for about two minutes, was experienced.

The second larva was much slower in effecting an entrance and required an hour and thirty-five minutes to bury itself completely in the skin. At the end of an hour approximately half of the anterior end was inside. At this time I rolled down my shirt sleeve and put on my coat to determine if the rubbing of clothing would loosen the larva or have any apparent effect upon its entrance. After spending about thirty minutes in walking about and in doing some work in the laboratory which necessitated using my arm rather actively, I removed my coat and inspected the larva. At this time it was all buried in the skin with the exception of the tip of the posterior end, and five minutes later that also was inside.

During the night following the entrance of these two larvæ into my skin a marked itching and pricking sensation at the sites of their location was experenced at intervals. Although this did not last more than half a minute at each time it occurred, it was sharp enough to awaken me several times during the night.

October 10. Fourteen hours after the entrance of the larvæ it would have been nearly impossible to locate them. Since I had ringed the sites with ink, however, and thus knew their exact situations, they could with the aid of a lens be detected as pinpoint raised areas which were slightly reddish. After twenty-four hours they were visible to the naked eye as slightly elevated tiny red dots. When viewed closely with the lens the tiny posterior ends of the larvæ could be detected slowing moving up and down in a pumping movement and forcing out minute quantities of fluid.

October 11. This evening a sharp itching was felt at two small pimples which were at first thought to be caused by mosquito bites. One of these was located at the midulnar margin of my right arm, approximately four and a half inches from the wrist joint. The other was on the internal surface of my right thigh about midway between the knee and perineum. When these were rubbed there seemed to be more soreness present than usually accompanies mosquito bites. My suspicions becoming aroused, a closer examination was made, and it was then found that each of the small lesions contained a larva of *D. hominis*. A further search showed two more of the larvæ infesting me. One of these was on the flexor side of my right wrist and the other on my right shin, about two inches below the lower margin of the patella. I had felt nothing which might indicate the presence of these last two larvæ, and it was only the tiny red pimples caused by them that revealed their presence to the naked eye. Apparently it had been just a case of carrying coals to

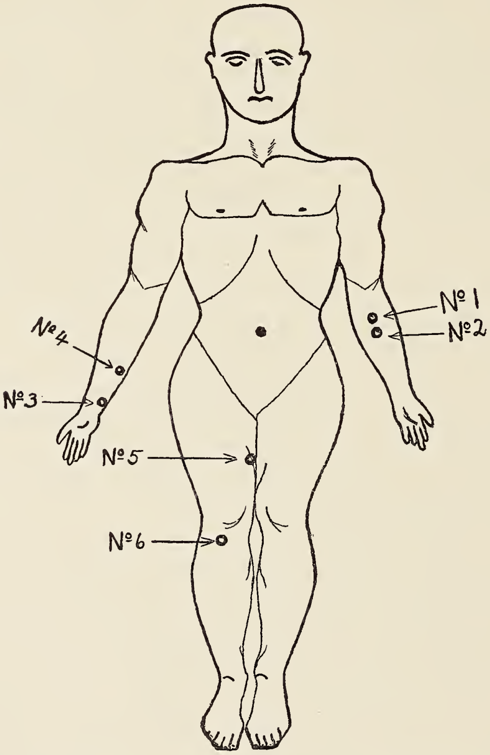

FIG. 1.—Diagram showing locations of the larvæ.

Newcastle when I allowed the two larvæ to enter my left arm, since I evidently was already infested with four of them at the time. It is quite certain that these four larvæ were deposited on me by the carrier fly while it was alighting on me just prior to its capture. This placed their entrance into my skin at about six hours earlier than when the two entered my left arm. Finding myself now infested with six of the larvæ I decided to allow them all to remain until they began to produce too great a reaction, either local or general. In order to record observations on the larvæ each one was given a number. The two on the left arm were numbered 1 and 2; the one at the right wrist was No. 3, in the right forearm No. 4, in the upper right leg No. 5, and below the right knee as No. 6. Nos. 1, 2, 4 and 5 were located in areas surrounded by considerable adipose and muscular tissues, while Nos. 3 and 5 were in situations surrounded mainly by fibrous tissue and with much less softer tissues.

October 16. Each lesion, or site of each larva, now appears as a bright red area, about three-eighths of an inch in diameter, and slightly elevated in the center. There is sufficient itching and pricking occurring to cause considerable discomfort. The irritation seems to be much greater during the evenings and nights than throughout the days. No. 6 proves an exception to this, since there is frequently a prolonged stinging or burning sensation experienced when I am walking. While I am at rest this larva seldom causes any annoyance. No. 4 seems to be causing the greatest irritation. This may be due to the location of this lesion on the lower surface of my right forearm, and thus subjected to considerable rubbing on desk and tables while I am at work.

October 17. Last night I was awakened by a severe itching and dull burning sensation at No. 4. The burning sensation seemed to feel more like an erosive burn caused by a strong acid than to contact with a hot surface. All the lesions are exuding serous fluid at times. That which comes from Nos. 1 and 4 is slightly tinged with blood.

October 18. Last night the lesions on both arms became very irritating and awakened me several times. There has also been considerable itching and pain today.

October 20. Yesterday and today there has been but little discomfort. The lesions now have the appearance of small boils. They are a deep red in color, swollen and with some induration of the surrounding area. The indurated area surrounding No. 4 is about an inch and a half in extent.

October 21. A severe stinging pain is occurring at intervals at Nos. 1 and 2 on my left arm. These two lesions are so close together that it is difficult to determine whether it is only one or both that cause the pain. There is also a severe itching at No. 5 and an occasional sharp, stabbing pain in No. 6.

October 22. During the night I was awakened several times by sharp stinging pain in Nos. 1 and 2. There was intense itching in No. 3 and on two occasions when I awakened during the night I found that apparently I had been scratching this lesion while still asleep. This morning a considerable area of the ulnar surface of my wrist was greatly swollen and an intense itching occurs when the skin is touched, even though it be at some distance from the lesion.

October 24. The lesions have increased in size and have more of the appearance of small boils which have "pointed" and erupted slightly. There is considerable oozing of serous fluid, blood-stained pus and dark-colored matter which I believe is digested blood being defecated by the larvæ. The exudate from the lesions is now sufficient to be quite disagreeable, owing to its staining clothing and bedding, and it is necessary to bandage all the lesions. It is to be regretted that the bandages were not applied earlier, so that the date of possibly a first molt of the larvæ might have been noted. It is my opinion that this molt occurred about October 21, and that the small amount of discomfort present on October 19 and 20 was due to the larvæ being in the first pre-molting period at this time and were not feeding and were quite inactive. Had the bandages been on the lesions at the time it is possible that some traces of the molted skins might have been found which would denote the time of the molt.

October 26. There seem to be three kinds of local sensations connected with the presence of the larvæ. The first of these is an intense itching of the skin of the area surrounding a lesion. This may be due to an infiltration of the tissues with the fæces of the larva and other fluids present in the lesions causing a slight cellulitis. This itching was not constant but occurred at frequent intervals, and is induced by even very slight friction in the vicinity of the lesion. The second sensation is a very irritating pricking which takes place in the lesion. This is probably caused by the rasping of the cutaneous spines or hooks on the larva during any movement of the latter. The third sensation is a sharp, stinging pain, which is believed to be produced by the tearing of the tissues by the oral hooks of the larva when it becomes necessary to use the hooks in order to excite the flow of serum or blood to serve as food.

October 29. Nos. 3 and 6 are now much more swollen than are the other four lesions which are located in areas of more adipose and muscular tissues. The four located in more favorable situations are but little swollen on the outside, but can be felt as hard nodules, each as large as a good-sized marble and seeming to extend into the subcutaneous tissues. During the past three days there has been less of the pricking sensation occurring. This may be due to the lesions becoming walled off so that each larva is to some extent encapsulated. Or, again, it may be due to wearing bandages over the lesions. When the latter were exposed to the air the exudate soon dried and formed small scabs that at times seemed to seal over the small openings of the lesions, and it is quite plausible to believe that in order to burst through these scabs some struggles were required on the part of the larvæ when it was necessary for them to take air or discharge fæcal matter. With the lesions bandaged the exudate is being continually absorbed and the holes left open and moist around the edge. A quite pronounced vesicular eruption has now appeared on both hands and wrists and on my right leg. This is accompanied by an intense itching and a slight oozing of serum from the vesicles.

October 31. During yesterday and today there have been several attacks of excruciating pain experienced from Nos. 3 and 4. This pain was possibly a nerve irritation caused by the oral hooks of the larvæ tearing the tissues. These attacks lasted from one to three minutes each time they occurred. Squeezing the arm just below the lesions seemed to stop the pains to some extent. These two lesions bled sufficiently to stain through the bandages several times today.

November 3. Drops of apparently unchanged blood oozes at intervals from Nos. 1 and 3 when the bandages are removed. Blood-stained serum is exuding from Nos. 2, 4 and 5. No pus is in evidence except a small amount from No. 6. When viewed with a lens at this time each larva may be seen pushing liquid from the hole with a quick, pushing, upward movement somewhat after the action of a plunger of a pump. The downward movement seems to draw back some of the fluid with each jerking back of the posterior end of the larva. When the end of a larva is retracted an occasional air bubble can be noticed coming up through the liquid. There has been very little pain or irritation caused by any of the lesions today.

November 4. A sharp pricking lasting several minutes has occurred at intervals during the day and early evening in No. 6. This lesion and the area surrounding it is quite red, considerably swollen and very sore to the touch. At about seven o'clock this evening when the bandages were removed for a while this larva was found to be pushing out a cast skin. The larva had molted, and since it probably needed more room in the hole for its future growth, was disposing of the cast skin. The movements of the larva caused the skin to emerge in its natural, round, tube-like form. As it came slowly out it formed a tiny crater about 2 mm. high around the hole and then continued to turn back upon itself with the posterior end of the larva pushing up through the center. From the manner in which the molted skin moved slightly from side to side it appeared as though the larva was pushing it up first at one side and then at the other, but keeping it about even so that the rows of hooks of each segment were all out before those of the next segment appeared. After observing the efforts of the larva with a hand lens for about three hours, it was estimated that about one-third of the cast skin was still in the hole. None of the other five lesions have caused very much discomfort.

November 5. This morning the molted skin from No. 6 was found all outside of, and still surrounding, the hole. This larva was quite active and caused considerable irritation during the day. None of the other five lesions caused much discomfort. The fluid is exuding in a smaller amount than usual, and it seems to be comparatively clear serum with the exception of that which is coming from Nos. 1 and 5, which is rather heavily tinged with blood. The other five larvæ are probably also preparing to molt.

November 6. The larva in No. 3 molted and ejected the cast skin during the A. M. Following the ejection of the skin, which was found adhering to the bandage, this lesion exuded a considerable amount of blood during the day. Frequent sharp, stinging pains at No. 6. This pain is so severe that at each attack it is necessary to remove the bandage and place a hand on each side of the lesion and press upward in order to stop the action of the larva. There is only a small amount of deep tissue surrounding this lesion and the larva is situated parallel with the surface of the skin.

November 8. Cast larval skins were ejected from Nos. 1, 2 and 4 this P. M. This leaves all the larvæ molted except No. 5. Both arms are now very sore, and sufficient bloom and serum is exuding from the lesions to stain through the bandages soon after they are applied.

November 10. No. 6 has caused excruciating pain at intervals throughout the day. During the evening one attack lasted for fifteen minutes and became almost unbearable. Pressing on the sides of the lesion and allowing cold water to run on it seemed to have but little palliative effect. This attack was followed by bleeding. Blood oozed from the lesion in a thin stream and continued until it had soaked three gauze pads that were applied one after the other. No. 1 also bled sufficiently at one time this evening to stain through the gauze pad, bandage, shirt sleeve and coat sleeve. During the night I awakened to find that this lesion was again bleeding and to the extent of soaking through the dressings and sleeve of my pajamas.

November 11. No. 1 gave the most trouble today. During the afternoon it suddenly developed a severe, deep-seated pain which seemed to extend for some distance up and down my arm. After this pain had lasted for about a minute, bleeding began. From the way in which the blood bubbled from the lesion it appeared as though it came from a small artery. This continued for several minutes until by applying cold compresses to the lesion it was induced to stop.

November 12. The exudate from No. 3 today consists largely of pus with a very fetid odor. Serum mixed with dark-colored digested blood and pus is oozing from No. 4. Several spasms of pain occurred during last night and today in No. 5. This pain was severe enough to awaken me several times during the night. No. 1 again bled profusely on two occasions today. The bleeding started both times soon after the bandage had been removed. The blood welled out in a small stream, and it was necessary to hold my arm beneath running tap water for some time before it ceased. These hemorrhages were sufficiently severe to cause me to consider the advisability of having No. 1 removed in order to prevent the possibility of losing a considerable amount of blood during the night while asleep. I have decided, however, to delay any action and await developments for another day or so. Both times that the bleeding occurred from this lesion it was preceded by a sharp, deep-seated pain which was sufficiently acute to cause a slight nausea.

November 13. The sharp pain and bleeding from No. 1 again occurred this afternoon just after a fresh bandage had been applied. Blood-stained serum is exuding from Nos. 2 and 5. Serum mixed with blood and pus is issuing from No. 5, while pus only is being discharged from No. 3. A cast larval skin was expelled from No. 5 today. All the larvæ have now molted with nine days' difference between the time the molted skin was ejected from No. 6 and No. 5. Both arms are now very sore and a lymphangitis extending almost from the elbow to the axilla of my left arm is evident. The epitrochlear and axillary lymph nodes of the left arm are enlarged to about the size of marbles and are tender to the touch. The nodes of the right arm are also swollen and tender, but not to the same extent as on the left side. A general feeling of lassitude which is quite marked has been experienced during the past few days.

This may be due to absorption of toxins from the lesions and may also be influenced by the many times that I am awakened each night by the larvæ. The lesions are now emitting a fetid odor which becomes very disagreeable if the bandages are not changed frequently. When they remain unchanged during the night the odor is extremely offensive in the morning.

November 14. During the night I was awakened by a severe pain in No. 3 and a contraction of the muscles of the wrist and forearm. This served to draw my hand back on the wrist, and I was unable to straighten the hand except by using my left hand. It was necessary to place the hand and wrist in cold water before relief was afforded. Considerable blood and serum oozed from this lesion following the pain and contraction. During the past few days this lesion has become much swollen and is very red and inflamed. The center of the lesion is taking on a dark purple appearance, although the aperture is well down on one side near the base of the swelling.

November 17. No. 5 is very painful and the muscles of the leg are stiff and sore to the touch, and is causing some lameness. All the lesions are oozing considerable serum and pus. I seemed to be quite feverish at one time when I awakened last night, but the feeling of lassitude was so great that no temperature was taken.

November 19. No. 3 has been causing severe pain and muscular contraction at intervals during the past four days and the wrist is very painful. No. 6 has been quite sore for several days, and this evening it was found that another opening had developed in it. This new opening is located on the side opposite the original opening and about where the anterior end of the larva seems to be. It is a question whether this second aperture is due to action of the oral hooks of the larva or to sloughing caused by pus inside the lesion.

November 20. No. 3 awakened me several times during the night by piercing and nauseating pain. This morning it was found that there were two more openings in this lesion and with serum and pus oozing from each. One of these openings is near the center of the lesion and the other at about where the anterior end of the larva is situated.

The development of this opening in the center of the lesion is evidence that these extra openings are due to ulceration.

November 21. Serum and pus with a very disagreeable odor is exuding from all the lesions at this time. At No. 3 the anal end of the larva is visible in the opening and the stigmal plates may be seen. The larva in No. 6 has been protruding from the opening about a quarter of an inch all day, regardless of whether the bandage is on or not. When the bandage and gauze are in place the protruding end of the larva makes a sort of a small burrow in the gauze pad. Several times during the day the larva twisted about rather vigorously as though it might be about to emerge.

November 22. The larva in No. 6 still remains with its posterior end protruding from the hole the greater part of the time. The pain from this lesion becomes so intense at times that it is almost impossible to walk until the paroxysm is over. These pains (although of frequent occurrence) are, fortunately, of short duration. Blood and serum issues from the new opening after each of these attacks. The larva in No. 3 seems to be enlarging the opening in the lesion today.

November 23. Larva No. 6 is still twisting about quite frequently and causing considerable pain. It continues to have its posterior end outside the hole and burrowed into the dressing during the greater part of the time. The dressings are very loose and would not prevent the larva from emerging. The dressings are removed frequently but the larva makes no attempt to come out any further when they are off. With the exceptions of Nos. 5 and 6 all the larvæ seem to be enlarging the apertures to the lesions. There is considerable discharge of serum, digested blood and pus from No. 5 today. The feeling of lassitude still continues and short spells of slight fever seem to occur at intervals. I am still being awakened many times during the night by the larvæ.

November 24. The posterior end of the larva in No. 2 protruded from the hole about a quarter of an inch this morning. When viewed with a lens the larva could be seen enlarging the hole by means of a rasping movement of the spines on its posterior end. The hole is now about

5 mm. in diameter. The larva looks larger and has a yellowish color. The larva in No. 1 has a reddish tint as though it is still taking blood as food. No. 6 is still protruding the greater part of the time and continues to be very painful. There is considerable discharge from No. 5 and much irritation present.

November 25. Larvæ Nos. 2 and 4 spent considerable time last night in enlarging the openings to the lesions occupied by them and they both emerged this morning. While in the bath taking a shower I noticed larva No. 2 as it came straight up out of the hole and dropped over on my arm. I immediately placed this larva in a test tube, and was about to return to the shower when I saw that No. 4 was protruding from the opening with a slight side to side weaving motion. It slowly and easily continued its emergence until it finally came entirely out with almost a slight spring. There was absolutely no pain or sensation as these two larvæ emerged, and had I not happened to see them as they did come out I should not have known that they were emerging. From the time when larva No. 1 began to enter my arm as a tiny larva until it emerged mature and ready to pupate was 46 days and 15 hours, while the period of infestation with No. 4 was approximately 46 days and 21 hours. These two larvæ emerged within ten minutes of one another. This is probably the first record of the exact time between entrance and emergence of a larva of *Dermatobia hominis.* This afternoon a sharp, stinging pain and much movement was felt in No. 6. The bandage was removed and the larva was found to be protruding somewhat more than it had been previously. During several minutes of observation the larva did not appear to be making any efforts to come out fruther and the bandage was replaced. About fifteen minutes later a movement was felt between the dressing and my skin, and an examination showed that the larva had emerged and after crawling nearly to the edge of the gauze pad was burrowing into the latter. There was no sensation felt with the actual emergence of this larva and it was only the movement of it against my skin that apprised me of the emergence. See Plate 13.

November 26. No. 3 gave numerous twinges of pain during the day and pus continued to ooze at times from the two extra openings in this lesion. There has been very little movement felt at Nos. 1 and 5 today. This evening the bandages were left off for a time and the larvæ were observed with a lens. Both these larvæ could be seen working vigorously enlarging the apertures to the lesions. This was done entirely by the spines on the posterior segments. They were rubbed against the side of the hole with a rasping motion, and this was carried on at first one side of the hole and then the other. It reminded one of enlarging a round hole with a round file. At intervals of from five to ten minutes each of the larvæ protruded from its hole for more than a quarter of an inch as though testing the diameter of the opening to see if it be large enough to permit the emergence of the larger anterior end. After protruding for a few minutes the larva withdrew within the lesion and again began its rasping on the edge of the opening. This continued for about three hours, when the bandages were again applied. There was considerable movement in No. 5 today and the escape of pus and digested blood from this lesion was sufficient to soak through the dressing twice during the day.

November 27. Larvæ Nos. 1 and 3 were quiet and gave very little trouble during the night, but this morning they became active and protruded so far that it was thought that they were about to emerge. No. 3 continued more or less movement during the early morning and the dressing was removed several times to see what was taking place. At each time the larva was partly out of the hole, but it always withdrew again after coming out about so far. At 10 A. M. a movement was felt on my skin at the lesion and upon examination the larva was found to be coming out. It appeared to be doing very little struggling, yet it slowly came from the hole and dropped over on my arm.

November 28. Larva No. 1 seems to be dividing its time between protruding for about half an inch and working very industriously at enlarging the hole, although the latter is now fully 5 mm. in diameter.

November 29. While I was taking a shower this morning, larva No. 1 protruded for nearly half an inch for a few moments, when it again withdrew. Ten minutes later it again began to come out, and this time continued very slowly and steadily to emerge. The emergence covered a period of about one-half hour. The exact infestation period of this larva was 50 days and 15½ hours.

December 3. The last larva, No. 5, has been alternating between enlarging the hole of the lesion and protruding its posterior end during the past four days, until it emerged some time between 12:30 and 6 o'clock this morning. It emerged and crawled outside the bandage without awakening me, and was found in the bed at 6 A. M. It was rather surprising to find that this larva was the smallest of the six. It was expected that since it had been located in an area with an abundance of muscular and adipose tissues together with its longer period in situ, about 54¾ days, that it would be the largest.

A slight exudate continued from the lesions until from three to five days following the emergence of the larvæ. Then as the discharge ceased and the swelling subsided the apertures soon healed.

With the exception of No. 6 the scars left by the lesions were very slight ones. Eight months later well-colored purple and brown spots still mark the sites of the two openings of No. 6.

The size and weight, taken within two hours after emergence of each of the larvæ were as follows:

Larva No.	Length	Diameter	Weight
1	22 mm.	10 mm.	0.692 gram.
2	20 mm.	9 mm.	0.575 gram.
3	25 mm.	11 mm.	0.725 gram.
4	24 mm.	11 mm.	0.740 gram.
5	20 mm.	7 mm.	0.480 gram.
6	20 mm.	8 mm.	0.520 gram.

Soon after each larva emerged it was placed in damp sand and sawdust to pupate. The pupation periods were from twenty-two to twenty-four days, at the end of which time the adult flies emerged.

Psyche, 1930 VOL. 37, PLATE 13.

DERMATOBIA HOMINIS

EXPLANATION OF PLATE 13.

Appearance of lesion No. 3 (at wrist) two days before the larva emerged, and of No. 4 eight hours after the larva emerged.

THE LOWER PERMIAN INSECTS OF KANSAS
PART 3. THE PROTOHYMENOPTERA

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The order Protohymenoptera was established by Tillyard (1924) to include a series of fossil wings contained in the Yale collection from the Lower Permian of Kansas. As indicated by the name, Tillyard believed that this group was ancestral to the Hymenoptera and was sufficient to prove that the Hymenoptera originated independently from the rest of the holometabolous insects (1926b). While it is true that certain morphological features of the Hymenoptera, such as the reduced wing venation, and the polynephric Malpighian system, remove the group from the true panorpoid orders; the results of morphological studies (Crampton, 1919, 1927) indicate that the Hymenoptera arose from the same stem as all the other insects with a similar metamorphosis.[1] It is therefore advisable for us to submit any paleontological evidence which seems inconsistent with this view to the carefullest examination.

Aside from phylogenetic consideratons, the question of the affinities of the Protohymenoptera has close bearing on the interpretation of the wing venation in the Hymenoptera; for the specialized condition of the wings in the Hymenoptera has prevented entomologists from satisfactorily homologizing the veins with those of other insects. As a result, a number of different systems of venational

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[1] Handlirsch, however, has held the opposite view (1906-08).

nomenclature are being used in the Hymenoptera, each more or less limited to a certain group of families. Comstock, MacGillivary, and a few others have proposed systems intended to homologize the venation with that of other groups, but hymenopterists in general have not accepted these schemes. More recently Tillyard has advanced a new and radically different system (1924) based on the assumption that the Protohymenoptera exhibit the primitive condition of the venation in the hymenopterous line of descent; and he believes that through this interpretation the whole of the homologies of the veins at once "becomes clear and of the utmost simplicity" (1926c, p. 256).

Let us consider briefly the opinions expressed by other entomologists on the affinities of the Protohymenoptera, and on the new system of venation in the Hymenoptera, based on these fossils. Lameere (1927) accepts the insects as representatives of the group ancestral to the Hymenoptera, and also adopts the venational interpretation, with a few slight modifications. Handlirsch (1927), however, has briefly (without discussion) suggested that the fossils are more closely related to the Megasecoptera than to the Hymenoptera, and may actually belong to that order. Cockerell (1927) appears to accept the fossils as of hymenopterous nature, but suggests some changes in the interpretation of the veins. Crampton (1927) agrees that the fossils are hymenopterous and he favors the venational system.

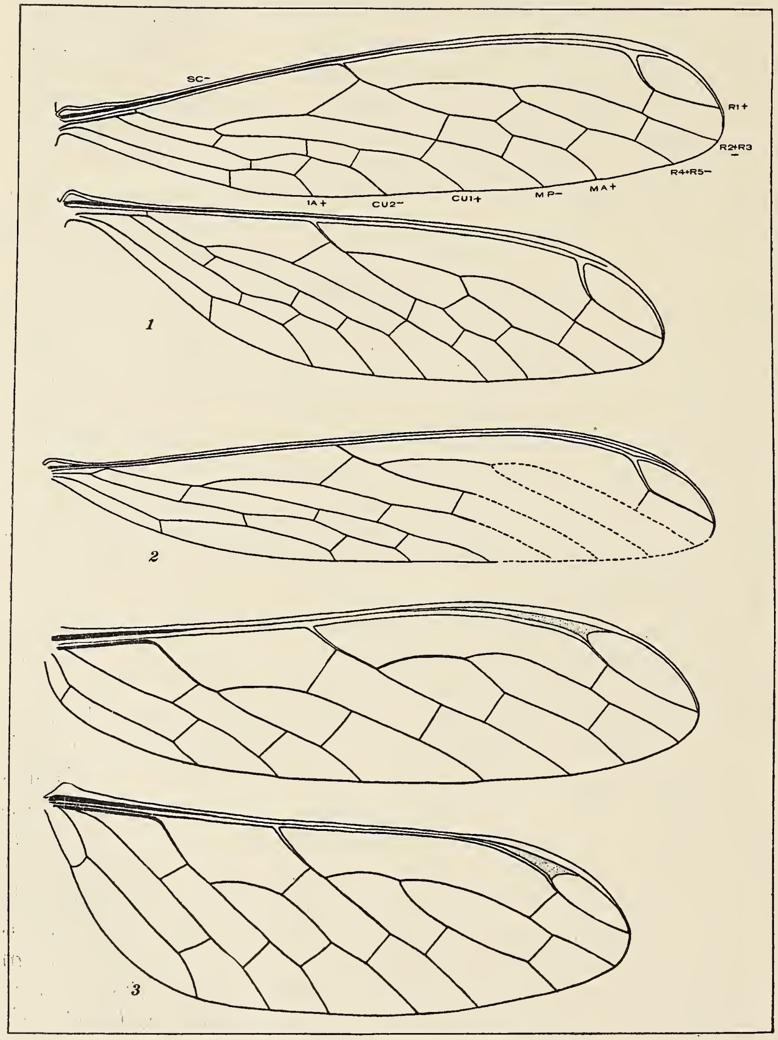
Martynov has studied the question more thoroughly. In 1928, while collecting insects in the Permian beds (Kazan) of Northwest Russia, he discovered a single wing which resembles both the Kansan Protohymenoptera and certain Carboniferous Megasecoptera. From his study of this fossil and the Kansan specimens in the Yale collection, he concluded that the Protohymenoptera were really close to the Megasecoptera, and not related to the Hymenoptera. "They belong to my subdivision Paleoptera containing all orders, chiefly extinct, in which the wings were outspread when at rest. Indeed, both *Protohymen permianus* Till. and *Permohymen schucherti* Till. were found in the outspread condition of the wings, and even Tillyard thinks that such a discovery 'suggests very strongly that the insects of this family rested with outspread wings, as did the Palæodictyoptera and Megasecoptera.' It is true that among Asthenohymenidæ specimens 'occur, in which one wing is laid exactly over the other,' but the same takes place in the case of the Zygoptera, and this manner of resting in Zygoptera in no way proves that they are allied to the Hymenoptera or to any other Holometabola or even Neoptera. When an insect of the division Neoptera, for instance a Neuropteron, puts its wings on the dorsum in roof-shaped manner, the upper surface of the wings is exposed upwards and outwards, with costal borders placed beneath, along the support. On the contrary, in Zygoptera, as also in some Agnatha, when at rest the upper surfaces of the wings are turned inwards, with the dorsal borders looking upwards, i. e., the manner of folding the wings at rest is very different in the Zygoptera and in the Neoptera. Perhaps some forms of Protohymenoptera could 'fold' their wings back on the dorsum, but such 'folding,' in all probability, recalled that of the Zygoptera or of the Agnatha, but not of the Hymenoptera or Copeognatha, or in general, of the Neoptera. Further, such facts as that the fore and hind wings in the 'Protohymenoptera' were of almost equal size, had the same wing venation, were not linked together in flight by hooklets, or by any hairs, and had some veins, at least the costa and the radius 'serrated along its outer edge, in exactly the same manner as that in Odonata,' clearly manifests that the whole order belongs to the division Paleoptera and is allied partly to the Megasecoptera, partly to the Odonata and Protodonata. The membrane of the wings was glassy, as in Agnatha or in Megasecoptera or in Odonata. Many Neuroptera, Mecoptera and Hymenoptera and even some Trichoptera have also a glassy membrane, but in these groups the wing membrane is furnished not only with chetoids . . . but also with numerous true hairs. In the wings of the Hymenoptera both chetoids and hairs are present everywhere, though the hairs sometimes become very small, minute. The wing membrane in the Odonata and Agnatha, as well as, probably, in Megasecoptera, is really glassy, i. e., perfectly deprived of both hairs and chetoids. One should suppose that in the group ancestral to the Hymenoptera we must inevitably find some remains of hairs, similar to those which exist, for example, in the wings of the fossil Mecoptera. Thanks to the kindness of Professor Schuchert . . . I examined the excellent remains of both Protohymen and Permohymen, but I could not perceive any hairs on their wings. The wing of the new genus Aspidohymen from Tikhie Gory also does not show any traces of hairs. Thus, such a character of the wing membrane manifests also that this order is very far removed from the order Hymenoptera, as well as from the remaining Holometabola, and is allied rather to the order Odonata, etc., i. e., belongs to the division Paleoptera." (1930, p. 79.)

In 1927, one year previous to Martynov's discovery of the Russian specimens, I was fortunate enough to secure fifty-five representatives of the Protohymenoptera in the limestone at Elmo, Kansas. At that time it was already clear that a knowledge of the structure of the body of these insects would help us immensely in determining their affinities. Since the Yale specimens consisted only of wings, the chief aim of our collecting trip was to obtain specimens of Protohymenoptera with the body preserved. In this respect we were most successful; several fossils show portions of the bodies, and one specimen includes nearly the whole body, with the minutest details perfectly preserved. Through the kindness of Professor Dunbar I have been able to examine the twenty-three specimens of Protohymenoptera in the Yale collection, including Tillyard's types; and I have also found four additional fossils in Dr. Sellards' collection. From my study of all these representatives of the group, totaling eighty-two, I am convinced that Handlirsch and Martynov were correct in their assumption that the Protohymenoptera were megasecopterous. The evidence which leads me to this conclusion will be presented after the description of the fossils.

It will be observed in these descriptions that I have employed an interpretation of the venation which differs from that used by Tillyard, as well as from that offered by Martynov. These changes in the nomenclature of the veins are necessary because both of these authors have been mislead by an erroneous conception of the convexities and concavities of the veins. The evidence for this will also be considered after the descriptions.

The Kansan Protohymenoptera were separated by Tillyard into two families, Protohymenidæ and Asthenohymenidæ, based largely on the degree of development of the pterostigma, the presence or absence of the radial sector, and the relative lengths of the second anal vein. This classification is a convenient one and is used here, but the most striking difference between the families lies in the width of the costal space. The second of the characteristics mentioned by Tillyard must be omitted, for the radial sector is present in all forms. One change in the terminology of the families must be made. In 1906 Sellards described one of the Kansan fossils in his collection as *Doter minor;* this specimen consisted of the thorax, abdomen, two long cerci, and the two front wings, but the latter were so twisted and folded that he was unable to determine satisfactorily the nature of the venation. He was not sure of the taxonomic position of the fossil, but believed that it was related to the Protephemeroidea. Handlirsch (1919) placed it within a separate family, Doteridæ, and doubtfully considered it to be a Paleodictyopteran. When I examined this type specimen in 1927 at Austin, Texas, I observed at once from the nature of the wing membrane and the venation that it belonged to the genus Asthenohymen, which Tillyard had just described. From the photograph, drawings, and notes which I made at that time, I am now able to recognize it as the same species which Tillyard called *A. dunbari*, the commonest of all the Protohymenoptera in the Elmo limestone. Of course this identity is not obvious from Sellards' figure of *Doter minor*, for the distortion of his fossil and the fact that the insect possessed an unusual type of venation prevented Sellards from obtaining a correct idea of the venation. This synonymy requires us to change the name of the genus from Asthenohymen to Doter, and the corresponding family name to Doteridæ. It is interesting to note that Dr. Martynov has observed (1930, p. 85) a similarity between the venation of Doter, as figured by Sellards, and the venation of Asthenohymen, and he has suggested that Doter may be a Protohymenopteron. Dr. Martynov deserves to be con-

Psyche, 1930 VOL. 37, PLATE 15.



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gratulated on the keenness of his observation and the accuracy of his conclusion.

FAMILY PROTOHYMENIDAE

Fore wing: costal margin very slightly convex, nearly straight; costal space present at very base of wing only; Sc rather long, extending a short distance beyond the origin of Rs; R close to the costal margin, except at the very base; R1 diverging downward distally, away from the pterostigma; pterostigma very slender; Cu straight at base of wing; Cu1 and Cu2 diverging near the base; 9-14 cross-veins.

Hind wing: a little shorter and broader than fore wing, and differently shaped; venation similar.

Protohymen Tillyard

Protohymen Tillyard, Amer. Journ. Sci. (5) 8 (44) : 113, 1924.

Fore wing; very slender, subpetiolate; R remaining in contact with the costa to the pterostigma and joined to the costal margin by a heavy cross-vein distad of the pterostigma; Cu1 diverging backward directly after its origin; 13-14 cross-veins. The positions of the cross-veins, designated by Tillyard as generic features, are subject to great individual variation; but the cross-vein between 1A and the hind margin is always remote from the base of the wing.

Hind wing: more petiolate than fore wing; Cu more remote from R+M at the base than in the fore wing.

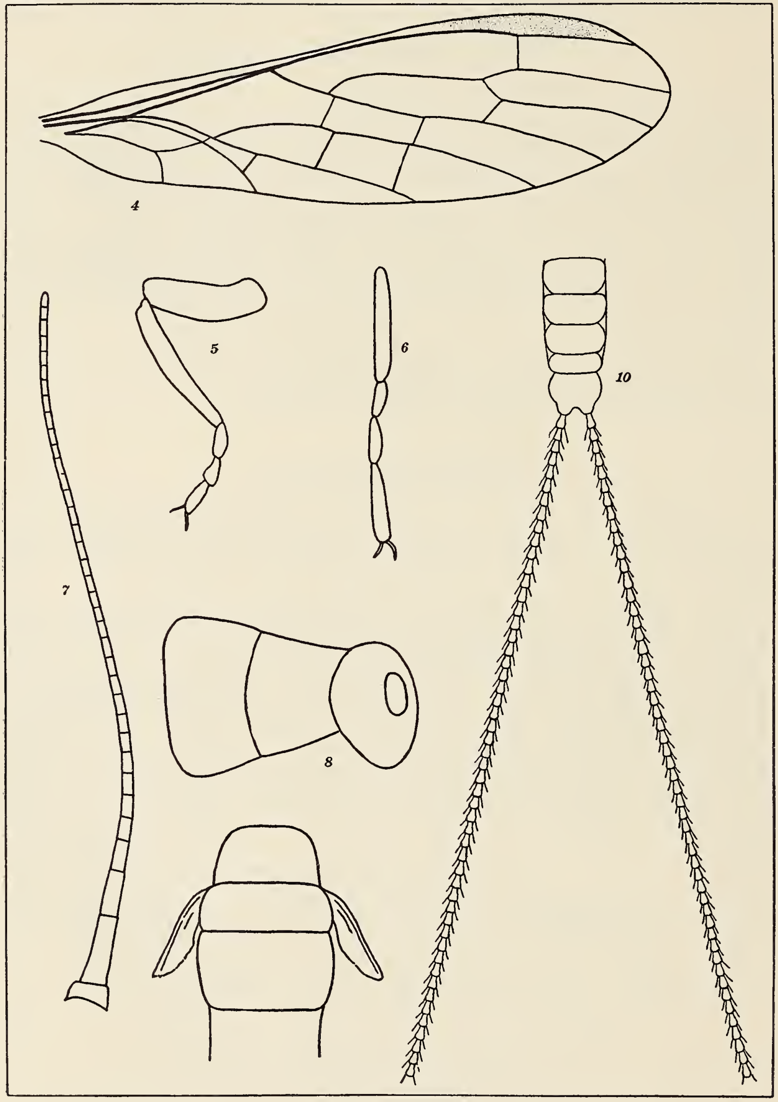
Genotype: *Protohymen permianus* Tillyard.

Protohymen permianus Tillyard

Figs. 1, 11

Protohymen permianus Tillyard, Amer. Journ. Sci. (5) 8 (44) : 114, 1924.

Psyche, 1930 VOL. 37, PLATE 16.



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Protohymen permianus Tillyard, Amer. Journ. Sci. (5) 11 (61): 58, 1926.

Fore wing: length, 10-13 mm.; width, 3 mm.; at the base the costa bends outward slightly, but there is no precostal area; R comes in contact with the costa before the divergence of Cu1 and Cu2, and at the middle of the pterostigma it diverges downward toward the apex; Cu2 strongly undulated. Cross-veins: one between R1 and R2+3; one between R2+3 and R4+5; two between R4+5 and MA; two or three between MA and MP; one between MP and Cu1; two or three between Cu1 and Cu2; two between Cu2 and 1A; one or two between 1A and the hind margin; the cross-veins between 1A and the hind margin are always attached to the distal half of the anal vein.

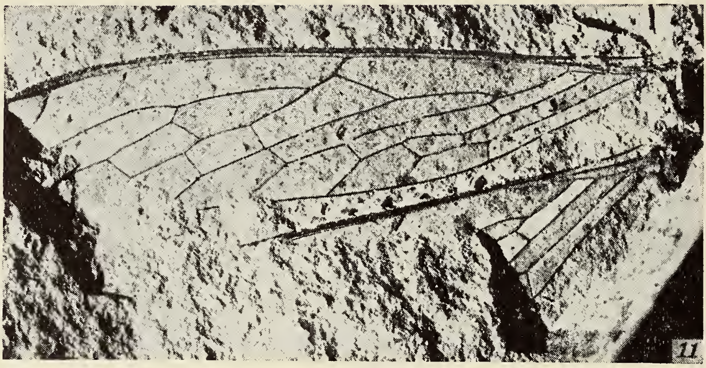
Hind wing: length, 9-11 mm.; width, 3.5 mm.; venation nearly identical with that of the fore wing; the length of the oblique vein between MP and Rs+MA is less than in the fore wing.

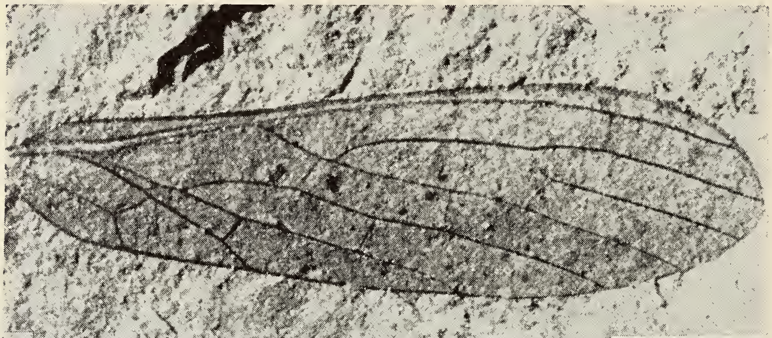
Holotype: No. 5001 (hind wing), Peabody Museum, Yale University; paratype: No. 5002 (fore wing), Peabody Museum; No. 1702, Tillyard collection.

In the Harvard collection there are ten specimens of this species, as follows: No. 3060ab, fore and hind wings complete, with fragments of head and thorax; No. 3061ab, fore and hind wings, folded together, but well preserved; No. 3062ab, hind wing, complete; No. 3063ab, fore wing, nearly complete; No. 3064ab, one pair of fore and hind wings (J. W. Wilson, collector); No. 3065ab, hind wing, complete except for the base; No. 3066ab, basal third of wing; No. 3067, middle third of wing; No. 3068ab, distal third of wing; No. 3070ab, basal two-thirds of wing. All specimens collected by F. M. Carpenter, unless otherwise indicated. In the Sellards collection there are two specimens: No. 1068, distal two-thirds of fore wing; No. 1558, distal third of wing.

The holotype specimen of this species is well preserved, but the base of the wing is missing. Since none of the other Yale specimens have this part preserved, Tillyard's figure is incomplete at the base. The wing is longer and more nearly petiolate than he supposed. The subcosta is

Psyche, 1930. PLATE 17.


11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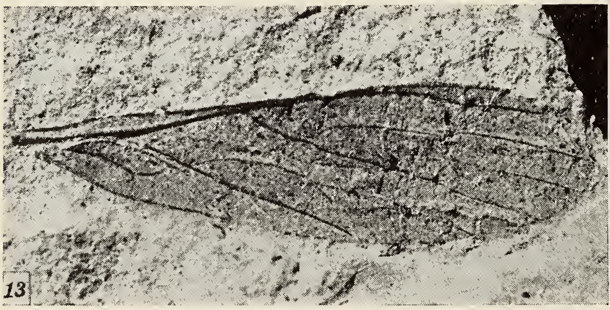
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14

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not well preserved in the Yale material, but in several of the new fossils it is very clear; it does not extend to the pterostigma as thought by Tillyard. The pterostigma is also differently formed than shown in his figure; the photograph accompanying his paper (plate 4, fig. 1) demonstrates clearly the true nature of this structure. The costa and R1 widen slightly in the region of the pterostigma, so that there is no space formed between these veins until R1 diverges towards the apex. R1 appears to fork here, but in reality, as I shall show later, the upper "branch" which connects R1 to the margin is a modified cross-vein. There is considerable variation in the distribution of the cross-veins, and sometimes a cross-vein may be absent altogether or an extra one added. The holotype specimen has two cross-veins between 1A and the hind margin, but all the other specimens I have seen possess only one here. The short vein, resembling a cross-vein, between the base of Cu1 and R+M is apparently the basal part of MP.

Protohymen elongatus n. sp.

Fig. 2

Fore wing: length, 20 mm.; width, 3.5 mm.; extremely slender and pointed; R1 separating from the costa at the beginning of the pterostigma, so that there is a distinct space between these veins in the region of the pterostigma (text fig. 1); Cu1 diverges upward after its separation from Cu2, and touches R+M; Cu2 only very slightly undulated; cross-veins distributed essentially as in *permianus*, but the one between 1A and the hind margin is attached to the middle part of the anal vein.

Holotype: No. 3069ab, Museum of Comparative Zoology; F. M. Carpenter, collector.

This species is based on a well-preserved and nearly complete fore wing. The only part missing includes the area between the terminations of MP and R1, along the posterior border. *Elongatus* can readily be distinguished from the previous species by its more slender habitus and the corresponding tenuity of the veins.

Permohymen Tillyard

Permohymen Tillyard, Amer. Journ. Sci. (5) 8 (115), 1924.

Fore wing: very broad; R1 remaining in contact with costal vein only a little beyond the origin of Rs; pterostigmal space wider than in Protohymen, narrowly triangular; R1 without a definite cross-vein between it and the costal margin in the region of the pterostigma; Cu1 remains parallel to R+M and in contact with it for some distance after its origin; 9-10 cross-veins; cross-vein between 1A and the hind margin is attached close to the base of the wing.

Hind wing: much broader than the fore wing, especially at the base; venation similar.

Genotype: *Permohymen schucherti* Tillyard.

Permohymen schucherti Tillyard

Permohymen schucherti Tillyard, Amer. Journ. Sci. (5) 8 (44): 116, 1924.

Permohymen schucherti Tillyard, Amer. Journ. Sci. (5) 11 (61): 61, 1926.

Fore wing: length, 13 mm.; width, 3.5 mm.; costal margin bends outward at base; R1 comes in contact with costa just before termination of Sc; Cu2 straight; cross-veins: one between R1 and R2+3; one between R2+3 and R4+5; one between R4+5 and MA; two between MA and MP; one between MP and Cu1; two between Cu1 and Cu2; one between Cu2 and 1A; one between 1A and margin of wing.

Hind wing: length, 12 mm.; width, 4 mm.; pterostigma a little broader apically than in fore wing; venation similar.

Holotype: No. 5003, Peabody Museum; counterpart, No. 1704b, Tillyard collection.

In the Harvard collection there are four specimens of this species, as follows: No. 3071, fore wing complete; No.

3072a, apical half of wing (fore?); No. 3073, hind wing, complete and splendidly preserved; 3074ab, base of hind wing. In the Sellards collection I find one specimen, No. 308 (reverse, No. 309), fore wing, complete except for apex.

The holotype specimen consists of a very nearly complete fore wing and hind wing, with parts of the corresponding pairs. The bases of the fore wings are obscured by an abrupt bend in the surface of the rock, and the bases of the hind wings are missing entirely. Tillyard was therefore not able to obtain a clear vision of the venation at the base of the wings, and his figure of this part is incorrect. Cu1 is undoubtedly united with Cu2 at the base of the wing, but it runs along in contact with R+M for quite a distance before diverging backwards; this is essentially the same structure as in Protohymen, only in that genus Cu1 diverges from R+M much nearer to the base of the wing. The subcosta cannot, of course, be seen in the holotype, but it is clearly preserved in several of the Harvard specimens. It is a strongly developed vein, extending only a short distance beyond the posterior divergence of Cu1. The apex of the fore wing is not pointed as figured by Tillyard. The apex of the left wing, on which Tillyard apparently based his figure, is distorted by an irregularity in the surface of the rock. The true shape of the wing is clearly shown in the right wing of the holotype, as can be seen in the photograph accompanying Tillyard's paper (plate 4, fig. 2).

FAMILY DOTERIDAE

Fore wing: anterior margin slightly concave, the maximum curvature near the base of the wing; costal margin serrated; costal space broad basally, present along the entire anterior margin of the wing; Sc short, not extending as far distad as the origin of Rs; R remote from the costal margin at the base, approaching nearer to it at the middle of the wing; R1 starts to diverge from the costa near the middle of the wing; pterostigma weakly developed, slenderly oval; frequently the pterostigma is bordered distally by a well-developed cross-vein between R1 and the anterior margin; stem of Cu curved posteriorly at the base; Cu1 and Cu2 diverging close to the base; 7-8 cross-veins.

The fore and hind wings have not been distinguished.

Doter Sellards

Doter Sellards, Amer. Journ. Sci. (4) 23: 355, 1907.

Doter Handlirsch, Denkschr. Akad. Wiss. Wien. Math. Naturw. (96) 82: 22, 1919.

Asthenohymen Tillyard, Amer. Journ. Sci. (5) 8 (44): 117, 1924.

Asthenohymen Tillyard, Amer. Journ. Sci. (5) 11 (61): 63, 1926.

Head small, oval; eyes small, oval, placed close together; antennæ long and slender with about 35 segments, the two basal ones several times as long as broad, the others about twice as long as broad; thorax broad; prothorax long, narrow, mesothorax short, metathorax about twice as long as the mesothorax; legs short and stout; femur and tibia nearly equal in length; 3 tarsal joints, the last bearing a pair of small claws; the last tarsal segment of front legs only a little longer than the others, the last tarsal joint of the middle legs about twice as long as the others; hind legs and basal segments of abdomen unknown; terminal four abdominal segments about twice as broad as long; last segment rounded posteriorly, bearing two very long, slender cerci, consisting of at least 52 segments (probably more), each segment with a pair of divergent hairs.

Wings moderately slender, nearly subpetiolate, apex well rounded; Rs divides into R2+3 and R3+4 about half way between its origin and termination; R2+3 terminates at the very apex; cross-veins constant in number, but variable in position.

Genotype: *Doter minor* Sellards.

Tillyard placed seven species of the Kansan Protohymenoptera in the genus Asthenohymen. Apparently the members of this genus rested with their wings back over the abdomen, as thought by Tillyard, for all the specimens with the four wings preserved are in that position. This condition, of course, obscures or confuses the venation to such an extent that we cannot distinguish satisfactorily the fore and hind wings. Two specimens in the Yale collection are preserved in the position of rest, but both of these lack the bases of the wings. When we consider the species of Doter, therefore, we must bear in mind that we may be describing the fore and hind wings as separate species, although from the condition in the Protohymenidæ we should not expect much difference in the venation.

From a study of the forty-three specimens of Doter in the Harvard collection and the eleven Yale types, I am convinced that several of the species described by Tillyard are not valid. The data on which I base this conclusion follow:

(1) *Dunbari.* The true shape of the wing of the holotype is not shown in Tillyard's figure. The basal part of the holotype wing was hidden when he studied it by a small piece of the limestone matrix. When I removed this chip of rock, the whole wing was exposed, revealing an outline much like that in Tillyard's figure of *affinis.* The subcosta is quite clear in the type and is represented in Tillyard's figure, although it is not labeled. The costal space is broader basally than shown in the figure. There is a distinct cross-vein between R1 and R2+3 (R and M, Tillyard), although the supposed absence of this cross-vein was given by Tillyard as a key character.

(2) *Affinis.* The base of the wing of the holotype is not very well preserved, but nevertheless it shows a broad costal space. I am not sure whether the basal cross-vein between Cu1 and Cu2 is present or not; at any rate, the wing is so faintly preserved here that its possible absence in the fossil might easily be due to lack of preservation.

(3) *Gracilis.* The holotype wing is not so slender as shown in the figure; the costal space is broadened basally even more than represented. The pterostigmal area is distinctly darkened, even more than it is in the type of *stigmatazans.* A careful examination of the holotype under

good illumination shows that there is unquestionably a cross-vein between Cu2 and 1A basally, and another one between 1A and Cu2. The supposed absence of these cross-veins was used by Tillyard as key characters. 1A does not join Cu at the base of the wing, but curves downward and away from the stem.

(4) *Stigmatazans.* The type specimen has a broad costal area at the base, and is shaped like the preceding fossils. The pointed appearance of the apex, as shown in Tillyard's figure, was due to the fact that the anterior margin was covered by a piece of limestone when he studied it. By removing this fragment, I found that the apex was more rounded. The pterostigma, which is slightly darkened, is not so noticeable as that in *gracilis.* There is no cross-vein visible at the base between Cu1 and Cu2, but this absence is due in all probability to the poor preservation at that part of the wing; the cross-vein at the distal ends of these veins is exceedingly faint.

(5) *Kansasensis.* This wing is not so narrow as shown in Tillyard's figure (see my photograph of the type, fig. 12); when I first examined the fossil, the anterior margin was partly covered by a piece of the matrix, but this was removed and the costal area was found to be as broad as in the other fossils. The removal of this chip also exposed the subcosta, which is partly shown in Tillyard's figure, although it seems to have been confused by him with the base of the radius. The type specimen is splendidly preserved and is one of the best representatives of Doter which I have seen.

(6) *Stenobasis.* The apical portion of the holotype wing was not missing, as stated by Tillyard, but only covered by the limestone. When this matrix was removed and the whole wing exposed, I found that the shape was identical with that of *affinis;* the costal area is broadened basally. The pterostigmal area, not seen by Tillyard, is fully as dark as that in *stigmatazans.* Even under the best illumination and highest power of binocular magnification I could not discern 1A in the type, or the two cross-veins shown by Tillyard between 1A and Cu2. The base

of the wing is distorted by an irregularity in the surface of the rock.

(7) *Pusillus.* The costal space is broadened basally, not straight, as shown in the figure of the type; otherwise the shape of the wing is correctly represented. The pterostigma region is slightly darkened. The piece of limestone covering part of the posterior margin was removed, exposing the termination of Cu1; this vein is unbranched, not forked as supposed by Tillyard. There is a faint trace of a cross-vein between Cu1 and Cu2 at the base, but none is apparent distally.

From these observations on the type specimens and a comparison with the Harvard fossils, I believe it is clear that most of the characteristics which Tillyard used to distinguish the species do not hold. Furthermore, I am certain that none of the type specimens have the very base of the wing preserved. Most of the Harvard fossils also seem to have the base of the wing broken away at a point near the maximum width of the costal space; but several of the specimens show a more basal part, where the costal space narrows again, and the posterior margin bends inward considerably, the wing becoming subpetiolate. This I believe to represent the true shape of the wing in the

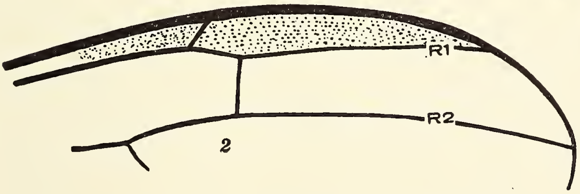


FIG. 1. Pterostigma of *Protohymen elongatus* n. sp.

FIG. 2. Pterostigma of *Doter minor* Sell., with cross-vein; specimen No. 3101, Mus. Comp. Zool.

genus *Doter* (see fig. 13). In classifying the wings of these insects, therefore, I consider *dunbari*, *gracilis kansasensis* and *stenobasis*, to be one species, which must be called *minor* Sellards by priority. *Affinis* and *stigmatazans* seem to comprise another species, chiefly distinguished from *minor* by the remoteness of 1A and Cu2; but these wings may be only the hind pair of the foregoing. By page precedence the name of the species must become *affinis*. *Pusillus* is removed all the other wings by its greater width.

Doter minor Sellards

Plate 2; text fig. 2; fig. 12, 13, 14

Doter minor Sellards, Amer. Journ. Sci., (4) 23: 355, 1907.

Doter minor Handlirsch, Denkschr. Akad. Wiss. Math. Naturw. (96) 82: 22, 1919.

Asthenohymen dunbari Tillyard, Amer. Journ. Sci. (5) 8 (44): 117, 1924.

Asthenohymen gracilis Tillyard, Amer. Journ. Sci. (5) 11 (62): 66, 1926.

Asthenohymen kansasensis Tillyard, ibid, p. 67.

Asthenohymen stenobasis Tillyard, ibid, p. 68.

Length of body, excluding cerci, 4 mm.; length of antennæ, 3.5 mm.; length of cerci, 10 mm. Wing: length, 7-8 mm.; width, 2-3 mm.; slender, subpetiolate, broadest beyond the middle; costal space narrow at base, widest opposite the point of divergence of Cu1 and Cu2; R+M straight at base, diverging upwards rather abruptly; Cu1 and Cu2 usually close together at base, diverging distally; 1A fused with Cu at very base; pterostigma always present, but frequently only weakly preserved; cross-veins: one between R1 and R2+3; one between R3+4 and MA; two between MA and MP; two between MP and Cu; two between Cu1 and Cu2; one between Cu2 and 1A; frequently a cross-vein is present in the pterostigmal region; posterior margin indented at the base.

Type: No. 62 Sellards collection, showing the thorax, abdomen, cerci, and folded wings.

In the Harvard collection there are twenty-five specimens of this species, aside from fragments; these are Nos. 3075-3094, and 3111-3115. The more important of these are as follows: No. 3078ab, complete wing; No. 3082ab, complete to very base; No. 3085ab, complete and finely preserved, the subcosta being very clear; No. 3086ab, complete, also with a distinct subcosta; No. 3111ab, nearly complete wings, with thorax and cerci; 3112ab, base of wing, head, thorax, and fine antennae; No. 3113ab, a whole specimen, thorax well preserved; No. 3114ab, most of wing and cerci; No. 3115ab, parts of wings, head, thorax, abdomen, legs, antennæ and cerci, all finely preserved. Tillyard has figured (1926a, p. 61) the "remains of head, thorax and legs" as preserved in specimen No. 5043ab of the Yale collection, showing three ocelli and one mandible. I have examined this specimen under various types of illumination and from all angles, but have been unable to make out any of the details which Tillyard has figured.

Doter affinis Tillyard

Asthenohymen affinis Tillyard, Amer. Journ. Sci. (5), 11 (61): 65, fig. 2.

Asthenohymen stigmatazans Tillyard, ibid, p. 66, fig. 4.

Length of wing, 7.5 mm.; width, 2.3 mm. Venation similar to that of *D. minor,* but 1A is remote from Cu2 and not connected with it by a cross-vein; wing broader at the base than *minor;* pterostigma weakly formed.

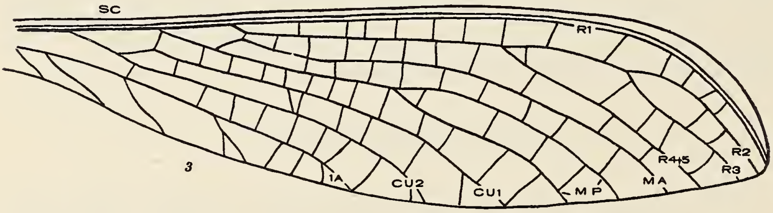
Holotype: No. 5050a Peabody Museum; counterpart in Tillyard collection. In the Harvard collection there is a complete wing of this species, No. 3095ab (F. M. Carpenter, collector). This species may represent the hind wing of *minor.*

Doter pusillus Tillyard

Asthenohymen pusillus Tillyard, Amer. Journ. Sci., (5) 11 (61) : 68, fig. 7.

Length of wing, 5-7 mm.; width, 2-3 mm. Wing broad, especially at the base, but the costal space is not quite so broad as in *minor;* pterostigma is rather well developed; 1A is short and remote from Cu2, but is connected with it by a cross-vein.

Holotype: No. 5051, Peabody Museum. In the Harvard collection there are two fine specimens of this species: one of these (No. 3097ab) is about the size of the type, 5 mm. long; the other is 7 mm. long, but otherwise identical. As I have stated above, Tillyard erroneously thought that this species was characterized by a forked Cu1. Both the Harvard fossils show two cross-veins between Cu1 and Cu2, although only one was apparent in the faintly preserved holotype.



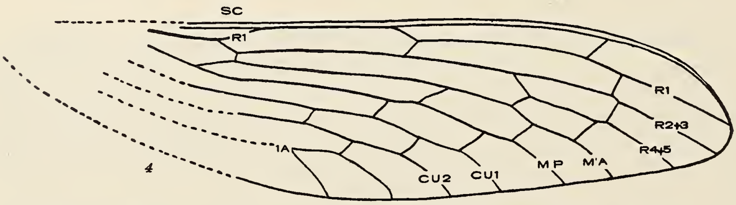


FIG. 3. Fore wing of *Aspidohymen triangularis* Brogn., from the Carboniferous of France (after Brongniart).

FIG. 4. Wing (hind?) of *Aspidohymen extensus* Mart., from Russian Permian (after Martynov).

THE VENATION OF THE PROTOHYMENOPTERA

Having considered the new fossils and the additional information which they give us on the wing structure of the Protohymenoptera, we are in a position to investigate the venation and to attempt to homologize the veins with those in other insects. Lameere, Martynov, and Tillyard have shown in recent years that the main longitudinal veins in an insect's wing are either convex or concave, and that the convexity or concavity is always constant for that vein. Thus, the subcosta, when viewed from the upper surface of the wing, is always concave ($^{-}$), R1 always convex ($^{+}$), Rs concave, etc.[2] In the more primitive insects, or at least in those with a fairly complete venational system, the convexities and concavities are strongly developed. Consequently, a well preserved fossil wing of such a type has the relief of the veins also preserved, and this is a great aid in identifying the veins and homologizing them with those in the wings of recent insects. Of course in the case of fossils, the *obverse* half presents the impression of the ventral surface of the wing, so that when we look at this half, we see the veins in the same relief as if we were viewing the original wing from the dorsal surface; that is, Sc is concave, R1 convex, etc. Conversely, the *reverse* half of the fossil is formed by the impression of the upper surface of the wing, so that we see the veins in the same relief as if we were looking at the wing itself from below; that is, Sc is concave, R1 convex, etc. Now the "key" to the identity of the two halves of a fossil wing is the subcosta; for it is the first vein in the wing below the anterior margin and it is present in nearly all insects. The subcosta is therefore easily recognized by virtue of its position, and when we find it concave in one-half of the fossil, we know we are dealing with the obverse piece, with the convexities and concavities of the veins just as on the dorsal surface of the wing itself. When we find the subcosta convex, we know we have the reverse half, with the relief of the veins in the negative position.

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[2] Of course when we state that a vein is convex or concave, we imply that we are observing the veins from the upper side of the wing.

When I commenced my study of the Protohymenoptera in the Harvard collection, I was astonished to find that in the *obverse* halves of the fossils (with Sc concave) the convexities and concavities of the other veins were directly opposite those which Tillyard described as characteristic of the Protohymenoptera; all the veins which he had indicated as convex (${}^{+}$) were concave (${}^{-}$) in my specimens, and *vice versa.* The explanation of this became clear, however, when I examined the Yale types which Tillyard had studied. In Protohymen and Permohymen the subcosta is crowded between R^{+}M on one side and the costa on the other; only at the very base of the wing (see fig. 1) is it free and independent of these other veins, and here only can it be seen distinctly. In all the Yale specimens, as I have previously mentioned, the bases of the wings are either obliterated or very poorly preserved; consequently Tillyard was unable to see the subcosta where it was best developed. In the Doteridæ (Asthenohymenidæ) the subcosta is free from R and the costa, but it is quite short. Tillyard seems to have had some difficulty in identifying the subcosta in the Yale specimens of Doter, and concluded that it was "obsolescent." He says, "A peculiarity about this genus is the difficulty of determining the exact limits of the obsolescent Sc, the main vein R, and the delicate traces of the basal portions of M and Cu running beneath. This seems to be due to the fact that both costa and R are somewhat widened and flattened veins, while Sc and the basal part of M and Cu are very slender and faint. . . . It is possible that both Sc and Rs are really fused with R right to its apex. . . ." Here again I believe that Tillyard's difficulty was largely due to the fact that the bases of the wings of the Yale specimens of Doter were not well preserved, if preserved at all; this I have already mentioned in connection with the shape of the wings. The holotype *kansanensis* is the one exception to this, but when Tillyard examined this specimen, the base of the anterior margin was partly covered by a piece of limestone, as shown in his figure. When I studied the type, I removed this chip of rock with a needle, exposing the subcosta for nearly its full length. With the assistance of the photographer of the Peabody Museum I obtained a fine photograph of this specimen, and it is reproduced here to show how well the subcosta really is developed in Doter (fig. 12). Only one-half of this specimen is now at the Peabody Museum, the other being in Dr. Tillyard's collection; the Yale half has the subcosta strongly concave, and is therefore the obverse. Now, when I compared this half with the obverses in the Harvard collection, I found that the convexities and concavities of all the veins agreed exactly. This means that Tillyard, who was not able to locate the subcosta in his specmens, and who consequently lacked the key to the identification of the two halves of the fossils, *confused the obverses with the reverses, so that all the veins which he thought were convex were really concave,* and *vice versa.* Consequently the veins of the Protohymenoptera cannot be interpreted as Tillyard supposed, for his R1 is really a concave vein, his Rs convex, etc. Martynov also made the same mistake in his interpretation of the veins in the Russian Protohymenoptera, *Aspidohymen extensus.* Unfortunately, the whole anterior border of the specimen was obliterated and did not show the subcosta. Apparently Martynov assumed that Tillyard's idea of the convexities and concavities was correct and based his own interpretation of the veins in Aspidohymen on the reverse.

We have now to identify the veins in the protohymenopterous wings according to our corrected understanding of the convexities and concavities of the veins. But the interpretation of the veins in this group is by no means an easy task; even a casual examination shows that several of the veins which existed in the primitive insect wing have been lost. The venation of the Protohymenoptera has been reduced so far that I do not believe we can homologize the veins with those in other insects until we have learned something of the ancestral condition of the venation and determined which veins have disappeared.

Martynov has already concluded from the nature of the wing membrane and the position of the wings at rest that the Protohymenoptera were close relatives of the Megasecoptera. Fortunately many details of the body structure of the Commentry Megasecoptera have been made known to us through the researches of Brongniart

(1893) and Lameere (1917), and we can now compare them with the corresponding features of the Protohymenoptera. All of the Megasecoptera possessed a pair of long multi-segmented cerci, identical with those which we have observed in the Protohymenoptera; no other insects which have been found (except a few Paleodictyoptera) had cerci of such a nature. The segmentation of the thorax and abdomen, the structure of the antennæ, and the contours of the head were also very similar to those of the Protohymenoptera. The fore legs of some of the Megasecoptera were undoubtedly raptorial (Lameere, 1917), while others were of the simple walking type, resembling those of the Doteridæ. The exact number of tarsal segments in the Megasecoptera is not known, but Lameere believed that he could distinguish five segments in one of the Commentry fossils. In Doter, as we have seen above, there were only three tarsal segments, but this difference is really of no significance, for in some of the recent orders the number of tarsal segments is equally variable.[3]

The body structure of the Protohymenoptera, therefore, not only agrees with Martynov's conclusions, but adds strong evidence in support of the view that the Protohymenoptera were very closely related to the Carboniferous Megasecoptera.

Let us now compare the wing venation of the two groups; can we derive that of the Protohymenoptera from the one found in the Megasecoptera? The most complete and detailed figures of the megasecopterous wings are those contained in Brongniart's classic account of the Commentry fossils, and I base my discussion of these wings chiefly on his work, for there are no unquestionable Megasecoptera known from the American Carboniferous. In particular, Brongniart's enlarged diagram of the wing of Aspidothorax is very useful and is reproduced here (text fig. 3). When we compare the wing of Protohymen with this figure, we at once note that there are two longitudinal veins less in the Protohymenopteron than in the Megasecopteron. In Aspidothorax the radial sector originates before the middle of the wing and gives rise to three

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[3] As in the Plectoptera, where the number is from five to one.

branches, R2, R3 and R4+5. The next vein is the media, which is fused with R basally according to Brongniart's figure; it diverges posteriorly a short distance before the origin of Rs, and then divides into its two main branches, MA (+) and MP (−). Shortly after its origin MA bends upwards towards Rs and is connected with it here by a short, stout cross-vein. MA is unbranched, but MP is forked near the middle of the wing. Cu separates from R close to the base of the wing and promptly divides into Cu1 and Cu2. In some of the Megasecoptera, as Mischoptera (plate 30, fig. 6), the anterior media (MA) not only bends towards Rs, but *actually fuses with it* for a short distance; and Cu1 diverges towards MP at its base. Now in Aspidohymen, the Russian Protohymenopteron (text fig. 4), Rs originates as in the Megasecoptera; R2+3 and R4+5 separate off as in Aspidothorax, but the former is unbranched. Hence, the structure of the radial sector in Aspidohymen is readily derived from that of the Megasecoptera by the elimination of the fork in R2+3.

When we pass to the more highly developed wing of Protohymen, we find that MA has fused with Rs at its base, just as in some of the Megasecoptera. The free basal piece of MA, between its origin and junction with Rs, is very long and decidedly convex, not flat like a true cross-vein, as it was interpreted by Tillyard and Martynov.

Now if we examine the posterior media in the Protohymenoptera we at once note that it is not forked as in the Megasecoptera; the posterior branch of MP is the other vein which has been lost in the Protohymenoptera. In certain of the Megasecoptera, as I have already mentioned, the basal part of Cu1 curves upwards towards M, just as MP approaches Rs. Unfortunately, this part of the wing of Aspidohymen is missing, but in *Protohymen permianus* there is a short vein, resembling a cross-vein, between the base of Cu1 and R (see fig. 11). In *Protohymen elongatus*, Permohymen, and Doter, Cu1 bends upward and actually fuses with R at this point. Now in order to obtain this condition present in Protohymen from that of the Megasecoptera, we have only to suppose that Cu1 coalesced with MP at the base just as MA fused with R. According to this interpretation the "cross-vein" between

Cu1 and R at the base is really the free, short piece of the stem of M. This tendency for MA to coalesce with the radial sector, and MP to coalesce with Cu1 is found in nearly every order of insects where there is a marked reduction in the venation. Whether my conception of the changes in the structure of the media is correct or not, the fact remains that the convex vein just below Rs in the Protohymenoptera can only be MA, and the concave vein before Cu1 must be MP. The nature of the modifications which resulted in the elimination of the two veins is perhaps not so obvious; but by merely carryng out the coalescence already suggested or begun in the Megasecoptera, we obtain conditions so strikingly similar to what we actually find in the Protohymenoptera that I believe the process outlined above is the correct one.

So few are the specializations in the wings of the Protohymenoptera over those of the Megasecoptera that we have in this fact further proof of the very close affinity of these two orders. It is true that we postulated such a relationship at the beginning of our discussion of the wing venation in the Protohymenoptera; but the ease with which we can derive one type from the other is itself an indication of such an association. From all aspects, therefore—wing structure, body structure, and wing venation—the evidence points to the one conclusion. I am therefore led to agree with Handlirsch's original suggestion, that these insects are not only allied to the Megasecoptera, but are actually members of that order. They undoubtedly constitute a distinct suborder (Protohymenoptera), as specialized Permian representatives of the true Carboniferous Megasecoptera (suborder Eumegasecoptera).

There are two modifications in the wings of some of the Protohymenoptera which were not considered above, because they are obviously of no more than generic or specific importance. I refer to the broad wings of Permohymen, and the formation of a pterostigma in the Protohymenidæ. Some students of insect phylogeny may object to the idea of deriving insects with broad wings like those of Permohymen from insects with narrow or subpetiolate wings like those of the Carboniferous Megasecoptera; for petiolation is usually considered a modification of the normally broad wings, exemplified in the Paleodictyoptera. But when the venation of the wing is not altered during the process of change in the shape of the wing, the broadening is of specific or even individual importance only. Many examples of this can be found in recent groups. In the Asilid genus Leptogaster the wings are frequently subpetiolate, while in Ospriocerus and Pogonosoma they are remarkably broad. In the Empidæ the wings are often subpetiolate, but in some species, as Rhamphomyia, they are enormously broadened, and almost oval. In this latter family also the broadening of the wings is frequently a secondary sexual characteristic of the male. But in none of these insects is the venation changed as the wings widen, aside from shift in the direction of the veins in the anal region. On the other hand, when the process of change in shape is accompanied by numerous modifications of the venation, then the breadth is of great phylogenetic value. I have already shown the impossibility of deriving the anisopterous dragon-flies from the petiolate Zygoptera, for here numerous changes in the venation would be necessary. In the genus Permohymen, however, we are dealing with the former type of modification in the shape of the wing, where there is no alteration of the veins. Aside from slight difference in the direction of the anal veins, the venation is exactly like that of Protohymen, which is as petiolate as the Carboniferous Megasecoptera. The assignment of such a broad-winged insect as Permohymen to the Megasecoptera is therefore not at all objectionable.

The pterostigma in the Protohymenidæ is a simple structure, much less of a specialization than Tillyard had supposed. In Aspidohymen there is no pterostigma, R1 being remote from the costal margin at this point; but there is a strong, oblique cross-vein connecting R1 with the costa in the pterostigma region. In *Protohymen permianus* R1 fuses with the costa up to the pterostigmal area, where it diverges downward to the apex of the wing; the pterostigmal cross-vein is present, and even more strongly developed (R1 of Tillyard). In *Protohymen elongate* R1 is slightly removed from the costa in the pterostigmal region, and the wing membrane between the veins is thickened and darkened. In Permohymen R1 is even more removed from the costa; the pterostigmal cross-vein is only weakly formed, as a slight thickening of the apical edge of the pterostigma itself. The Doteridæ have only a very feeble pterostigma; R1 is remote from the margin, and the area between is slightly darkened. In most specimens there is no pterostigmal cross-vein, but in other specimens of the same species there is a definite cross-vein here. The pterostigma in the Protohymenoptera is very primitive in structure and does not, therefore, eliminate them from the Megasecoptera; it is merely another slight specialization developed in connection with the reduction of the venation.

RELATIONSHIP WITH THE HYMENOPTERA

Now in demonstrating that the Protohymenoptera are megasecopterous we do not *necessarily* prove that they have no connection with the Hymenoptera. Only the wording of the question becomes slightly changed: were the Hymenoptera evolved from the Megasecoptera? If we attempt to derive the Hymenoptera in this way, we at once remove the order from all the other holometabolous insects, unless we postulate that they also originated from the Megasecoptera. The latter assumption hardly deserves consideration, for the Megasecoptera were far more specialized than the lower members of the panorpoid orders. The former proposition—that the Hymenoptera were evolved separately from the other holometabolous insects and developed complete metamorphosis independently—has already been offered by Tillyard (1926b). He says, "The fossil evidence is now fairly strong that there were three distinct groups of holometabolous insects which evolved a pupal stage independently of one another in the Permian period. These are (a) the Mecopteroid orders, namely, Mecoptera, Neuroptera, Paramecoptera, Paratrichoptera, Diptera, Trichoptera, Lepidoptera, and Siphanaptera; (b) the Hymenopteroid orders, Protohymenoptera and Hymenoptera; and (c) the Coleopteroid orders, Protocoleoptera, Coleoptera, and their parasitic offshoot, Strepsiptera."[4] Although I cannot agree with Tillyard's statement that the fossil evidence indicates this polyphyletic origin of holometabolism, it is clear that the question of the relationship between the Protohymenoptera and Hymenoptera is a complicated one and not easily answered.

So far as the body structure of the Protohymenoptera is concerned, there is really nothing definite either way. Of course we should hardly have expected to find such well developed cerci in the direct ancestors of the Hymenoptera, but that is only an indication that the body structure of the Protohymenoptera was much more primitive than the wing venation. The three-segmented tarsi of Doter are more specialized than the five-segmented ones in the primitive Hymenoptera; but some of the more primitive, unknown Protohymenoptera may have had five-segmented tarsi also. I believe, however, that Martynov's arguments, based on the nature of the wing membrane and the position of the wings at rest, are definite proof that the Protohymenoptera had no connection with the Hymenoptera; at least his arguments are sufficient to make Tillyard's conclusions seem doubtful.

But even if it is true that the Hymenoptera are derivatives of the Protohymenoptera, and that the venation of the former has evolved from that of the latter, the venational system which Tillyard proposed for the Hymenoptera must be changed, for I have shown above that Tillyard had erroneously interpreted the veins in the Protohymenoptera by confusing the obverses with the reverses. The veins which he designated as M1 and M2 in the Hymenoptera (1924, p. 119, fig. 4) would be branches of Rs; his M3+4 would be MA; his Cu1 would be MP; and so forth with the rest of the veins. In other words, if we

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[4] A few remarks may be necessary on the Carboniferous *Sycopteron symmetricum* Bolton (Commentry). The specimen on which this species was based is poorly preserved, and lacks the base and apex of the wing. Bolton considered the fossil to be a possible relative of the psocids, but Tillyard (1927) regarded it as a Carboniferous representative of the Protohymenoptera. Martynov thinks that Bolton's opinion is "not improbable." For my own part, I fail to find anything in the fossil which is at all reminiscent of the Protohymenoptera; the few features of the wing that are preserved seem to be more orthopteroid than anything else.

accept Tillyard's theory that the Protohymenoptera were the ancestors of the Hymenoptera, we must reject his interpretation of the hymenopterous venation based upon that association and substitute another one founded upon the corrected interpretation of the protohymenopterous wings advanced in this paper. Conversely, if his system of hymenopterous venation is the correct one, we must reject his doctrine of the origin of the Hymenoptera.

As I have mentioned above there are a few structures in the Hymenoptera (such as the polynephric Malphigian system) which isolate the group slightly from the other holometabolous insects; but so many other features are identical in the Hymenoptera and panorpoid orders that we can safely say that the comparative morphology of all these insects, especially in the developmental stages, demonstrates satisfactorily that the Hymenoptera arose in common with the other holometabolous forms (see Crampton, 1927, etc.). It is true that the venation of the Hymenoptera, as interpreted by Comstock, MacGillivary, and Tillyard, is not in complete agreement with that of the Mecoptera and allies; but Dr. Martynov, after an extensive study of the wings of the Hymenoptera, has concluded (1930) that the "venation in the Hymenoptera, though very specialized, shows many features of similarity with that of the Megaloptera and Mecoptera, thus proving that the Hymenoptera evolved from ancestors somewhat intermediate between the Megaloptera, Raphidioptera, and Mecoptera. The resemblance of the wings of the Megasecoptera, or the Protohymenoptera to those of the Hymenoptera (and Mecoptera) is purely superficial.[5]" Although Martynov's paper is still in the process of publication, it seems already certain that the Protohymenoptera and the rest of the Megasecoptera have nothing in common with the Hymenoptera.

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[5] Martynov has suggested that since the name "Protohymenoptera" is not appropriate for these fossils, it should be changed; and he proposes "Synsecoptera." This procedure does not seem practicable to me, for we already have other "Proto" orders (as Protodonata) which are no longer regarded as ancestral to the recent order concerned. This policy also means that investigators with diverse views on the affinities of the fossil would refer to the order under different names.

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EXPLANATION OF PLATES

PLATE 15

Fig. 1. Wings of *Protohymen permianus* Till.

Fig. 2. Fore wing of *Protohymen elongatus*, n. sp.

Fig. 3. Wings of *Permohymen schucherti* Till.

PLATE 16

Fig. 4. Wing of *Doter minor* Sell.

Fig. 5. Front leg of *D. minor;* specimen No. 3115a, Mus. Comp. Zoölogy.

Fig. 6. Middle leg of *D. minor;* specimen No. 3115a.

Fig. 7. Antenna of *D. minor*; specimen No. 3115a, 3112a.

Fig. 8. Head, prothorax, and mesothorax of *D. minor* (lateral): No. 3115a.

Fig. 9. Thorax of *D. minor* (dorsal): No. 3113a.

Fig. 10. Last five abdominal segments and cerci of *D. minor;* No. 3115a.

PLATE 17

Fig. 11. Photograph of obverse of *Protohymen permianus* Till., specimen No. 3060a, Mus. Comp. Zoölogy.

Fig. 12. Photograph of holotype of *Asthenohymen kansasensis* Till.; No. 5044a, Peabody Museum.

Fig. 13. Photograph of wing of *D. minor*, specimen No. 3087a, Mus. Comp. Zoölogy.

Fig. 14. Photograph of part of cerci of *D. minor*, specimen No. 3115a, Mus. Comp. Zoölogy.

A REVISION OF THE AMERICAN SPECIES OF THE GENUS OZYPTILA

By Elizabeth B. Bryant

Museum of Comparative Zoölogy, Cambridge, Mass.

The genus Ozyptila was made by Simon in 1864 for the single species *Thomisus claveatus* Walckenaer (Ins. Apt.; 1837, 1, p. 510, Aug., 1833, Pyrenees), and wrongly identified as *Thomisus hirtus* Savigny, 1837, from Egypt. *O. claveata* of Walckenaer has not been recognized and in 1875 (Arach. France, 2, p. 211), Simon renamed the species that has been called *claveata* by Blackwell and others *O. blackwalli*, and selected *Thomisus brevipedes* Hahn as type of the genus.

The genus has a wide distribution in Europe with many species. In America all the species were known first from females, wth the exception of *O. marshalli* Barrows. Recently in revising the material at the Museum of Comparative Zoölogy the males have been identified and two new species were found. The males are easily distinguished by the palpi and the females by the epigynes. The clavate bristles may have specific value, but they are easily broken and the scar is difficult to see, so that they are found to be unsatisfactory. The number and position of the spines on the anterior legs is apparently constant throughout the genus, with the possible exception of *O. nevadensis* Keyserling, which is known only from the description. This is supposed to have two lateral spines on the first metatarsi instead of one. The color markings are also disappointing.

The genus is not well represented in collections, as the spiders are small, of a dull brown color with indistinct marks and as they live on the ground they are easily overlooked. Nine species have been recognized, known by both sexes, with the exception of *O. neglecta* and *O. marshalli,* which are represented only by the males. *O. mar-*

shalli is the only species not in the Museum of Comparative Zoölogy collection, and that is known only by the type.

I am greatly indebted to Mr. Banks for his unfailing kindness and help, and to Mr. J. H. Emerton for the generous use of his collection. Dr. W. M. Barrows has very kindly allowed me to examine the type of *O. marshalli,* and has generously given to the Museum of Comparative Zoölogy *O. neglecta* collected by him at Hayden Falls, Columbus, Ohio.

Ozyptila

Cephalothorax slightly elevated. Anterior and posterior rows of eyes procurved, posterior row longer, laterals larger than medians and on separate tubercles, the anterior being the larger. Quadrangle higher than wide, usually with parallel sides, but occasionally wider in front. Abdomen depressed, broad at base and rounded behind. Legs short and stout, I and II longest, tibia with 2-2 spines, metatarsus, 2-2-2 spines beneath and one or more lateral. Cephalothorox and abdomen roughened, and with the legs usually covered with clavate bristles and spatulate hairs. Male palpus rather short, tibia but little longer than patella, with two or three apophyses. Palpal organ simple. But little difference in size and markings between the sexes.

Ozyptila

Males

1. Tibia of male palpus with two apophyses, one superior and one inferior 2

   Tibia of male palpus with three separate apophyses, one superior, one inferior and a small one intermediate 7

2. Superior apophysis forked, upper branch bent almost parallel to tibia ....*marshalli*

   Superior apophysis not forked 3

3. Superior apophysis slender and more than half the length of the tarsus; inferior apophysis thickened

bent downward, embolus long and tip bent at right angles .... *conspurcata*

Superior apophysis less than half the length of the tarsus 4

4. A crescent-shaped piece in lower part of palpus.... 5

No crescent-shaped piece in palpus 6

5. Superior apophysis of tibia, short and very heavy, crescent-shaped piece with serrate edge................*modesta*

Superior apophysis slender, reaching almost to middle of tarsus ....*americana*

6. Inferior apophysis slender and straight, embolus following curve of palpal cavity ....*monroensis*

Inferior apophysis thin and folded, lower apophysis of palpus bifid ....*neglecta* sp. n.

7. Superior apophysis more than half the length of tarsus, slender, with a small tooth on upper margin near base; inferior apophysis more than half as long as superior ....*formosa* sp. n.

Superior apophysis less than half as long as tarsus 8

8. Superior apophysis slender and sinuous, inferior apophysis short, scarcely reaching the palpus, embolus short and ending in a curve..............................*pacifica*

Superior apophysis stout and curved, inferior apophysis as long as superior and intermediate leaf-like and folded almost double ....*floridana*

Ozyptila americana Banks

Figs. 1, 15

Psyche, 1895, 7, p. 242; ♀ N. Y.; Ithaca
Oxyptila conspurcata Emerton.
Trans. Conn. acad.; 1894, 9, pl. 4, fig. 7c.

♂ 3 mm. long.

Cephalothorax brown with a broad, irregular dark stripe each side of the median light stripe; yellow between median eyes; irregular marginal dark stripe; abdomen brown with dark spots and blotches and irregular cream color spots at base; legs brown, femora blotched with darker brown, tibiæ, metatarsi and tarsi light; spines, one spine above on femora I, II and III; I tibia 2-2, metatarsus 2-2-2, 1 lateral, all paired spines longer than diameter of joint. No clavate bristles on edge of clypeus, a pair of small clavate bristles between median eyes. Quadrangle slightly wider in front than behind.

Palpus. Tibia no longer than patella. Superior apophysis of tibia, slender and reaching to the middle of the tarsus; inferior apophysis slender, curving and ending in an enlarged hook bent away from the palpus. Palpal organ rather simple, superior apophysis with widely separated tips and a rounded lobe between, opposite is a sharp black cusp; on the lower opposite side is a dark piece curved to the contour of the palpus. This corresponds to the crescent-shaped piece in *O. modesta.* The embolus ends in a flattened tip which rests on the superior apophysis.

♀ 4 mm. long.

Cephalothorax brown with dark stripe each side of median light stripe and an irregular dark margin, cream color between the eye rows; abdomen brown with dark spots and a few cream color stripes; sternum and coxæ light brown, venter mottled; legs, brown, I femur mottled; spines, one spine above on femora I, II and III; I tibia 2-2, metatarsus 2-2-2, 1 lateral; all paired spines longer than diameter of joint, clavate bristles on clypeus longer than distance between A. M. E., pair of clavate bristles between M. E. and a clavate bristle below P. L. E. Quadrangle of eyes a little wider in front than behind.

Epigynum. A broad U-shaped depression with two small dark dots behind and the usual median lobe at the anterior part, much smaller than in *O. conspurcata.*

Type. 1 ♀, 2 juv. ♀, N. Y.; Ithaca, N. Banks Coll.

1 ♀, Can.; Ottawa bog, 1883, J. H. Emerton Coll., fig. as *O. conspurcata,* Trans. Com. acad.; 1894, 9, pl. 4, f. 7c. 1 ♀, N. H.; Intervale, Aug., 1910, E. B. Bryant Coll.; 1 ♂, 1 ♀, North Woodstock, 4 June, 1908, J. H. Emerton coll., 1 ♀, Jackson, 20 Feb., 1906, J. H. Emerton coll.

Ozyptila conspurcata Thorell

Fig. 2, 16.

Bull. U. S. Geol. Surv.; 1877, 3, p. 496; ♀, Colo.; Manitou Spring, 13 July.

Oxyptila georgiana Keyserling, Spinnen Amer.; Laterigradæ, 1880, p. 52, pl. 1, f. 26. "Many ♀ Peoria, Georgia, Simon Coll."

Oxyptila conspurcata Emerton, Trans, Conn. acad.; 1894, 9, p. 417, pl. 4, fig. 7 (nec 7c).

♂ 3 mm. long.

Cephalothorax brown with distinct light median stripe, sides mottled, with dark spot each side of median stripe; abdomen yellow with scattered cream colored dots and streaks and two pairs of laterally elongated dark spots near the center; sternum and coxæ light, venter light, spotted with dark; legs, I and II darker than III and IV. I femur mottled, the other joints clear, bright brown; spines, one spine above on femora I, 11 and III; I tibia 2-2, metatarsus 2-2-2, as long or longer than diameter of joint, no lateral. No clavate bristles on clypeus. Quadrangle as wide behind as in front.

Palpus. Superior apophysis very long and slender, parallel to tarsus and more than half as long; inferior apophysis short and bent. Palpal organ simple, a small dark cusp near the center near the large dark body; embolus long, slender, curving and resting on this central piece.

♀ 4 mm.

Cephalothorax brown, markings not as distinct as in male, abdomen darker and marks less distinct; sternum and coxæ light; legs marked same as in male, but the paired spines longer. Clavate bristles on edge of clypeus not as long as distance between A. M. E. Quadrangle as wide behind as in front.

Epigynum. The median anterior lobe is large and has a clear center with a small central spot; beneath are dark converging edges.

1 ♀ Can.; Laggan, J. H. Emerton Coll.; 1 ♀ N. H.; Intervale, Aug., 1919, E. B. Bryant Coll.; 1 ♂, 1 ♀ Mass.; Holliston, 10 June, 1924, Emerton and Banks coll.; 3 ♀ N. Y.; Ithaca, N. Banks Coll.; 1 ♀ Cold Spring Harbor, 25 June, 1903; J. H. Emerton coll.; 1 ♂ Ill.; Riverside, 8 June, 1912, N. Banks Coll.; 1 ♀ Iowa; Ames, N. Banks Coll.

Ozyptila floridana Banks

Figs. 3, 4, 18.

Psyche, 1895, 7, p. 243. "1 ♀ Fla.; Punta Gorda."

♂ 2.5 mm. long.

Cephalothorax brown, mottled with darker brown to form four irregular stripes; abdomen brown with irregular dark marks in bands, cream color blotches on basal margin; legs, basal part of femora, metatarsi and tarsi light, patella and tibiæ shaded with dark. Spines, one spine above on femora, I, II and III. I tibia 2-2, metatarsus 2-2-2, 1 lateral, the paired spines on metatarsus longer than diameter of joint. No clavate bristles on edge of clypeus, but pair of short clavate bristles between median eyes, and a long clavate bristle over coxæ I. Quadrangle wider in front than behind.

Palpus. Superior apophysis short and bent at an angle, inferior apophysis slender and straight and about the length of the superior and extending a short distance on palpus; intermediate apophysis a thin plate folded almost double. Palpal organ very simple, without apophyses and embolus ending in a curve following contour of palpus.

♀ 4 mm. long.

Cephalothorax brown mottled with a darker brown, yellow between the eyes; abdomen dark with few irregular markings; legs, tarsi light, and all other joints mottled with dark brown; sternum, coxæ and venter mottled. Spines, one spine above on femora, I tibia 2-2, metatarsus 2-2-2, 1 lateral, all paired spines as long or longer than the diameter of the joint. Clavate bristles on edge of clypeus as long as distance between A. M. E., a pair of clavate bristles between median eyes, and one long clavate bristle on margin above coxæ I. Many small clavate bristles on cephalothorax and abdomen, spatulate hairs on legs arranged in rows. Quadrangle wider in front than behind.

Epigynum. A shallow depression divided by a septum, on each side large oblique opening. The usual anterior lobe is large and quite remote from the other parts.

1 ♀ Type. Fla.; Punta Gorda, Mrs. A. T. Slosson coll.; 1 ♀, 2 ♂, Dunedin, 1927, W. S. Blatchley coll.

Ozyptila formosa sp. n.

Figs. 5, 7, 17.

♂ 3 mm. long.

Cephalothorax dark brown, median light stripe very obscure at anterior portion; abdominal markings indistinct; legs, I femur, patella and tibia dark brown, slightly mottled with light brown; II, III, IV femora light yellow at base, patellæ and tibiæ dark brown; all tarsi and metatarsi light yellow; sternum, coxæ and venter light without markings. Spines; one spine on upper side of all femora; I tibia 2-2, metatarsus 2-2-2, no lateral; II tibia 2-2, metatarsus 2-2-2, 1 lateral; all paired spines longer than diameter of joint. Quadrangle of eyes slightly narrowed posteriorly. Clavate bristles small and only ordinary bristles on clypeus.

Palpus. Superior apophysis of tibia, with a slight tooth near base on the exterior side, prolonged into a sinuate spine more than half the length of the tarsus, and parallel with it. Inferior apophysis about half the length of the superior, slender and ending in slightly enlarged tip, which rests against a blackened lobe on the lower side of the palpus. The superior and inferior apophyses are separated by a white intermediate lobe. The palpal organ is very simple and has, like the typical Xysticus, a superior and inferior apophysis widely separated; between the two is a small black cusp. At the opposite side is a dark crescent-shaped piece. The embolus is short and rests against the superior apophysis. There is a slight tutaculum similar to Xysticus.

♀ 4 mm. long.

Cephalothorax dark brown with median light stripe extending to clypeus; sides mottled; abdomen brown with irregular markings in a light cream color and a darker brown; legs not as dark as in the male, the femora more spotted and the contrast not as great between the tarsi and tibiæ. Spines, the same as in the male, except I metatarsi has 1 lateral. Clavate bristles on clypeus as long as distance between A. M. E. Cephalothorax, abdomen and legs covered with white, spatulate hairs. Quadrangle of eyes a little wider in front than behind.

Epigynum. Two oval depressions separated by a septum. At the anterior end is the usual opening with a small hood-like projecton.

Type. 1 ♂, Fla.; Royal Palm Park, 24 March, 1925, W. S. Blatchley coll.

Co-types. 3 ♀♀ Fla.; Royal Palm Park, March and April, W. S. Blatchley coll.

This species is nearer *Ozyptila brevipes* Hahn, than any American species. It differs from the other American species in the greater length of the upper apophysis of the male tibia and the characteristic vulva.

Ozyptila marshalli Barrows

Figs. 8, 10.

Ohio journ. sci.; 1919, 19, p. 357, pl. 15, f. 2, "1 ♂ Ohio, Sugar Grove, 11 Sept., 1917."

♂ 3 mm. long.

Cephalothorax dark golden brown, with four darker stripes, lateral broader, the median with a darker line in the center which reaches the thoracic groove; abdomen light with dark marks arranged as parallel stripes on sides but obscure in the center; legs light golden brown, much lighter than the cephalothorax, with faint dark blotches on the first femur, patella and tibia; posterior legs much lighter and markings more obscure. Metatarsi and tarsi of all legs light yellow. Spines, one spine on upper side of all femora; I femur, 3 basal spines, tibia 2-2, metatarsus 2-2-2, 1 lateral. Clavate bristles on clypeus half as long as distance between A. M. E. A long, clavate bristle on margin of cephalothorax above palpus. Eyes; quadrangle wider in front than behind.

Palpus. Tibia no longer than patella; superior apophysis of the tibia bent and almost parallel to the upper edge of tibia; from the basal part a smaller spur bent downward. Inferior apophysis slender with an enlarged tip. Palpal organ simple, without apophyses; embolus ending with a bifid tip about the middle; under this are two slender, dark rods close to the largest part of the organ.

Known by the type only.

Type 1 ♂. Ohio; Sugar Grove, 11 Sept., 1917, W. M. Barrows coll. Ohio State Univ.

Ozyptila modesta Scheffer

Figs. 6, 20.

Xysticus modesta Scheffer, Ent. news, Phila.; 1904, 15, p. 257, pl. 17, f. 1. "Several females . . . Manhattan (Kans.), in June."

Ozyptila beaufortensis Strand, Arch. Naturges, Berlin, 1916, 81, A. 9, p. 124. "2 ♂ ♂ von Beaufort, N. California."

♂ 3.8 mm. long.

Cephalothorax brown, mottled behind the eyes, median light stripe as wide as P. L. E. to about half the width at posterior margin; sides mottled with darker brown and a distinct dark marginal stripe; a pair of light spots at posterior part; abdomen pale yellow with darker marks, muscle spots not conspicuous; sternum with dark marks above margin, coxæ light; legs, I femur light, more than half covered with dark brown marks; tibia, metatarsus and tarsus clear yellow; basal part of femora II, III and IV clear yellow with dark rings at apex of femora, middle and apex of tibiæ; tarsi and metatarsi light. Venter mottled. Spines, I femur 2 above, one spine above on femora II, III and IV. I tibia 2-2, about diameter of joint, metatarsus 2-2-2, longer than diameter of joint, no lateral.

A pair of small clavate bristles between median eyes, and no clavate bristles on margin of clypeus. Quadrangle of eyes as wide in front as behind.

Palpus. The superior apophysis of the tibia is short and stout; the inferior apophysis is short with an enlarged tip, and extends only a short distance on the palpal organ. The palpal organ is simple. The superior apophysis is distinctly lobed, with a small dark cusp between the two lobes. In the opposite side is a large crescent-shaped body with a distinct serrate edge. This corresponds to a smaller one found in *O. americana* and a much heavier piece in *O. formosa.* The embolus is short and curved, with a flattened tip which rests on the upper apophysis.

♀ 5 mm. long.

Cephalothorax brown, with two dark stripes each side of median light stripe; light band between eye rows; sternum, coxæ and venter light and mottled with darker brown; legs, I and II mottled and much darker than III and IV. Spines, one spine above on femora I, II and III; I tibia 2-2, not as long as diameter of joint, metatarsus 2-2-2, 1 lateral, paired spines longer than diameter of joint. Clavate bristles on edge of clypeus not as long as distance between A. M. E., a pair of clavate bristles between M. E. and a long clavate bristle on margin above coxæ I. Head rather broad. Quadrangle of eyes as wide behind as in front.

Epigynum. Wider than long; a central septum extends forward in a sharp point; behind are the two small dark spots, more widely separated than in *O. americana,* and in front the usual median lobe.

Co-type 1 ♀ Kans.; Manhattan, 10 June, Scheffer coll.; N. Banks coll.; 1 ♂ Va.; Falls Church, N. Banks coll.; 1 ♂, 1 ♀, Ind.; Pine, N. Banks coll.

The male described by Strand as *Ozyptila beaufortensis,* from Beaufort, N. California (sic) is undoubtedly this species.

Ozyptila monroensis Keyserling

Figs. 9, 19.

Verh. zool. bot. Ges. Wein; 1883, 33, p. 671, pl. 21, f. 19. "♀ Va.; Fortress Monroe, Marx Coll."

♂ 1.8 mm. long.

Cephalothorax dark brown, median stripe very faint, light mark at the end of the thoracic groove; abdomen with irregular dark markings; legs clear brown without markings. Spines; I femur, 1 spine on upper side, tibia 2-2, a little longer than diameter of joint, metatarsus 2-2-2, longer than diameter of joint, no lateral; no spines on anterior surface of femora II, III, IV. Quadrangle as wide in front as behind. Clavate bristles on clypeus short.

Palpus. Tibia very broad, especially above the middle, superior apophysis short slender spur, inferior apophysis short with a slightly enlarged tip. Palpal organ simple, with two slender apophyses about the middle and the embolus following the curve of the cavity.

♀ 3 mm. long.

Cephalothorax bright brown with median stripe a little lighter; light mark at end of thoracic groove; abdomen coffee color with paired dark blotches; venter brown with scattered light spots; legs clear brown, little lighter than the cephalothorax without markings, but distinct light rings at the ends of patellæ and tibiæ. Spines; I femur, 1 spine on upper surface, tibia 2-2, metatarsus 2-2-2, 1 lateral on basal third; paired spines at least twice the diameter of the joint; no spines on anterior surface of femora II, III and IV. Clavate bristles on clypeus longer than distance between A. M. E. Quadrangle as wide in front as behind.

Epigynum. The small paired openings more than twice their diameter apart. The median hood-shaped body or lobe, rather large and connected with the paired cavities below.

Found from Long Island, New York, south to Virginia, and west to Ohio and Illinois.

Ozyptila neglecta sp. n.

Figs. 11, 14.

♂ 2.8 mm. long.

Cephalothorax brown, median light stripe very faint, sides mottled, darker about margin; abdomen with irregular dark marks arranged about the five muscle spots; narrow cream color line around anterior margin; legs light brown without markings, femora darker than other joints. Sternum light with dark marks opposite coxæ; coxæ light, venter pale with transverse dark lines. Spines; I femur, 1 on upper side, tibia 2-2, metatarsus 2-2-2, no lateral; no spines on II, III and IV femora. Clavate bristles on clypeus shorter than space between A. M. E. Quadrangle of eyes as wide in front as behind.

Palpus. Tibia very broad, especially before the middle. Superior apophysis short and pointed; inferior apophysis thin and folded. Palpal organ simple, with a bifid apophysis half surrounding a dark circle about in the center. Embolus ending with a short curve near the top of the palpus.

Type. 1 ♂, Ohio; Columbus, Hayden Falls, 13 June, 1926, W. M. Barrows coll.

Ozyptila pacifica Banks

Figs. 12, 13, 21.

Psyche, 1895, 7, p. 243, "1 ♀, 1 ♂, Juv. Wash.; Olympia, T. Kincaid coll."

♂ 3 mm. long.

Cephalothorax brown, median stripe mottled behind eyes but not a clear yellow in posterior half; sides with two pairs of interrupted darker stripes; abdomen pale, with white, broken lines and dots at base, and a pair of widely separated dark spots about the middle; apex much darker than basal portion; sternum, coxæ and venter light; legs light brown, I and II femora mottled with a darker brown, other joints clear yellow; broken dark bands at tip of III and IV femura and base of tibiæ III and IV. Spines; one spine above on all femora, I tibia 2-2, metatarsus 2-2-2, no lateral; all spines longer than diameter of joint. Clavate bristles between median eyes and on edge of clypeus as long as distance between A. M. E. Quadrangle of eyes as wide in front as behind.

Palpus. Superior apophysis short and sinuous, inferior apophysis short and bent downward, between the two a rounded white lobe. Palpal organ with two apophyses bent downward on the outer side and a dark cusp on the opposite, lower side; embolus ending in a thickened tip near the upper part of the palpus.

♀ 4 mm. long.

Cephalothorax bright brown, median stripe mottled about eye region, but a clear yellow in posterior half; sides faintly mottled; abdomen pale with cream color lines and spots about basal portion and posteriorly two or three interrupted darker bands; sternum and coxæ pale; legs a little lighter than cephalothorax, I and II without marks, III and IV with broken dark bands at top of femora and patellæ and at base of tibia IV. Spines, one spine above on femora I, II and III; I tibia 2-2, as long as diameter of joint, metatarsus 2-2-2, 1 lateral; the paired spines longer than diameter of joint. Clavate bristles on edge of clypeus equal to distance between A. M. E. Quadrangle as wide in front as behind.

Epigynum. Median lobe close to dark bodies, under the skin and paired openings a diameter apart.

Type. 1 ♀, Wash.; Olympia, T. Kincaid coll.; N. Banks coll. 1 ♂, Col.; Florissant, N. Banks coll. 1 ♀ B. C.; Metlakatla, J. H. Keen coll., N. Banks coll. 1 ♂, 1 ♀, B. C.; Masset, J. H. Keen coll., N. Banks coll.

Explanation of Plates

Plate 18.

Fig. 1. *O. americana* Banks, ventral view of palpus.
Fig. 2. *O. conspurcata* Thorell, ventral view of palpus.
Fig. 4. *O. floridana* Banks, ventral view of palpus.
Fig. 4. *O. floridana* Banks, lateral view of palpus.
Fig. 5. *O. formosa* sp. n., lateral view of palpus.
Fig. 6. *O. modesta* Keys., ventral view of palpus.
Fig. 7. *O. formosa* sp. n., ventral view of palpus.

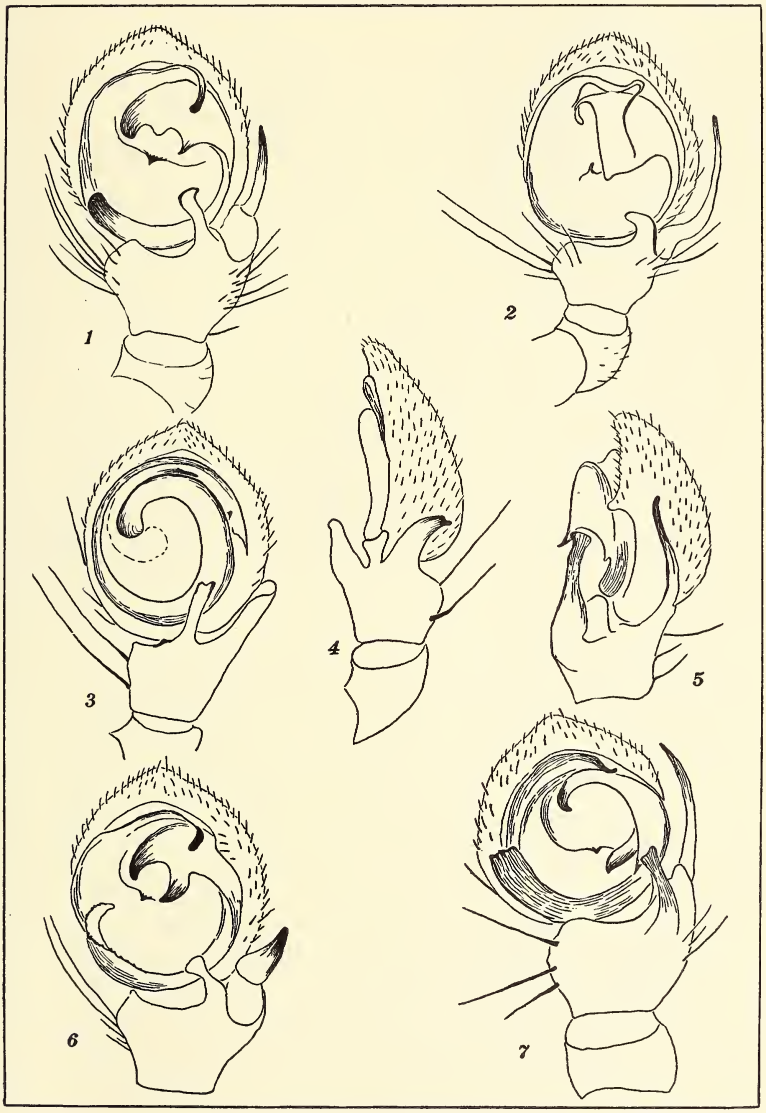
Plate 19.

Fig. 8. *O. marshalli* Barrows, ventral view of palpus.
Fig. 9. *O. monroensis* Keys., ventral view of palpus.
Fig. 10. *O. marshalli* Barrows, lateral view of palpus.
Fig. 11. *O. neglecta* sp. n., lateral view of palpus.
Fig. 12. *O. pacifica* Banks, lateral view of palpus.
Fig. 13. *O. pacifica* Banks, ventral view of palpus.
Fig. 14. *O. neglecta* sp. n., ventral view of palpus.

Plate 20.

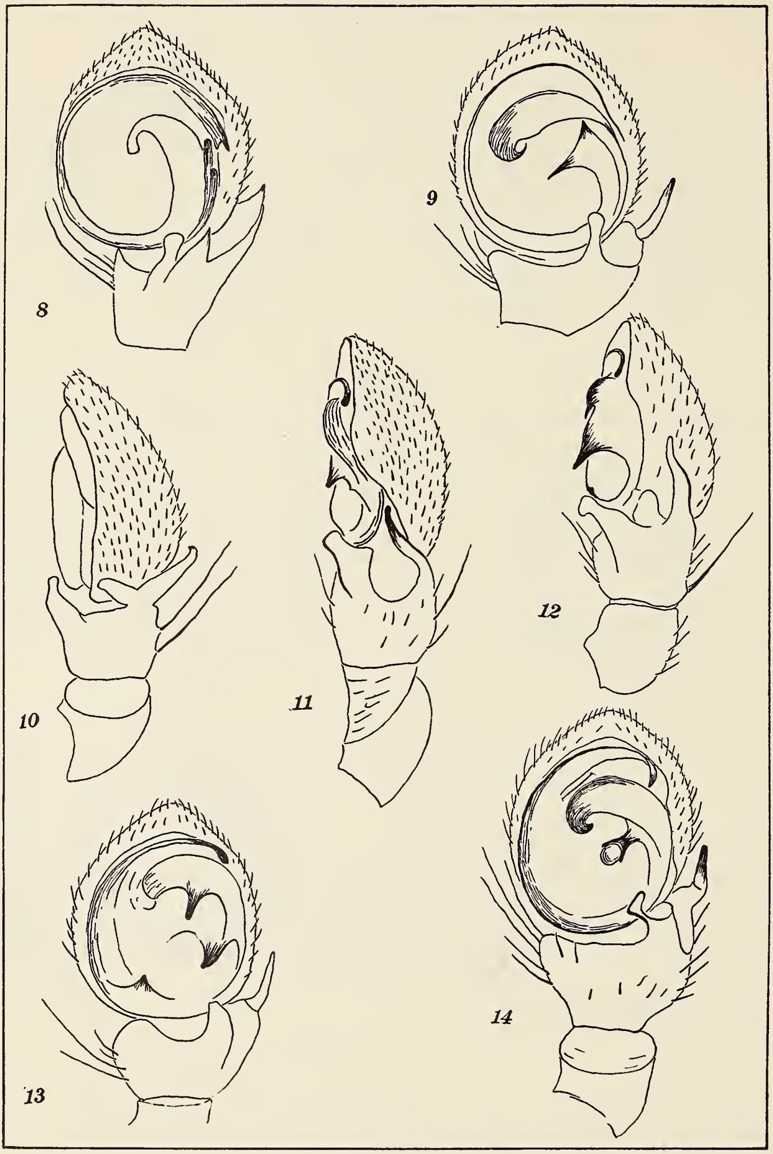
Fig. 15. *O. americana* Banks, epigynum.
Fig. 16. *O. conspurcata* Thorell, epigynum.
Fig. 17. *O. formosa* sp. n., epigynum.
Fig. 18. *O. floridana* Banks, epigynum.
Fig. 19. *O. monroensis* Keys., epigynum.
Fig. 20. *O. modesta* Keys., epigynum.
Fig. 21. *O. pacifica* Banks, epigynum.

Psyche, 1930 Vol. 37; Plate 18.



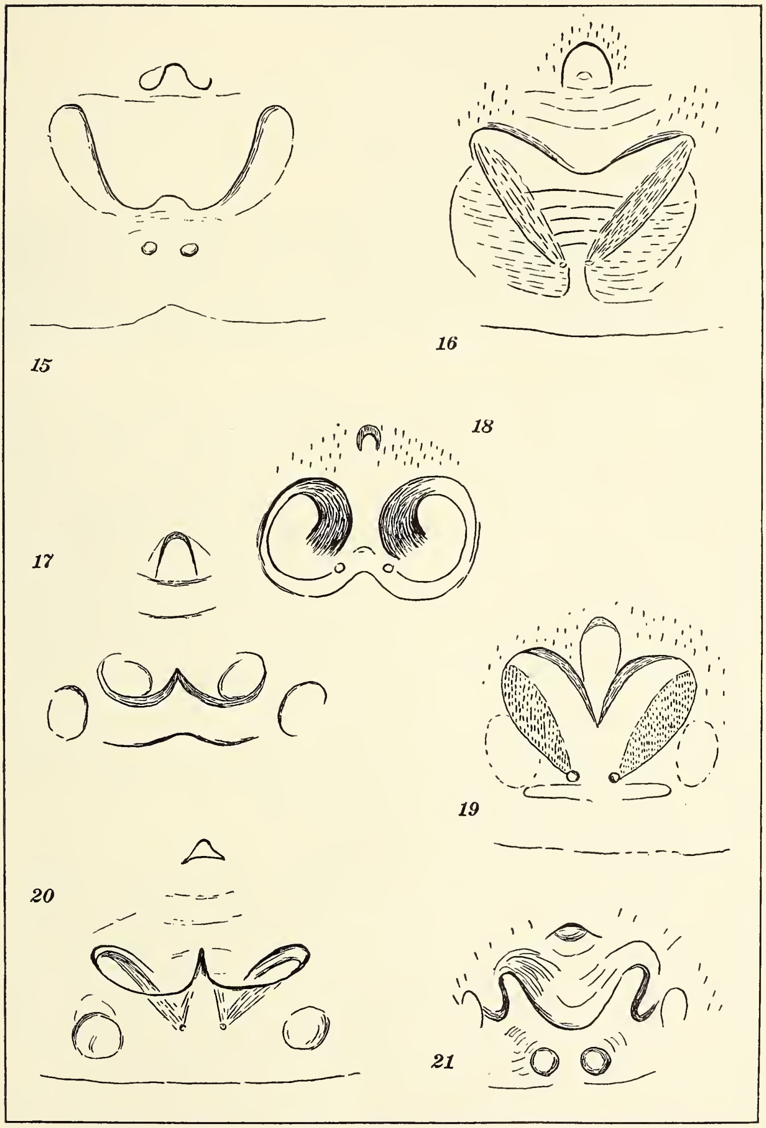
Bryant—American Ozyptila.

Psyche, 1930 Vol. 37, Plate 19.



Bryant—American Ozyptila.

Psyche, 1930 VOL. 37, PLATE 20.



Bryant—American Ozyptila.

JEWELLED CADDIS-WORM CASES

By Charles T. Brues

During the summer of 1930 while collecting in the northwestern part of Nevada, I secured some caddis-worm cases which have interested me greatly on account of a striking peculiarity evinced by these larval Trichoptera in selecting the minute stones that serve as material for covering their cases.

We were returning from a sojourn in the far northwestern, almost uninhabited, desert portion of the state, where permanent water is to be found at very few places. Reaching Fish Springs at dusk we decided to camp for the night close to the spring which furnishes sufficient cold water to form a tiny stream and a series of several small pools before it is absorbed and disappears in the soil. Examining the spring and short stream the next morning, I noticed in the blackish mud that numerous minute glistening bits of opal flecked the dark background. It is not surprising to find opal at this place, as there are extensive deposits of opal and opalized wood in the contiguous country to the northeast, where the material is mined commercially. All the pieces in the spring were small or minute, but they emitted a brilliant pale blue fire.

We collected a number of aquatic insects and noticed a concerted movement of the fiery opal flecks upon the bottom, which proved to be a caddis-fly dragging its case across the surface of the mud. Search revealed a number of others and finally we obtained nine specimens, each thickly jewelled with bits of opal. As the amount of opal in the muddy bottom of the spring was far less in proportion to the other sandy or crystalline material than it is in the assortment utilized by the caddis-fly larvæ, there can be no doubt that the brilliant color of the opal in some way influences the larvæ in their choice. The cases are covered with sand,

and under the microscope the particles are seen to be in part crystalline (consisting of broken bits of highly refractive quartz) and in part dull opaque, usually yellow, brown or dark colored, non-crystalline material. The transparent particles are all opalized to some extent, although some are much more brilliant or "fiery" than others. A count of the particles from two cases, after removing them from the silken network by immersion in a caustic potash solution, shows that more than half are opalized to some extent. Thus in one case the ratio of crystalline and opalized particles to dull ones is 102:68 and in another 380:222. On the other hand, the amount of material from which selection is made by the larvæ shows a far smaller, though difficult to estimate, proportion of opal.

Several caddis-worms are known to exhibit a considerable intra-specific variation in selecting the material for their cases, depending usually upon what material is within reach. Lloyd ('21) describes a clear-cut example of this in *Limnephilus combinatus,* where he found either shells or bits of bark used by the larvæ in accordance with the availability of the two types of material. Here and in other species, *e. g.,* in *Phryganea vestita* and *Limnephilus submonilifer,* such differences are to some extent associated with age, as the younger and older larvæ build cases of a different structure, or again the larvæ may migrate as they mature and leave the area where certain materials are available. Some species are furthermore quite indiscriminate in their choice of building material.

It would seem that the sense of discrimination of caddis-worms in general in selecting objects to attach to their cases is such that it may be entirely dependent upon a tactile sense coupled with an appreciation of weight. Even where crystalline sand is chosen and rounded grains discarded, the same is true. Thus, the almost exclusive use of small quartz crystals by some species need not involve vision, as the latter may be recognized by their sharp edges.

In the present case vision must, however, form a necessary factor in the selection, as the brilliant opalized bits are not physically different from the white or slightly opalized pieces of quartz. All undoubtedly are of the same origin, having been formed as crystallization products in connection with fossilized wood that was silicified in extinct hot springs.

As a brief examination of the voluminous literature on caddis-worms has yielded no definite statements relative to the part played by vision in the choice of case-building material, it has seemed appropriate to present the accompanying observations.

I have not been able to determine the larva accurately, but it is structurally very similar to that of *Platyphylax designatus,* and undoubtedly belongs to some rather closely related form. Professor Banks has suggested that it may quite likely belong to one of two species of Heterophylax that are common in that part of the United States, *H. magnus* Banks or *H. occidentalis* Banks. On account of their size it is probable that they may be the latter species, as this is decidedly the smaller form.

CUBAN FULGORINA

1 The Families Tropiduchidae and Acanaloniidae

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and

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The present series of papers will deal with the Fulgorids of Cuba. It is our purpose not only to list the species which have been recorded previously from Cuba with critical bibliographic and taxonomic notes, but also to describe certain species which are apparently new. Special emphasis is placed on the male genitalia, as it is believed that these furnish the most reliable, specific characters. The descriptions will include only characters which may be readily observed by external examination. The internal genitalia of nearly all the species are illustrated by detailed drawings which are believed to be of more value than any attempt to describe these elaborate structures.

The specimens on which the present paper is based were collected largely by S. C. Bruner, J. Acuna and C. H. Ballou.

Family Tropiduchidae

The family Tropiduchidæ was monographed in 1914 by Melichar. He listed only one species, *Tangia sponsa* Guerin, from Cuba, although Uhler, 1910a: 510, described *Cyphoceratops furcatus* from Cuba and Haiti. However, four years previously Pedro Valdes, 1910: 442, had recorded four species belonging to this family from specimens preserved in the Gundlach Museum, Havana, although the systematic position of all of these cannot be determined either from the names employed, which are badly misspelled, or from the word or two of description giving only the length and color of the insects. Osborn, in 1926c: 354, listed *Pelitropis rotulata* Van Duzee among the Fulgoridæ taken by him in Cuba, a species described from Florida and known also from Mississippi and North Carolina. Myers in a recent paper, 1928a :23, deals with two species of this family, *Neurotmeta sponsa* Guerin and *Remosa spinolæ* Guerin. A number of other genera and species have been recorded from the adjacent West Indian Islands, but so far as we know no other species heretofore assigned to this family have been recorded from Cuba. The present paper lists eight species, four species apparently being new. The synonymy and distribution of the other species are discussed.

Neurotmeta sponsa Guerin

This species was described by Guerin Meneville in 1856a: 180. This description was copied in Guerin Meneville, 1857a: 429. There is a brief popular description of this insect by Uhler, 1884a: 231. He lists it from Cuba, San Domingo and Florida, and assigns it to the genus *Tangia* Stal. The next reference to the species is by Van Duzee, 1907a: 35. But the insects which he collected in Jamaica and which we have examined are not the same as the Cuban material; "Elytra with a broad costal membrane crossed by numerous oblique veinlets." Melichar, 1914f: 100-101, redescribed the genus *Tangia* Stal with *Monopsis viridis* as the type, and then redescribes the species *sponsa,* which he assigns to Uhler. Van Duzee, 1917b: 739, assigns this species to the genus *Neurotmeta.* Metcalf, 1923a: 154, separated *Neurotmeta sponsa* from *Monopsis tabida* Spinola on the basis of the presence of costal cross-veins in the former and their absence in the latter. This is not a good character, however, as it is doubtful if the few irregular lines in the costal area can be interpreted as costal cross-veins. As has been pointed out by Melichar it would be better to separate these two genera on the basis of the branching of medius, the fork occurring near the base of the wing in *Monopsis* and near the middle of the wing in *Neurotmeta.* Otherwise these two genera are quite similar.

In *Neurotmeta* the costal vein is separated from the costal margin and connected apically with the costal margin by a series of short, indistinct transverse veinlets.

In this connection it might not be amiss to make a statement in regard to the status of the genus *Tangia* Stal. This genus was described by Stal, 1859a: 317-318, for three species *Monopsis viridis* Walker, and *Tangia kraatzi* and *Tangia schaumi* n. spp., *viridis* Walker differing in having no transverse veins in the costal area while these veins are present in the other two species. Melichar, failing to recognize that Guerin in describing *sponsa* and *spinolæ* had indicated the new genus *Neurotmeta,* made *viridis* the type of *Tangia* and erected a new genus *Tangiopsis,* including *Tangia kraatzi and T. schaumi* with *kraatzi* as the type. If *viridis* Walker is congeneric with *sponsa,* as the descriptions would seem to indicate, then *Tangia* Stal would be a synonym of *Neurotmeta* Guerin and *Tangiopsis* Melichar, with *Tangia kraatzi* Stal as type, is a valid genus. The name *Tangiopsis,* however, is preoccupied by *Tangiopsis* Uhler, 1901a: 512, haplotype *T. tetrastichus* Uhler, which is described as a Dictyopharid with a median ocellus. An examination of the type, through the kindness of Dr. E. D. Ball, reveals that this genus belongs to the *Tropiduchidæ,* falling into Melichar's tribe *Tambinini* near the genus *Amapala* Melichar. The median ocellus is not present, being represented by a small spot of glue or similar substance which simulates an ocellus. We propose the name *Tangella* type *Tangia kraatzi* Stal, 1859a: 318, to replace *Tangiopsis* Melichar, and would suggest that Van Duzee's *Tangia sponsa* belongs to this genus, although the vertex is very much prolonged, median length 1.75 times the width between the eyes.

Neurotmeta sponsa may be recognized by its distinct venation and by the short, broad, spatulate vertex. Fresh specimens are light green, but fade to dull tawny yellow. The last ventral segment of the female is short with the median length one-third the length of the lateral borders.

The male genitalia may be described as follows: The eighth ventral segment deeply incised on the median line, elevated in a U-shaped ridge almost to the base of the segment. The ninth segment short, ring-like, the posterior border when viewed laterally is strongly sloping cephalad. Genital plates large, extending caudad beyond the apex of the tenth segment. The ventral margins straight, contiguous, the apical border triangularly produced, the dorsal margin strongly curved with a distinct notch. The tenth segment spatulate, deeply notched, caudad; the anal notch deep; the anal spine small.

This species is common and widely distributed in Cuba. Specimens are at hand from Jarahueca, Oriente, July 14-18, 1927, S. C. B., on *Coffea arabica;* Nagua, Oriente, July 7, 1922, S. C. B. and C. H. B.; Santiago de las Vegas, June 12, 1920, Havana, S. C. B.; S. Nicholas, Oriente, July 20-21, 1927, S. C. B., taken at light; Camaguey, August 10-20, 1924, J. A., and Manzanillo, Oriente, July 31, 1922, S. C. B and C. H. B.

Neurotmeta breviceps n. sp.

Head across eyes narrower than prothorax. Vertex, flat, somewhat more than twice as broad as median length, considerably produced in front of eyes, anterior margin obtusely angled, slightly rounded, posterior margin deeply incised to beyond anterior margin of eyes, lateral margins straight, parallel, median carina strong, lateral and anterior margins strongly but obtusely carinate. Pronotum, as long or slightly longer than median length of vertex, flattened above, strongly tricarinate as is also mesonotum. Venation, transverse line of veins to apex of clavus nearly straight, at right angle to longitudinal axis of elytra, costal membrane narrow, without distinct transverse veinlets.

Color, testaceous, but probably green in life.

Length, 7 mm., approximately.

Type, from Havana, Cuba, Dr. J. Gundlach, collector; in Gundlach Museum, Havana, No. 289, labeled "*Monopsis tabida* Spin."

The junior writer is indebted to Prof. Joaquin Folchs and Lieutenant Gonzalez of the Instituto de la Habana, for the privilege of examining this and several other specimens in the Gundlach Museum referred to in this paper.

In general facies this species resembles *Neurotmeta sponsa* Guer., except for much shorter vertex and broader form, aside from smaller size. It was listed by Valdés, 1910a, under the name given on the label in the Gundlach Museum, but it is quite distinct from *Monopsis tabida,* which does not appear to have been taken since the original description was published. Dozier, 1928a, says that *Monopsis tabida* was described from Cuban material, but he is evidently mistaken, as Spinola only mentions the "United States." On what authority the species has been listed by Van Duzee and others from Florida, we are unable to learn.

Pelitropis rotulata Van Duzee

This species is rather common in Cuba. Specimens are at hand from Omaja, Oriente, July 24, 1927, S. C. B.; Sto. Thomas, P. de Zapata; Sto. Clara, May 5-9, 1927, S. C. B. and J. A.; Santiago de las Vegas and Cojimar, Habana, S. C. B.; Sierra Rangel, P. del Rio, August 29, 1927, altitude 1500 feet; Camaguey, December 29, 1921, J. A.; and Nagua, Oriente, July 7, 1922, S. C. B. and C. H. B.

Nymphs are at hand from Nagua and from Santiago de las Vegas. They resemble the adult in a general way, being bright green in color with the carinæ tending toward bright orange. Vertex, distinctly spatulate, about as in the adult with the posterior border deeply incised and with a distinct median carina. Frons differs in having two strongly elevated median carinæ and a pair of intermediate carinæ which originate on the clypeal border about midway between the median carina and the lateral border and diverge upward, uniting with the carina at the apical border in front of the compound eyes.

Female genitalia, the last ventral segment of the female, is as long as the penultimate and about two-thirds as wide.

Male genitalia, eighth segment very short; deeply and roundly emarginate. Ninth segment ring-like, the caudal margins sinuate. Genital plates broadly triangular in outline, ventral margins slightly curved and contiguous. Tenth segment elongate, exceeding the genital plates. The caudal margins reflexed over the apex of the genital plates. Anal spines small, conical.

The name *Pelptiopsus mitratus* (Uhler MS) employed by Pedro Valdés (1910a: 443) for a specimen, No. 777, in the Gundlach Museum, Havana, is a synonym.

Colgorma Kirk

This name was proposed by Kirkaldy, 1904b: 279, to take the place of *Temora* Kirkaldy, 1901a:6, which was to take the place of *Rudia* Stal, 1866a:187, nec Costa 1861, Hymenoptera. Unfortunately *Temora* Kirkaldy, 1901, was preoccupied by *Temora* Baird, 1860, a genus of *Crustacea.* Since Stal, 1866c: 392, made *Achilus dilutus* Stal, 1859b: 271, the type of the genus *Rudia,* it is the type of the genus *Colgorma.* Melichar, 1914f: 79, uses *Temora* Kirk. with *Achilus dilutus* Stal as the type, and places it in the tribe *Tambiniini* and *Colgorma* Kirk with type *C. fowleriana* Kirk and places it in the tribe *Paricanini.* The tribe *Tambiniini* is distinguished from the tribe *Paricanini* by both Melichar and Muir because the genera in the former tribe have the "cross line distad of the middle of the wing," whereas in the latter tribe the "cross-vein is basad of the middle of the wing." Assuming that this is correct, and assuming further that *Rudia diluta* as figured by Fowler, 1904b, Pl. 11, Fig. 10, is correct and really represents *diluta,* as Fowler states that he compared his specimens with the type, *Colgorma* Kirk type *Achilus dilutus* Stal would fall in the tribe *Tambiniini* and would include *Temora* Kirkaldy as used by Melichar. This genus would include, therefore, the three species *C. diluta* Stal, *C. proxima* Fowl and *C. verticalis* Fowl. In regard to *Achilus bicinctus* Spinola, 1839a: 321, and *Rudia bicincta* Fowler, 1904b: 105, Kirkaldy, 1907b: 249, believed that these were distinct species, and he renamed the latter *Colgorma fowleriana.* Careful examination of the two descriptions and figures would lead us to believe that these are the same or closely related species. They differ in several respects from typical *Colgorma,* the most important being that the first branch of cubitus is not branched before the transverse line as it is in *Colgorma.* We would suggest, therefore, a new genus *Achilorma,* type *Achilius bicinctus* Spinola, and including the *Colgorma fowleriana* Kirk.

Our Cuban material includes two new species of the genus *Colgorma.*

Colgorma montana n. sp.

This species is close to *C. diluta* Stal as figured by Fowler; the head is narrower, the vertex longer and more pronounced, the frons narrower, meeting the vertex at an acute angle not broadly rounded as in *diluta.*

Vertex, elongate, about one and one-half times as broad as the median length; anterior margin broadly curved with a strongly elevated carina; lateral margins nearly parallel, carinæ distinct; posterior margin curved having the appearance of being triangularly incised because there is a triangular elevated area, the lateral margins of which extend from the posterior angles almost to the anterior margin of the vertex. Frons, about twice as long as its greatest width, appearing longer because it is distinctly narrowed between the eyes; central area almost flat, distinctly separated from the lateral margins by furrows which are characteristic of the genus; dorsal margin distinctly separated from the vertex by a transverse carina, the margin itself is straight and horizontal; lateral margins with an evident carina, nearly parallel to the lower margin of the eye, then gradually diverging for an equal distance, then converging to the clypeal margin which is narrower than the dorsal margin; clypeal margin broadly concave. Clypeus, elongate, triangular, obtuse, about one-third as long as the frons, shallowly inserted in the frons; central area strongly elevated, continuing the central area of the frons. Labium, short, the basal segment about one-half as long as the distal segment which is about one-half as long as the median segment. Genæ, distinctly separated from the frons and vertex. Antennæ, short; the basal segment, collar-like; distal segment capitate; flagellum elongate, about five times as long as the distal segment. Ocelli, distinct, placed below the ventral margin of the eyes. Compound eyes, sub-globular, ventral sinus indistinct. Pronotum, short, broad, median carina distinct; lateral carinæ strongly diverging, following the contour of the compound eyes. Fore legs, coxa, short, about as long as the diameter of the eye; femora, slender, elongate, about twice as long as the coxæ, prismatic, the margins with short, slender but distinct sub-erect setæ; fore tibiæ stout, about as long as the femora, prismatic, the margins lined with hairs as in the femora. Mesonotum, large, quadrangular; the median and lateral carinæ very distinct, the lateral carinæ converging anteriorly meeting on the median line. Tegulæ rather large; broadly elliptic with a horizontal carina. Fore wings, broad, the costal margin nearly straight, the apical border broadly rounded; costal vein broad, with fine tubercles on the apical half, these tubercles continuing around the apical margin; transverse line distinct but irregular; sub-costal-radial vein branching just anterior to the transverse line; medius united with radius for about one-half the length of the basal cell; cubitus one branched about two-thirds the distance between the basal cell and the transverse line; anal veins united for about two-thirds their length. Middle legs about as the fore legs but slightly longer. Hind femora elongate, somewhat capitate; hind tibiæ prismatic, longer than the femora with distinct sub-erect setæ on the margins, three evident spines on the lateral margins before the apex, two groups of spines at the apex, the lateral group of two elongate spines, and a median group with four shorter spines.

Male genitalia, eighth ventral segment short, collar-like; roundly emarginate posteriorly. Ninth ventral segment about three times as long as the eighth, the lateral margins sinuately curved. Tenth segment elongate spatulate, the apex broadly sinuate. Anal style short. Genital plates quadrate, the ventral margin curved, continuous along the median line.

Color, fresh specimens are pale olive green, more or less tinged with tawny, especially on the venter and legs. Wing veins in both fore and hind wing bright olive green. Eyes reddish brown. Antennæ greenish olive. Claws and tibial and tarsal spines black.

Size, length of apex to abdomen 4.5 mm. Length of the tip of the wing 5.1 mm. Width across the tegulæ 1.6 mm.

Types, Holotype, male, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B. and S. C. B. Allotype, female, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B.

and S. C. B. Paratypes, three males, one female, Sierra Mæstra, July 10-20, '22, 1100-1300 meters, C. H. B. and S. C. B., Pico Turquino, July 20, '22, S. C. B. and C. H. B. 5500 ft.

Colgorma campestris n. sp.

This species differs chiefly from *Colgorma montana* in the following points: the vertex is much shorter and broader; the wings are narrower and more elongate with the costal cell narrower and more elongate.

Vertex, broad and short, three times as long as broad; anterior margin broadly rounded; posterior margin triangularly incised; lateral margins parallel. Frons, broad; lateral margins nearly parallel, not narrowed between the eyes, slightly wider at the level of the antennæ; the median area broadly elevated. Clypeus, elongate diamond-shaped, triangularly inserted into frons; the median elevated area not conspicuous. Antennæ, with basal segment very short; apical segment capitate. Pronotum, short and broad; with median carina indistinct; lateral carinæ conspicuous; the lateral impressed points deep. Mesonotum slightly broader than long, about as 13 is to 10; median and intermediate carinæ distinct, intermediate carinæ converging anteriorly nearly parallel posteriorly. Fore wings, narrow, elongate, the costal cell narrow elongate.

Holotype male, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B.

Allotype female, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B.

Paratypes, one male, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B; one male, Barrio Caobilla, Camaguey, June 23-25, '27, J. A.; two females, Jarahueca, July 14-18, '27, on *Coffea arabica.* S. C. B; and one female, Nagua, Oriente, July 7, '22, S. C. B. and C. H. B.

Cyphoceratops furcata Uhler

This species was described by Uhler 1901a: 510 from Cuba and Port au Prince. We have seen one of the type series from Port au Prince through the kindness of Dr. E.

D. Ball. It agrees in all essential details with our series from Barrio Caobilla, Camaguey, June 23-25, '27, J. A. This genus was described by Uhler as belonging to the family *Cixiidæ.* It belongs, however, to the family *Tropiduchidæ* and the tribe *Tambiniini.* In Melichar's key it falls next to his genus *Amapala* with two species from South and Central America. It differs principally from this genus in cephalic and thoracic characters. The wing venation is apparently quite similar. The essential characters of this genus are well illustrated by the figures and need not be repeated. The general color is greenish testaceous, bright green on the frons between the carinæ and on the lateral fields of the pronotum. The carinæ of the frons, the lateral carinæ of the clypeus and a stripe on the lateral fields of the pronotum are bright orange red. The lateral carinæ of the vertex are bordered with black. There is also a broad irregular cloud of the same color on the genæ above the compound eyes, on the anterior margin of the mesonotum and on the bases of the wings, also on the lateral fields of the clypeus. Two irregular rings on the fore and middle femora and one at the apices of the fore and middle tibia and an irregular cloud on the hind femora are dark brown shading to black. The mesopleura have a conspicuous round black spot.

Male genitalia, the ninth segment is short and broad. The genital plates are about three times as long as the ninth segment with a distinct triangular tooth occupying the basal third, followed by a distinct notch apically. Tenth segment elongate, slender, deeply inserted into the ninth segment. Anal spine reaching about half way to the apex of the tenth segment.

There is also a specimen of this insect in the Gundlach Museum, Havana, labeled *"Steptocratus,* No. 328." Gundlach records this (MS notebook) as taken at "Rangel" (Sierra Rangel Mountains, Pinar del Rio).

Remosa spinolae Guerin

Myers 1928a: 23 places *Fulgora spinolæ* Guerin in the genus *Remosa* Distant after comparing specimens with the type of the genus. Melichar 1914f: 11 describes the genus as having the costal membrane broad with many cross-veins. Distant 1906n: 355 in the original description makes no mention of costal cross-veins, neither does Myers. The specimens we consider *spinolæ* have no costal cross-veins. The structural characters are indicated by the figures. This insect was listed by Pedro Valdés as *Dictyophora spinolæ* based on the specimen in the Gundlach Museum (No. 102) which is probably also the origin of the name employed by Osborn 1926c: 354.

The color of fresh specimens is bright olive green with the eyes orange brown, faded specimens are more or less testaceous.

Male genitalia, seventh segment elongate, the median notch strongly elevated, forming a triangular tooth. Eighth segment short, almost concealed by the seventh segment. The median length of the ninth segment about twice as long as the median length of the seventh segment, broadly emarginate posteriorly. Genital plates elongate, nearly three times as long as the median length of the ninth segment; contiguous ventrally; dorsal margin with a distinct triangular tooth, basally. Tenth segment spatulate; the apex notched. Anal spine elongate, extending about one-third of its length beyond the apex of the tenth segment.

Specimens are at hand from Camaguey, July 15, J. A., Jarahueca, Oriente, July 14-18, '27; Sierra Rangel, P. del Rio, August 29, '27, 1500 feet; Casa Blanca, Havana, June 2, '26, S. C. B. and Santiago de las Vegas, September 2, '23; J. A., and June 3, '27, S. C. B. and B. T. Barreto, on *Cestrum diurnum* L.

Ladella acunae n. sp.

This species differs principally from *Ladella pallida* Walk in the short transverse vertex. The vertex in *acunæ* is twice as broad as its median length whereas in *pallida* it is not as broad as its medan length.

Vertex, twice as broad as its median length; the anterior and lateral margins distinctly carinate, the anterior margin broadly rounded, the lateral margins parallel, the posterior margin nearly parallel to the anterior margin; median carina not strongly elevated. Frons, elongate, about one and one-half times as long as the greatest width, distinctly narrowed between the eyes; the lateral margins parallel to the level of the lower margin of the eyes, divergent to the level of the antennæ, suddenly converging to the narrower clypeus. Dorsal margin with a broad carina, the lateral margins strongly carinate, the median carinæ not strongly elevated. Clypeus broader and more elongate than in *pallida;* the lateral margins of the clypeus almost continuous with the lateral margins of the frons. Antennæ short, the second segment about four times as long as its basal width. Ocelli inconspicuous. Prothorax short, broad; anterior margin broadly rounded following the contour of the posterior margin of the vertex, the posterior margin broadly incised forming about a right angle; lateral margins straight, about as long as the median length; median carina distinct; intermediate carinæ converging to median line anteriorly, broadly diverging but not reaching the posterior margin; lateral margin with two distinct carinæ diverging posteriorly; lateral area of the pronotum almost quadrangular. Anterior legs short, weak; tibia shorter than the femora. Mesonotum large; median length about equal to its width between the tegulæ; median and intermediate carinæ strongly elevated meeting anteriorly on the median line and reaching the posterior margin. Fore wings, venation characteristic of the genus; the costal border relatively broader than in *pallida;* radius and cubitus forked at about the same distance from the basal cell, medius forked at slightly greater distance; transverse line irregular, cross-veins in apical area few, some of which form a single distinct line. Hind legs, long, slender; tibiæ one and one-half times as long as the femora; tibiæ armed with three distinct spines, one near the apex, one near middle and one between these two; claws weak. Male genitalia, ninth ventral segment robust, broadly excavated posteriorly; genital plates elongate triangularly, rounded apically, meeting on the median line; tenth segment elongate, exceeding the genital plates, slender, spatulate; apex broad, rounded, notched.

Color, uniform pale green; spines on the posterior tibiæ and tarsi tipped with black; eyes concolorous.

Size, length to apex of wing 8.40 mm., width across tegular 1.90 mm.

Male Holotype, Los Llanos, Maisi, Oriente, Cuba. February 5, 1929, J. A.

FAMILY ACANALONIIDAE

In this family Guerin, Melichar, Osborn and Myers all record *Acanalonia servillei* Spinola from Cuba; Osborn records *Acanalonia sublinea* Walker; and Myers records an undetermined species. Our collection contains no less than seven species as indicated below.

Acanalonia servillei Spinola

This well known species has a wide distribution in the Southeastern states, having been recorded from Pennsylvania to Florida and in Cuba and Jamaica. We are inclined to question the Pennsylvania record of Amyot and Serville 1843a: 520. The short description would fit *Acanalonia latifrons* Walker, which was described later equally well and *latifrons* is the more northern species. The length given, 10 mm., is much nearer the average length of *latifrons* than it is of *servillei.* According to Melichar 1901a: 186 and Dozier 1928a: 110, this species is also found in South America but according to Distant 1910a: 298 the South American species is *A. laurifolia* Walker, which is distinct. *Servillei* may be recognized by its large size, 14-15 mm. to tip of wings, nearly uniform green color with the apical border of the wings marked by short brown dashes. The last ventral segment of the female is short with a short but distinct median flap with a curved posterior border. The width of the median flap is about one-fifth the width of the entire segment. In the male the genital plates are very broad, about three-fourths as broad as long. The tenth segment is short and broad, not reaching the apex of the genital plates. Anal style short, reaching about one-third the distance to the apex of the tenth segment; broadly spatulate in outline, bulbous at the base.

Specimens are at hand from Santiago de las Vegas, May, June and October, S. C. B., Hoyo Colorado, Havana, Camaguey, July 20, '23 and August 20, '24, J. A.; and from Mansanillo, July 31, '22, S. C. B. and C. H. B.

Acanalonia pumila Van Duzee

This species was described from Florida and has been recorded from Bermuda and North Carolina. Specimens are at hand from Isla de Pines, January 15, 1923, C. H. B., Barrio Caobilla, Camaguey, June 1927, J. A., Cojimar, Havana, July 1928, S. C. B., and Playa de Marianao, Havana, August 1927, S. C. B., Loma J. de la Torre, Oriente, January 1929, J. A. Also a pair of nymphs from the last locality. In general they resemble the adults. The frons is more elongate however, and has a double row of pustules along the lateral borders. These pustules are closely crowded and the inner row extends from the clypeal margin to the vertex and consists of about 13 distinct pustules. The outer row is shorter with about 8 pustules.

Female genitalia, the last ventral segment elongate; lateral and posterior borders distinctly sinuate to a rather deep notch on either side of the median projection which is about as long as the lateral margins of the segment and obtuse apically.

Male genitalia, the genital plates triangularly obtuse at the apex, exceeding the tenth segment by about one-fourth of their length. The tenth segment broad at the base; the anal groove broad and flat. Anal style elongate slender, bulbous at the base, the apex extending almost to the apex of the tenth segment.

Acanalonia impressa n. sp.

This species resembles *A. depressa* Melichar and *A. brevifrons* Muir. All three species have peculiar depressed vertexes. The present species is smaller than *depressa* but larger than *brevifrons*. From *brevifrons* it differs also in the more depressed vertex with the anterior margin nearly straight, not upturned as in *brevifrons*. The genital styles are not roughened in *impressa* as they are in *brevifrons*.

Vertex, impressed; its median length about half its width; surface smooth, somewhat shiny; anterior margin projecting in front of the eyes about one-half the median length; the posterior margin broadly rounded, indistinctly carinate; lateral margins about as long as the diameter of the eyes; diverging at an angle of about 20 degrees with strongly elevated carinæ which are continuous with the lateral carinæ of the frons and then curving abruptly caudad; lateral margins strongly carinate; nearly parallel but slightly diverging for about one-half the length and then abruptly converging to the clypeus; clypeal margin indistinct, the two arms forming an angle of about 45 degrees with each other. Clypeus, triangular, shallowly inserted in the frons, its width about three-fourths its length. Labrum, conical, about one-third the length of the clypeus; its surface distinctly hirsute. Epipharynx about one-half as long as the labrum. Labium, with basal segments small; second segment about twice as long as the distal segment. Mandibular sclerite small. Genæ, surface smooth, distinctly separated from the rest of the head by lateral carina of vertex and frons. Antennæ, short, length about one-fourth the diameter of the eyes; the basal segment about one-half as long as the distal segment; distal segment cylindric; flagellum slender, length about twice the diameter of the eye. Ocelli, evident, situated below the horizontal diameter of the eye. Compound eyes, large, ventral emargination indistinct. Pronotum, short, deeply impressed on either side of the median line; anterior margin rather broadly rounded, projecting about one-half its length; posterior margin very broadly rounded, not parallel with the anterior margin; lateral flaps large. Fore legs, coxæ large; femora stout, about as long as the coxæ without evident spines; tibiæ stout, prismatic; tarsi short, claws weak. Mesonotum, large, smooth, shiny; lateral carinæ indistinct; disc somewhat elevated, lateral areas strongly sloping; lateral borders elongate. Metanotum, small, triangular. Tegulæ, about as long as the diameter of the eye; somewhat crescentric with apices blunt. Fore wings, large; costal borders nearly straight; apical borders slightly rounded. Venation typical; stem of medius about twice as long as the basal cell, three branches occurring together, the first branch branching distad to the third branch. Middle coxæ shorter than the fore coxæ but about as stout; middle femora about as the fore femora with a row of six to eight indistinct teeth along the ventral anterior border. Middle tibiæ about as the fore tibiæ. Hind femora stout, about as long as the fore femora; hind tibiæ prismatic, distinctly clubbed apically, apex of the median face with two groups of teeth, one composed of two large teeth and the other of four small teeth. Hind tarsi, with the basal joint swollen with two large lateral teeth apically and a row of small teeth ventrally; claws short, stout.

Male genitalia, ninth segment broad, about three times as long as the eighth segment. Tenth segment short, not reaching the apex of the genital plate. Anal style short, robust, reaching about half way to the apex of the tenth segment. Genital plates elongate, nearly four times as long as its width; median border straight, contiguous throughout their entire length with an evident tooth dorsally; when viewed laterally genital plates are broadly triangular with the dorsal margin distinctly thickened posteriorly and projecting caudad as a blunt triangular tooth, and cephalid as a triangular tooth.

Female genitalia, last ventral segment short, the median flap short but distinct, its posterior border broadly rounded. Its width about twice its length.

Color, general color light green. The head and thorax tinged with tawny, especially on the carinæ and sides which are inclined to orange yellow; compound eyes dark with border distinctly black. Legs inclined to brown, the apex of femora and tibia externally more or less fuscous, with the claws and spines black. Fore wings with the costal and sutural borders tawny, the former paler anteriorly; the posterior half of the costal, apical and sutural borders distinctly marked with short brown dashes between the veins, the latter in large part faintly tinged with tawny. Hind wings milky with veins brownish. Abdomen tawny.

Size, length to apex of wings 10 mm; to apex of abdomen 6 mm; width across tegulæ 2.2 mm; length of wing 8.5 mm; width at apex 4.5 mm.

Holotype, male, Sierra Rangel P. del Rio, Cuba, August 29. Altitude 1500 feet. J. A. and S. C. B., on *Phoebe* *elongata.* Allotype, female, Barrio Caobilla Camaguey, Cuba, June 23-25, J. A. Paratypes, two males same as allotype and male, Baracoa, Oriente, Cuba, April 21-30, 1929, S. C. B. and L. Boucle.

Acanalonia lineata n. sp.

This species may be the same as the species listed by Osborn as *Acanalonia sublinea* Walk. It is apparently close to *A. viridis* Melichar. Walker gives no diagnostic characters of value for *sublinea* except length of body and length of wings. Our species is much smaller. Melichar gives as the chief diagnostic character for *viridis* "dass der innere Gabelast des N. ulnaris Ext. einfach ist," but it is evidently branched in the specimens before us.

Head across the eyes as wide as prothorax. Vertex, broad, about five times as broad as the median length; anterior margin confluent with the frons, broadly rounded when viewed laterally; posterior margin not concentric with the anterior margin, more deeply angularly emarginate; lateral margins diverging, definitely carinate. Frons, about one and one-third times as wide as long with a definite median carina; lateral margins carinate, slightly diverging to the level of the antennæ and then converging to the clypeus; clypeal margin fairly definite. Clypeus, conical, the median carina indistinct. Labium, basal segment short, intermediate segment elongate, robust; distal segment about two-thirds as long as the intermediate, slender. Antennæ, basal segment short, collar-like; distal segment broader than long, capitate with a definite apical notch. Flagellum, elongate, slender, longer than the great diameter of the eye. Ocelli, conspicuous at the level of the horizontal diameter of the eye. Compound eyes, large, ventral sinus small. Pronotum, broad, the dorsal field barely four times as broad as its median length, without carinæ or with faint median carina; anterior margin following contour of the head; posterior margin shallowly excavated; lateral fields large. Fore legs, coxæ elongate, about one-half as long as the femora; tibiæ prismatic, the margins distinctly elevated, ciliate with very short sub-erect setæ. Mesonotum, large, about three times as long as the vertex and pronotum together, wider across the tegulæ than its median length with a fine but distinct median carina. Tegulæ, very small, broadly U-shaped. Fore wings, subcosta short; radius elongate, breaking up into reticulations; medius branching into two branches at about the length of the basal cell, the costal branch branching again at about the same distance; claval branch unbranched; cubitus one unbranched. Middle coxæ, shorter than the fore coxæ, definitely conical; middle femora about as long as fore femora, stout; the ventral border carinate; middle tibiæ about as the fore tibiæ, the margins definitely short, ciliate. Hind legs, femora slightly longer and stouter than the fore femora; tibiæ about twice as long as the hind femora, distinctly clavate, the base slender, the apex with seven stout spines; tarsi with the basal segment stout, about twice as long as the intermediate, with a pair of stout lateral spines and eight short ventral spines.

Male genitalia, ninth ventral segment slender, elongate, about twice as long as the eighth; the genital plates very obtuse but slightly longer than the ninth segment; tenth segment elongate, slender deeply inserted in the ninth segment, not exceeding the genital plates; anal style short, slender, reaching one-third of the distance to the apex of the tenth segment.

Female genitalia, last ventral segment short, the median flap about as long as the lateral margins, its width about four times its median length.

Color, general color greenish, head and thorax fading to tawny olive green. Fore wings bright green, the apical margin marked with a row of indistinct brownish dashes. There is a distinct pale tawny line from the apex of the vertex to the tip of the mesonotum, which is continued along the commissural margins, where it is margined by indistinct brownish dashes. The pale tawny line from apex of vertex is absent in one of the paratypes. Legs tawny. The fore and middle tibiæ and hind tarsi brownish. Eyes dark brown.

Size, total length 8.25 to 9.00 mm., from apex of vertex to apex, 8.25 mm.; width of tegulæ, 2.10; total length of wings, 7.20; greatest width of wings, 4.70.

Holotype male, Barrio Caobilla, Camaguey, June 23-25, 1927, J. A. Allotype, female, Sto. Thomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A. Paratypes, male and female, Barrio Caobilla Camaguey, June 23-25, 1927, J. A.; female, Sto. Tomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A.

Acanalonia carinata n. sp.

This species resembles *A. umbraculata* Fabr., but is smaller, the median carina of the frons is very evident and extends to the base of the vertex.

Vertex, strongly sloping, confluent with the frons, anterior and posterior margins parallel, lateral margins strongly diverging. Frons, distinctly longer than broad, the side margins diverging slightly to the level of the eye and then converging to the clypeus, dorsal margins confluent with the vertex, median carina strongly elevated; a pair of intermediate carinæ start above the clypeal margins and diverge to the level of the dorsal margin of the frons, then converge to the base of the vertex where they are united by a transverse carina. Clypeus about as long as the width of the frons, median carina indistinct, the frontal margin indistinct, forming an obtuse angle. Antennæ, short, the basal segment collar-like, about one-half as long as the distal segment, which is short terete, the two segments together about one-fourth as long as the great diameter of the eye. Pronotum short, the anterior margin obtusely produced, the posterior margin shallowly excised; the impressed points small and shallow. Mesonotum, elongate without definite carinæ. Fore wings, elongate, relatively narrow, nearly twice as long as its greatest width. Medius three-branched.

Male genitalia, ninth segment elongate, tenth segment elongate, not reaching the apex of the genital plates; genital plates about twice as long as broad, obtuse, the dorsal angle strongly recurved in a blunt hook.

Color, grass green, the head, thorax, legs and abdomen fading to tawny, eyes clouded with black, claws and tips of spines black; margins of the wing fuscous or with fuscous dashes between veins.

Length, to the apex of wing, 6.50 mm.; length of wing, 6.00 mm.; width of wing, 3.20 mm.; width across tegulæ, 180 mm.

Holotype, male, Santiago de las Vegas, June 2, 1922, S. C. B. Allotype, female, Sto. Tomas, P. de Zapata, Cuba, May 5-9, 1927, J. A.. Paratypes, male Sto. Tomas, P. de Zapata, May 5-9, 1927, S. C. B. and J. A.; Habana, Nov., 1927; Sto. Fe, Is. de Pines, Sept. 6, 1926, S. C. B.; Wajay, Aug. 31, 1928, S. C. B., Santiago de las Vegas, Feb. 1, 1929, and May 24, 1928, S. C. B. Female, Calabazar, August 5, 1928, S. C. B.

Acanalonia viridula n. sp.

This species is close to *A. virescens* Stal, but the vertex is rounded anteriorly, not produced as in that species, and the wings are elongate.

Vertex, anterior and posterior margins nearly parallel, surface smooth, median carina indistinct. Lateral margins but slightly diverging, nearly parallel to the anterior margins of the eyes, strongly elevated. Frons, slightly broader than long, the median carina strongly elevated to the dorsal margin; lateral margins slightly diverging to the level of the antennæ and then strongly converging to the clypeus; clypeal margin distinct, the two limbs forming a right angle. Clypeus elongate, together with the labrum, longer than the frons. Antennæ, short, length about one-third the great diameter of the eye; basal segment, collar-like, distal segment capitate. Flagellum about as long as the great diameter of the eye. Pronotum short, its width to the tegulæ about six times its length; anterior and posterior margins not parallel, without carinæ. Fore legs, the fore tibiæ longer than the femora and trochanter together; femora stout, tibiæ prismatic, the margins strongly emarginate and ciliate. Mesonotoum about twice as long as the vertex and pronotum together; median and lateral carinæ evident. Middle legs, about the same as the fore legs, hind tibiæ elongate, clavate. Fore wings are elongate, nearly twice as long as their greatest width. Medius with three branches evident, the inner branch indistinctly forked near the apex.

Male genitalia, the ninth segment elongate, about one-half as long as the genital plates; the tenth segment reaching the apex of the genital plate, genital plates broad, their width about three-fourths their length, apex broadly rounded, distinctly ciliate.

Size, length to the apex of the wing, 7.50 to 7.75 mm.; width across the tegulæ, 2.20 mm.; total length of the wing, 6.60 mm.; greatest width, 3.50 mm.

Color, general color grass green, the head, legs and abdomen fading to tawny green, the eyes clouded with black. The flagellum, claws and spines of the legs tipped with black. Apical border of wings with short, indistinct fuscous dashes.

Holotype, male, Cape San Antonio, March 13, 1924, S. C. B. Paratype, male, Santiago de las Vegas, July 11, 1922.

Acanalonia gundlachi n. sp.

Head across eyes distinctly narrower than prothorax. Vertex, strongly produced into an acute angle, obtusely rounded at extreme apex, as long or somewhat longer than broad, about twice the length of pronotum, flat or very faintly concave over disc, slightly elevated towards apex, surface smooth, without carinæ, lateral margins sharp. Frons, flattened, meeting vertex at an acute angle. Pronotum, short, rather strongly impressed on either side of median line, anterior margin well rounded and extending between eyes to more than three-fourths distance to their anterior margin, posterior margin very broadly and shallowly emarginate, not parallel with anterior margin, surface smooth, without carinæ, somewhat flattened dorsally. Mesonotum, large, about four times as long as pronotum, smooth with faint indications of lateral carinæ, rounded above, disc not distinctly elevated. Fore wings, large, broad, broadest across center, narrowing slightly towards apex, strongly rounded before center, then straight, apical margin vertical, nearly straight, slightly rounded. Venation, prominent, medius long, strongly elevated. Color, bright green; fore wings very narrowly bordered with tawny, broader on sutural margins; the elevated medius appearing pale orange testaceous; legs brownish testaceous.

Size, length to apex of tegmen, 13 to 15 mm.

Holotype and paratype from Yateras, Oriente Province, and Monte Toro, Cuba, Dr. J. Gundlach, collector; in the Gundlach Museum, Habana, Cuba, No. 344.

The above brief description was made from the two specimens preserved in the Gundlach Museum in a sealed, glass-covered box, from which they could not be removed for more careful study. This striking species is not easily confused with anything else reported from the West Indies. It appears to be related to the very recently described *Acanalonia coniceps* Osborn from Porto Rico (Jour. Dept. Agric. Porto Rico, 3, pp. 108-109, July, 1929—issued November, 1929), but is much larger.

Acanalonia insularis n. sp.

This species resembles *Acanalonia lineata* in general appearance, but is much smaller, 6.5 mm., as contrasted with 9.5 mm. of the other species. The genitalia is also decidedly different. It resembles *carinata* in having the diverging intermediate carinæ, but differs in having the shorter, somewhat broader frons and in having relatively narrow and more elongate wings. The genitalia is also decidedly different from those of *carinata*.

Vertex, somewhat elongate with median length slightly more than one-half the width between the eyes; median carina fine, distinct; anterior margin broadly triangular; lateral margin slightly diverging. Frons, nearly as broad as long; lateral margins parallel to the level of the antennæ and then converging to the clypeus. Median carina distinct; a pair of intermediate carinæ arise about the middle of the frons and diverge to the lateral margin. Clypeus, short, about as long as broad. Pronotum, short, with its median length about two-thirds as long as the median length of the vertex; anterior margin obtusely produced; posterior margin broadly sinuate. Mesonotum, longer than broad, ecarinate. Fore wings, rather short and broad; medius, three-branched.

Male genitalia, ninth segment elongate; tenth segment short, reaching about two-thirds of the distance to the apex of the genital plates. Genital plates, broad, obtuse; dorsal angle broad, not recurved.

General color, grass green, with the tips of the tibia and the tarsi fading to tawny. Eyes, chocolate color. Claws and spines black. Costal and apical margins of wings with fine black dashes between the veins. A median pale stripe extends from the apex to the vertex across the pro and mesonotum to the apex of the claws.

The length to the apex of wings, 6.80 mm. Length of wings, 5 mm. Greatest width of wings, 4.50 mm.

Holotype: Male, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B.

Allotype: Female, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B.

Paratypes: Male, Sta. Fe, Isla de Pinos, Sept. 8, 1928. S. C. B. and L. B. Female, Nuena Gerona, Isla de Pinos, Sept. 12, 1928. S. C. B.

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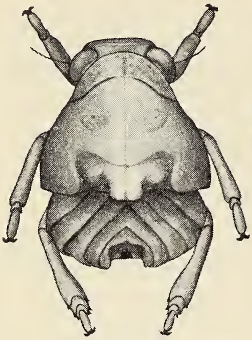
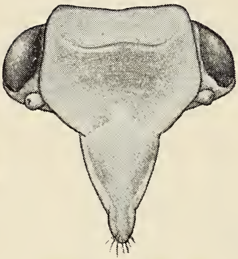
Descriptions of Plates

Plate 21.	Adults and nymphs of Cuban Tropiduchidæ and Acanalonidæ.
Plate 22.	Outlines of head and thoracic characters of Cuban Tropiduchidæ and Acanalonidæ.
Plate 23.	Wings of Cuban Tropiduchidæ.
Plate 24.	Male Genitalia of Cuban Tropiduchidæ.
Plate 25.	Male genitalia of Cuban Acanalonidæ.

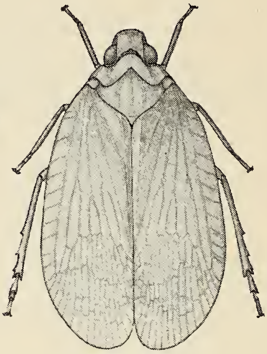
Psyche, 1930 Vol. 37, Plate 21.



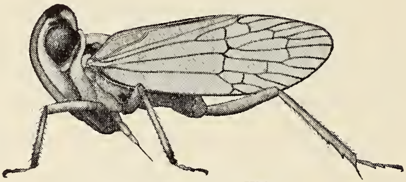
Acanalonia pumila Van D. nymph



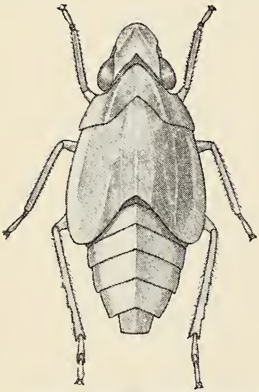
Acanalonia impressa n.sp.



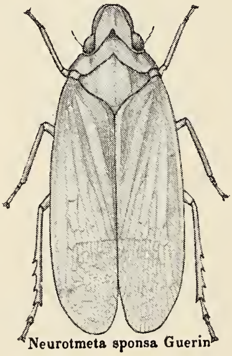
Ladella acunae n.sp.



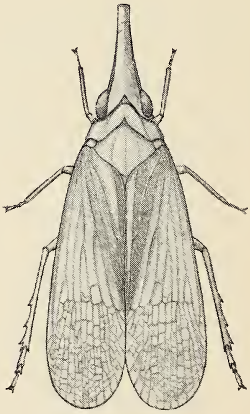
Cyphoceratops furcata Uhler



Neurotmeta sponsa Guerin.nymph.



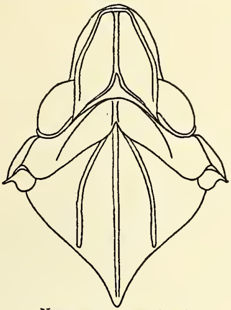
Neurotmeta sponsa Guerin

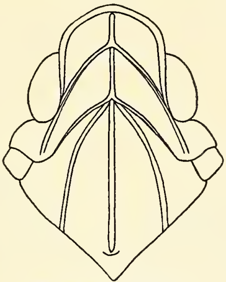


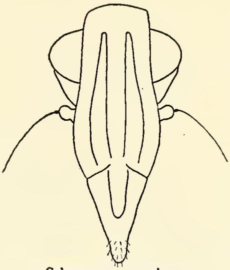
Remosa spinolae Guerin

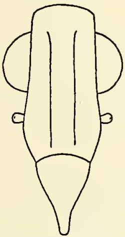
Metcalf and Bruner—Cuban Fulgorina.

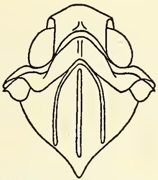
Psyche, 1930 Vol. 37, Plate 22.

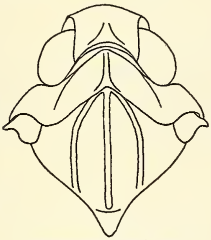

Neurotmeta sponsa Guerin

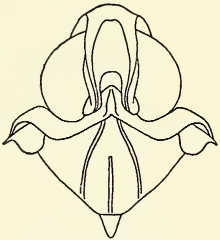

Neurotmeta breviceps n.sp.

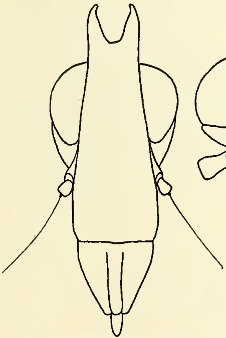

Colgorma campestris n.sp.

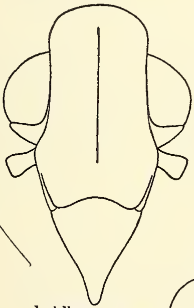

Colgorma montana n.sp.

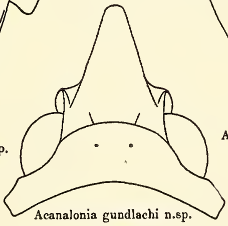

Colgorma montana n.sp.

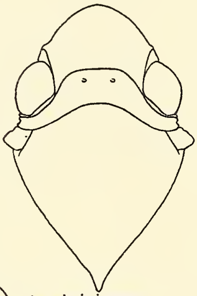

Colgorma campestris n.sp.


Cyphoceratops furcata Uhler


Cyphoceratops furcata Uhler

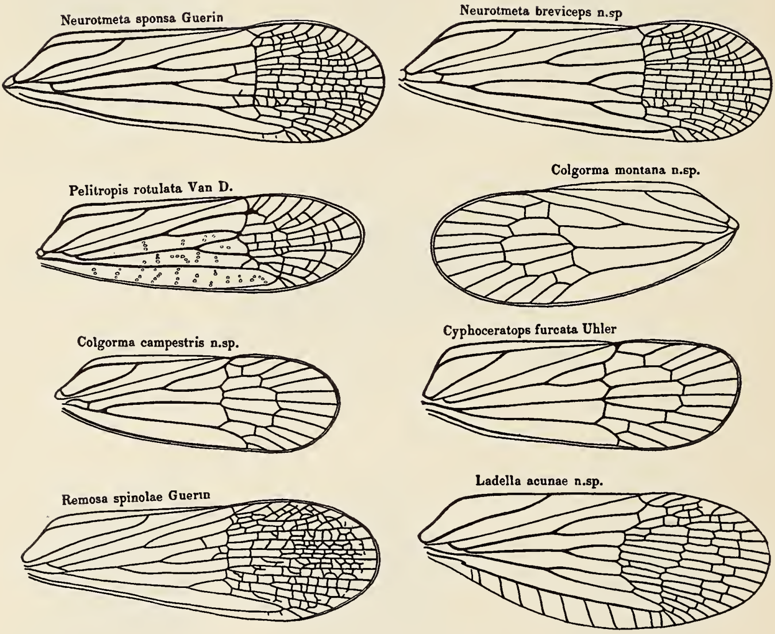

Ladella acunae n.sp.


Acanalonia gundlachi n.sp.


Acanalonia impressa n.sp.

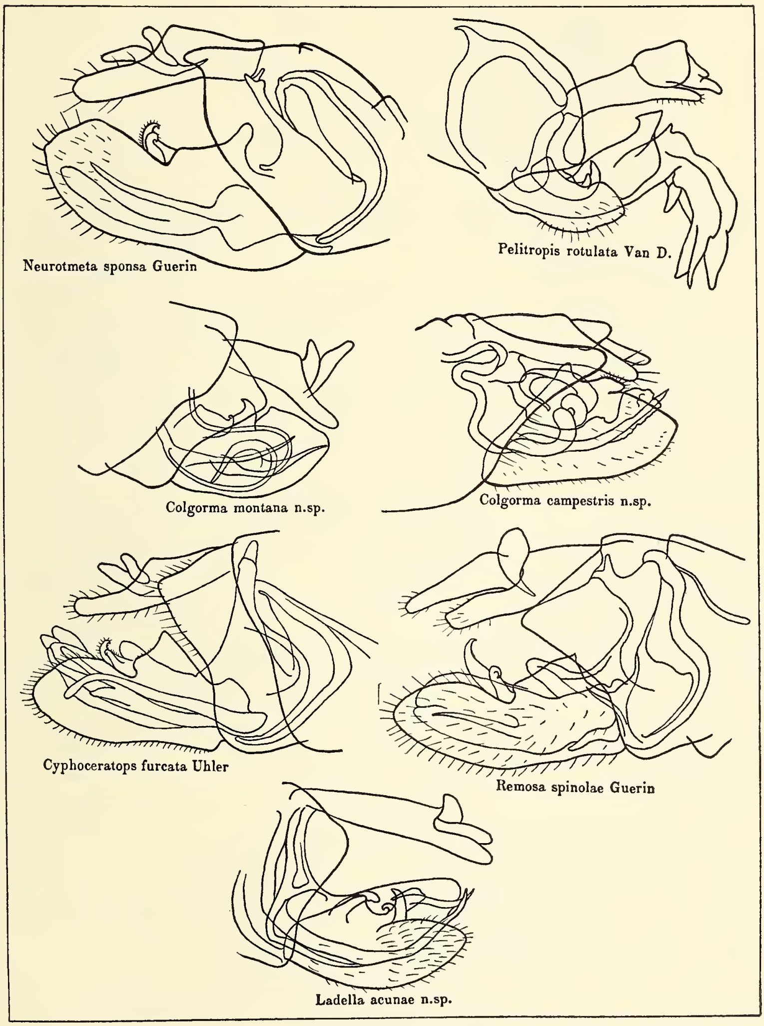
Metcalf and Bruner—Cuban Fulgorina, Head and Thoracic Characters.

Psyche, 1930 VOL. 37, PLATE 23.



Metcalf and Bruner—Cuban Tropiduchidæ, Fore Wings.

Psyche, 1930 Vol. 37, Plate 24.



Neurotmeta sponsa Guerin

Pelitropis rotulata Van D.

Colgorma montana n.sp.

Colgorma campestris n.sp.

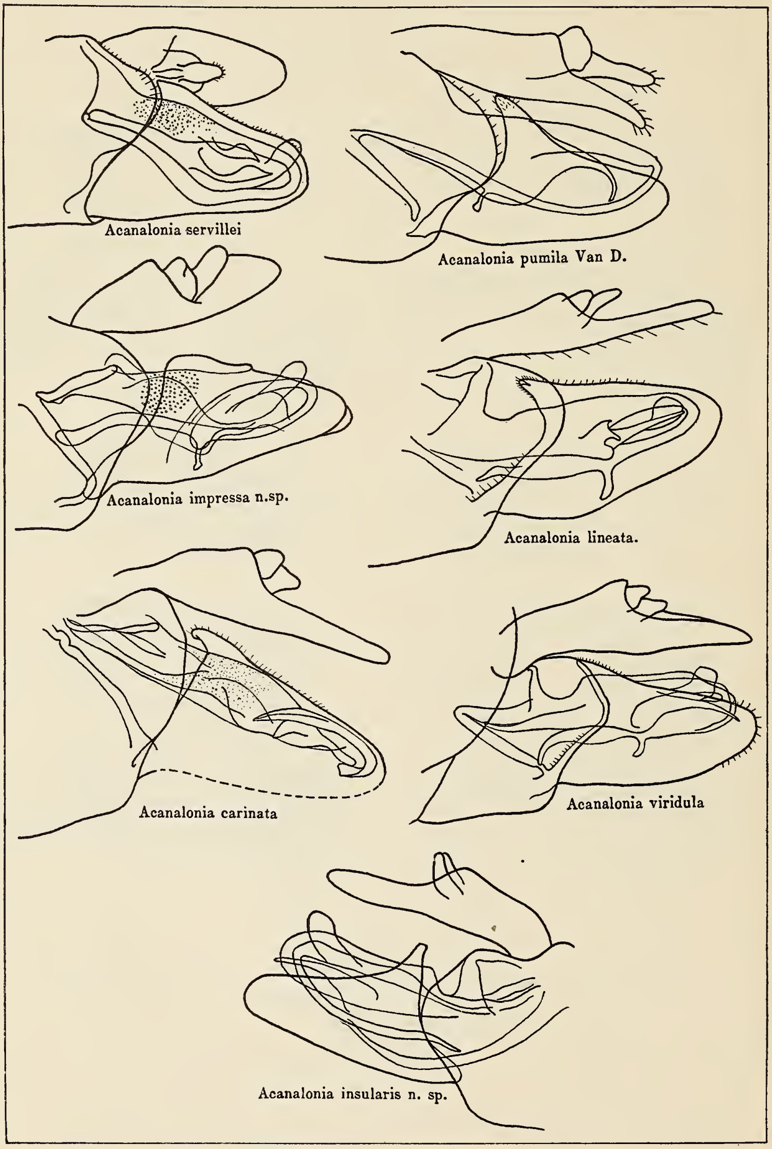
Cyphoceratops furcata Uhler

Remosa spinolae Guerin

Ladella acunae n.sp.

Metcalf and Bruner—Cuban Tropiduchidæ, Male Genitalia.

Psyche, 1930 VOL. 37, PLATE 25.



Acanalonia servillei

Acanalonia pumila Van D.

Acanalonia impressa n.sp.

Acanalonia lineata.

Acanalonia carinata

Acanalonia viridula

Acanalonia insularis n. sp.

Metcalf and Bruner—Cuban Acanaloniidæ, Male Genitalia.

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All new genera, new species and new names are printed in SMALL CAPITAL LETTERS.

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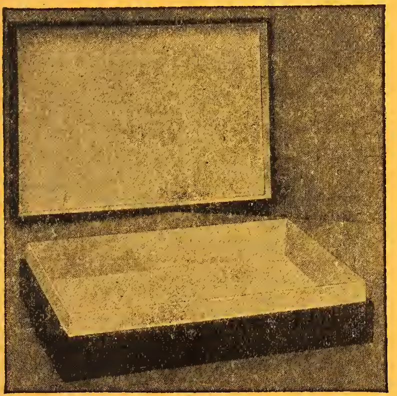

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