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Vol. 62 March, 1955 No. 1

HEALED WOUNDS AND GALLS ON FOSSIL LEAVES FROM THE WILCOX DEPOSITS (EOCENE) OF WESTERN TENNESSEE

By H. K. Brooks

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Introduction

The specimens described herein are not the first evidence of insects to be reported from the Eocene deposits of Western Tennessee and the adjoining states of Alabama, Mississippi, Arkansas and Kentucky. Features produced by the activities of insects on fossil leaves have been described and figured by Berry (1916, 1928, 1930, and 1931). Collins (1925, p. 406) observes that "Insects must have been more or less plentiful at this time, as we find such evidence of them as fossil insect galls and caddis fly tubes, while leaves occasionally exhibit holes, galleries and irregular margins which are due in all probability to insect ravages."

The alleged evidence of insect activities, a termite wing described by Collins (1925), a wing of a large ponerine ant by Carpenter (1929) and the elytra of three species of beetles by Wickham (1929) are the only traces of arthropods reported from the Wilcox deposits of Tennessee and adjoining states. These deposits have yielded one of the best preserved early Tertiary floras of North America and it seems anomalous that arthropods should have left such a meager record.

The caddis fly cases constructed of fragments of leaves are well preserved and have been well illustrated by Berry

(1928). With the exception of the galls, the other alleged insect-produced features have either been misinterpreted or the features are of questionable significance.

COLLECTION AND OCCURRENCE

The specimens described below were collected by the late Dr. R. Lee Collins. They are from a clay lens in the Holly Springs formation exposed in a clay pit immediately southwest of Puryear, Henry County, Tennessee. This lens of kaolinitic clay contains an abundance of well preserved angiosperm leaves. Berry (1916 and 1930) studied the flora and determined the age of the deposit to be lower Eocene.

Berry (1928, p. 3) interpreted the paleoecology of these deposits of crossbedded sands and lenses of plant bearing clays to be nonmarine. "The general environmental picture of this area during the time of deposition . . ., is of a low, abundantly forested, warm temperate coast, with bayou-like stream distributaries emptying into lagoons ponded behind extensive barrier beaches, beyond which the gulf waters were extremely shallow, and not typically marine for a considerable distance."

EVIDENCE OF LEAF-CUTTING BEES

In 1916, Berry (p. 33, pl. 107, fig. 5) figured a leaf of *Icacorea prepaniculata* from Puryear, Tennessee, which he states is "badly riddled in a manner suggesting the work of leaf-cutting bees." The figured specimen has over sixty small, irregular holes. This is not the type of injury produced by recent megachilid bees and therefore Berry's alternate suggestion that the holes "are due to a brood of leaf-eating caterpillars" is a better guess. Later, Berry (1930, pl. 48, fig. 33) figured a leaflet of *Cassia fayettensis* from the same locality with a very irregular saw-toothed margin. Small notches variable in size but all less than 2 mm. across have been cut-out all around its margin. The explanation of the figure states that it is "A leaflet showing an insect-cut margin," and it is cited (Berry, 1931, p. 302) as "a specimen which has been cut in a manner which may indicate the work of some lower Eocene leaf-cutting bee." In the same paper, a leaf of *Icacorea* *perpaniculata* from Graves County, Kentucky, with embayments cut into its margins, 6 to 9 mm. across, is figured and discussed. The notches are crudely semicircular and are variable in outline and in size. Berry admits the dubious nature of these injuries and suggests as an alternative that the cuts may have been made by caddis fly larvae for the construction of cases.

These examples are all suggestive of the work of leaf-eating insects. The last specimen cited may have been cut by a primitive leaf-cutting bee, the work of which appears cruder than that of the modern Megachilidae but can hardly be regarded as conclusive evidence of the presence of megachilid bees in the Eocene forest of Tennessee and adjoining states.

A bee-cut *Nectandra pseudocoriacea* leaf, more authentic than those described by Berry, was collected by R. Lee Collins at Puryear, Tennessee. The leaf has four semicircular pieces, 5 to 6 mm. in diameter, cut from one of its edges (pl. 1, fig. 1 and 1a). The darkened borders of the wounds appear to be lignitized remains of scar tissue. Recent female megachilid bees inflict similar injuries in cutting pieces of leaves for the construction of nests. Semicircular pieces are cut for the construction of the sides and circular pieces for partitions. In contrast, damages to leaves produced by phytophagous insects are irregular in shape. The scar tissue proves that the leaf remained on the tree for some time after it was injured and could not have been cut by a caddis fly larva for pieces of leaves to construct a case (pl. 1, fig. 6) as Berry suggested (1931, p. 303). The uniformity of the shape and size of the injuries and the presence of the scar tissue is credible evidence that the fossil leaf was damaged by a leaf-cutting bee.

No fossil Megachilidae have been reported from rocks older than the Oligocene deposits of Florissant, Colorado (Cockerell, 1908). The deposit has also yielded a leaf with semicircular notches cut into its margin which Cockerell (1910, p. 429) states is evidence that the habit of cutting out pieces of leaves for building nests was as highly developed by the megachilid bees during the Oligocene as it is at present. On the basis of the above described insect-cut leaf, the range of the Megachilidae is provisionally extended to the Eocene.

LEAVES DAMAGED BY PHYTOPHAGOUS INSECTS

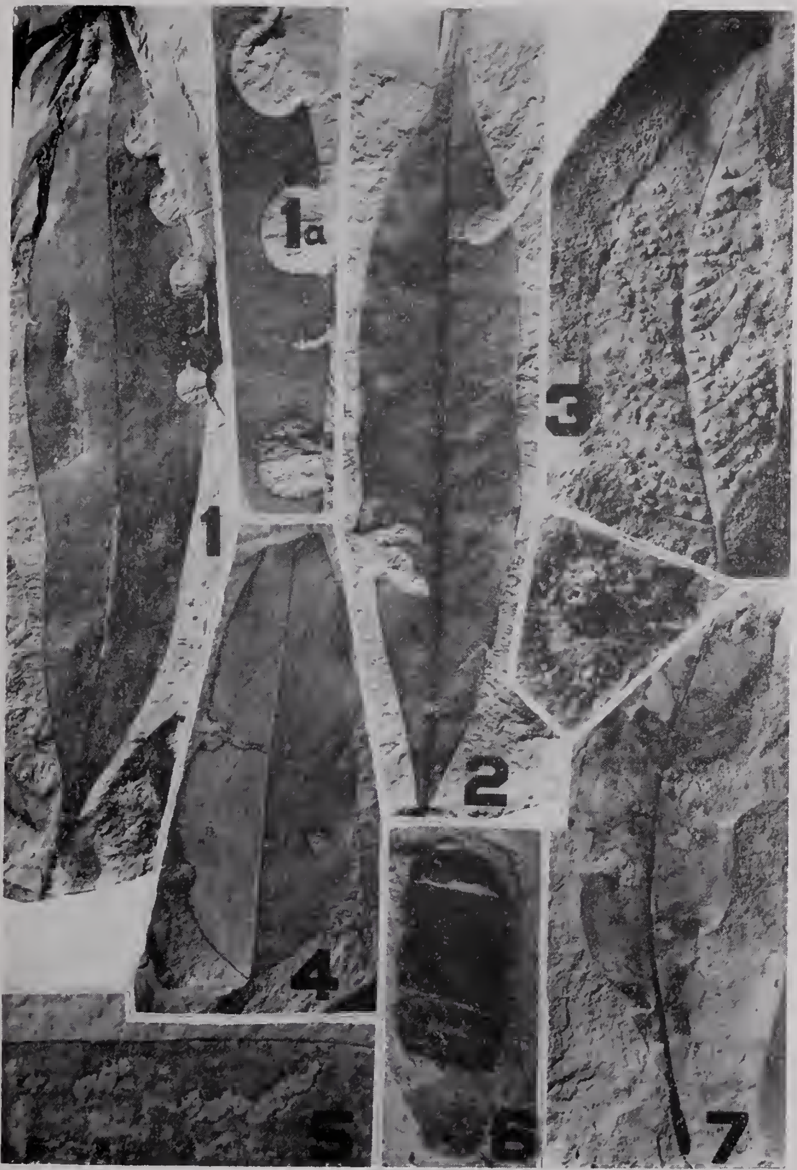
Nearly half of the extant species of insects are phytophagous (Brues, 1946, p. 90) and phytophagy is generally assumed to be the primitive diet. It is perplexing, therefore, that no example of the remains of fossil plants from the Paleozoic and lower and middle Mesozoic have been reported exhibiting healed wounds that could have been caused by insects. However, most Recent defoliators feed on angiosperms and healed damages are rather common on fossil angiosperm leaves from the Cretaceous and Tertiary.

A variety of healed injuries which appear to be due to phytophagous insects are shown on leaves figured on plate 1, fig. 2, fig. 4, fig. 5, and fig. 7. Determination of the culprits responsible for the different types of damage is impossible.

The "galleries" in the angiosperm leaves from the Wilcox deposits mentioned and figured by Berry (1916, p. 32; pl. 23, fig. 3; pl. 31, fig. 1 and fig. 3; pl. 38, fig. 4; pl. 39, and pl. 92) and which were later referred to by Collins (1925, p. 406) are not the same as the meandering, elongate, narrow wounds surrounded by scar tissue on the portion of a *Proteoides wilcoxensis* leaf shown enlarged in fig. 5.

EXPLANATION OF PLATE 1

Figure 1. A fossil leaf, *Nectandra pseudocoriacea* Berry, from the Wilcox deposits of Puryear, Tennessee, bearing injuries inflicted by megachilid bees. Figure 1a. A portion of the above described leaf enlarged to twice natural size to show the scar tissue surrounding the injuries. Figure 2. A fossil leaf, *Nectandra pseudocoriacea* Berry, bearing healed wounds probably inflicted by defoliating phytophagous insects. Figure 3. A fossil leaf, *Cupanites formosus* Berry, bearing simple pouch galls. Figure 4. A fossil leaflet, *Cassia sp.,* bearing healed wounds. Figure 5. A portion of a fossil leaf, *Proteoides wilcoxensis* Berry, enlarged four times to show healed meandering wounds. Figure 6. Fossil caddis fly case, *Folindusia wilcoxiana* Berry, found in association with the other figured specimens. Figure 7. A fossil leaf, *Nectandra pseudocoriacea* Berry, badly damaged by leaf-eating insects and bearing 11 galls. Figure 7a. A portion of figure 7 enlarged 10 times to show one of the galls.



Brooks — Fossil Galls

These wounds were inflicted by some creature crawling on the surface of the leaf and not by a mining insect, such as the larvae of some moths and saw flies which tunnel through mesophyll.

This author has seen nothing suggestive of the activity of leaf mining insects on fossil leaves. The "galleries" referred to appear to be products of preservation as they consist of low ridges of uniform width which run across the leaves irrespective of the veins and the midribs.

GALLS

Traumatic plant growths comparable to Recent galls are uncommon on the remains of plants from Tertiary. Fossil galls have been figured from the Wilcox deposits of Tennessee by Berry (1916, p. 33, pl. 56, fig. 2, and pl. 111, fig. 1), mentioned by Collins (1925, p. 406) and again by Berry (1931, p. 301). Scudder (1886, p. 98) mentions cynipid galls from the Oligocene deposits of Florissant, Colorado and a gall was figured, discussed and named by Cockerell (1908, p. 66, pl. 5, fig. 7) and Brues (1910, p. 14, fig. 7). The Oligocene galls were later discussed by Kinsey (1919, p. 44-49) and he states that they are synonyms and definitely are not cynipid galls. Miocene galls from Douglas County, Washington, have been described by Hoffman (1932, p. 341-342, fig. 1) and compared to Recent cynipid and itonid galls. Brues (1946, p. 171) mentions that galls have been observed on Cretaceous leaves but does not document his statement.

The leaf of *Cupanites formosus* illustrated on plate 1, fig. 3 from Puryear, Tennessee, has many malformations between the veins and veinlets which closely resemble Recent simple pouch galls. The individual irregular pouches average about 1 mm. in diameter and vary from about one-half to twice this size. The individual pouches are simple invaginations from the ventral side of the leaf. Similar Recent homeomorphic abnormalities are commonly produced on leaves by gall mites (Eriophyidae), aphids (Aphidae), jumping plant lice (Chermidae=Psyllidae) and several other types of lowly arthropods. Crinkling of leaves which bears some resemblance to the malformations on the fossil leaf are sometimes produced by fungal infections.

Not only does the leaf of *Nectandra pseudocoriacea* figured on plate 1, fig. 7, bear the results of the activity of some leaf-eating organism, presumably an insect, but the remaining part of the leaf bears eleven well preserved "cone" galls (fig. 7a). The structures are mammilliform and seem to be separated from the leaf by a constriction at the point of attachment. They are elliptical at the base, 1 mm. by 0.8 mm., and taper to a blunt apex about 0.4 mm. above the surface of the leaf. Immediately surrounding the galls, the leaves are darkened. The darkened areas probably reflect sclerotized leaf tissue in the vicinity of the galls as the coloration is due to a greater amount of lignitized leaf residue.

These "cone" galls are comparable in size and general shape to some Recent galls induced to develop on leaves by gall mites (Eriophyidae), plant lice (Phylloxeridae) and especially by gall midges (Cecidomyiidae=Itonididae) and by gall wasps (Cynipidae). The sclerotized leaf tissue surrounding the galls is suggestive of Recent "leaf spot galls" produced by the gall midge, *Cecidomyia ocellaris* on maple leaves (Felt, 1940, fig. 258).

Neither of the alleged insect galls described and figured by Berry (1916, pl. 111, fig. 1, and pl. 56, fig. 2) is similar to the structures described above. One consists of small, deep, conical depressions on the impression of a leaf and the other is a compression of a petiole gall. Both figured specimens seem to bear authentic galls.

Though binomial names have been proposed by Cockerell (1908) and Brues (1910) for fossil galls, it is believed that no useful purpose is served by naming such objects.

Gall forming arthropods are small and fragile and thus there is an extremely meager fossil record of their remains. The reported stratigraphic ranges of the families mentioned above are as follows:

Class Arachnida
  Order Acarina, Family Eriophyidae, no fossils
Class Insecta
  Order Hemiptera, Family Phylloxeridae, no fossils
    Family Chermidae, Oligocene to Recent (Handlirsch, 1921).

Family Aphidae, Cretaceous (?) to Recent (Essig, 1937).

Order Diptera, Family Cecidomyiidae, Eocene? to Recent (Handlirsch, 1921).

Order Hymenoptera, Family Cynipidae, Cretaceous (?) to Recent (Kinsey, 1937).

ACKNOWLEDGEMENTS

Dr. Frank M. Carpenter kindly provided information on the known stratigraphic ranges of the families mentioned. Dr. Roland W. Brown identified the fossil leaves and made several helpful suggestions and corrections on a preliminary copy of this paper.

It is hoped that this paper will be a tribute to the late Dr. R. Lee Collins who recognized the significance of these fossils. They have been placed in the collections of the United States National Museum where many other excellent specimens of fossil plants from the Wilcox deposit collected by Dr. Collins have previously been placed.

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THE FEMALES OF *ENALLAGMA LATERALE* MORSE AND *RECURVATUM* DAVIS (ODONATA: COENAGRIONIDAE)

By Robert H. Gibbs, Jr.

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Of the 23 northeastern members of the genus *Enallagma*, the females of *piscinarium*, *laterale*, and *recurvatum* have not been described. *E. piscinarium* is apparently known only from the type male. Although males of *laterale* have been taken in several localities, the female remains unrecorded. The female of *recurvatum* may have been collected, but references to it are quite misleading. In the original description of the species by Davis (1913) the female is supposedly described, but the description is quite inadequate and not diagnostic. Byers, in his key (1927), does not distinguish it from *E. hageni* other than by its comparative rarity. Garman (1927) stated that "all supposed females thus far examined have proved to belong to other species."

Systematic collecting on Cape Cod, Massachusetts, has resulted in the finding of tandem pairs of both *laterale* and *recurvatum*. In addition, Thomas W. Donnelly has allowed me to examine some collections sent to him by Mr. Roy Latham from Riverhead, Long Island, New York, which contained two females of *recurvatum* and one of *laterale*. The following descriptions are based on these Cape Cod and Long Island specimens.

For suggestions during the preparation of this manuscript, I wish to express appreciation to E. M. Walker, L. K. Gloyd, M. J. Westfall, Jr., T. W. Donnelly, H. E. Evans, and J. G. Franclemont.

Enallagma laterale Morse. Female

Psyche 7: 274. 1895

Color: Olivaceous, washed with light blue, and black.

Head: Dorsum black; pale frontal margin reaching bases

of antennae; postocular spots elongate, comma-shaped, connected by a narrow, pale occipital bar, not quite reaching the ocular margins; face pale except postclypeus black with pale margins; mouthparts and rear of head pale; antennae black, apices of first and second segments pale.
Prothorax: Front lobe pale bordered with black; middle lobe black dorsally, pale laterally, a dorsolateral pale spot present on each side and variable in size, a pair of prominent dorsolateral pits present near the caudal margin; hind lobe black with pale lateral margins, caudal margin convex and entire.

Pterothorax: Pale with black middorsal stripe occupying about half the mesepisternum and slightly narrowed posteriorly; black humeral stripe slightly narrower than pale antehumeral stripe, of about constant width throughout, but with a slight widening posterior to the mesinfraepisternum; first lateral stripe represented by a mere posterior vestige; metapleural suture covered by a thin second lateral stripe, which expands posteriorly into a spot; humeral and middorsal stripes connected posteriorly by the black of the antealar carina and sinus, which fades slightly laterad of the humeral stripe. Coxae and trochanters entirely pale. Femora and tibiae pale, each with a black external stripe for almost the entire length; tarsi pale, each with distal end of third segment dark; spines of legs black; claws pale with black tips.

Mesostigmal laminae: Widest in mesal half; a closed mesal concavity present, deepest posteriorly; the entire lateral half twisted and upturned at an angle of 60 degrees or more; most of lateral half pale; separated from the thoracic depression by a posterior groove for its lateral half only.

Wings: Venation black or dark brown; pterostigma light brown. M_2 arises between the 4th and 5th postnodal crossveins in the front wings, between the 3rd and 4th in the hind wings; postnodals 9-12 in front wings, 8-10 in hind wings; M_{1a} arises at about the level of the 8th postnodal in both wings.

Abdomen: Pale with black as follows: Segment one, a squared middorsal spot on basal half, a small apical spot on each side; segment 2, entire dorsum, widened slightly toward apex, connected to a narrow apical ring; segments 3-7, entire dorsum, abruptly constricted basally, slightly widened anteapically, connected with a narrow apical ring; segment 8, entire dorsum, widened gradually from base to apex; segments 9 and 10, entire dorsum. Midventral sternal carinae black on 1-8. Anal appendages and valves and styli of ovipositor pale; apex of each valve of ovipositor, to base of stylus, extends not quite to apex of segment 10 excluding appendages. Ventral spine of segment 8 black to dark brown, sharp.

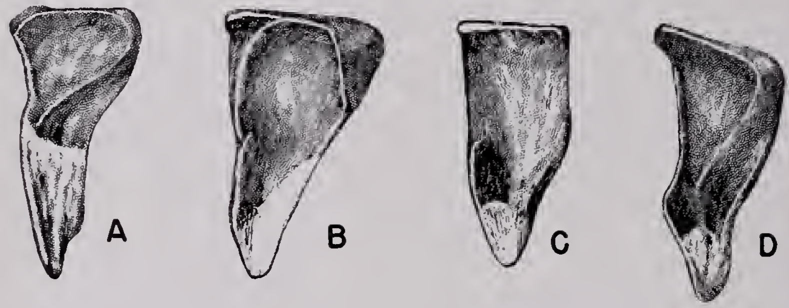

Figure 1. Left mesostigmal lamina of *Enallagma* females in dorsolateral aspect. A. *laterale*. B. *recurvatum*. C. *davisi*. D. *minusculum*. ca. 35x.

Measurements: Total length to apex of segment 10, excluding appendages: 24.8-28.0 mm.; length of abdomen: 20.0-22.7 mm.; length of front wing: 14.5-17.8 mm.; length of hind wing: 15.4-16.3 mm. The two Cape Cod specimens are larger; the Long Island specimen is represented by the smaller extreme in each case.

Described from two specimens captured in tandem with males by the writer at Jabinette's Pond, West Yarmouth, Massachusetts, on June 13, 1953, and one specimen from Riverhead, Long Island, New York, caught on May 29, 1953, by Mr. Roy Latham.

Enallagma recurvatum Davis. Female

Jour. N. Y. Ent. Soc. 21: 15-16. 1913

Color: Olivaceous, washed with light blue, and black.

Head: Dorsum black; pale frontal margin not quite reaching bases of antennae; postocular spots comma-shaped, isolated from the light occipital carina, not quite reaching ocular margins; face pale except postclypeus black and pale lateral edges; mouthparts and rear of head pale; antennae black, apices of first and second segments pale.

Prothorax: Front lobe pale bordered with black; middle lobe black dorsally, pale laterally, a dorsolateral pale spot either present on each side and variable in size, or absent, and a pair of prominent dorsolateral pits present near the caudal margin; hind lobe black with pale lateral margins, caudal margin convex and entire.

Pterothorax: Pale with black middorsal stripe occupying slightly more than half the mesepisternum, somewhat narrowed posteriorly; humeral black stripe slightly wider than the pale antehumeral stripe, widened at the mesinfraepisternal suture, narrower on the mesinfraepisternum; first lateral stripe absent or a mere vestige; second lateral stripe a fine line on the metapleural suture, widened posteriorly into a spot; middorsal and humeral stripes connected posteriorly by the black of the antealar carina and sinus, which continues laterad to the region of the first lateral stripe. Coxae and trochanters entirely pale. Femora and tibiae pale, each with a wide black lateral stripe covering most of their lateral surface; tarsi pale, each with tip of third segment dark; spines of legs black; claws pale with black tips.

Mesostigmal laminae: Mesal edge at about a 30 degree angle to middorsal carina; mesal half much wider than lateral half; postero-mesal corner much thickened; a deep depression near mesal margin; anterior margin of lateral portion upturned; lateral end with a variable, usually small, light spot.

Wings: Venation black or dark brown; pterostigma light brown. M_2 arises between the 4th and 5th or 5th and 6th postnodal crossveins in the front wings, between the 3rd and 4th or 4th and 5th in hind wings; postnodals 9-11 in front wings, 8-10 in hind wings, the majority having

11 and 9; M_{1a} arises at about the level of the 7th to 9th postnodal crossvein in the front wings, about the 7th or 8th in the hind wings, the majority arising at the 8th in both wings.

Abdomen: Pale with black as follows: Segment one, a middorsal basal spot and a lateral apical transverse dash; segment 2, entire dorsum, constricted or narrower in anterior half, connected with an apical ring; segments 3-7, entire dorsum, abruptly constricted basally, slightly widened anteapically, connected with an apical ring; segment 8, a narrow middorsal line abruptly widened to cover apical dorsum; segments 9 and 10, entire dorsum. Midventral sternal carinae black on 1-8. Anal appendages and valves and styli of ovipositor pale; apex of each valve of ovipositor, to base of stylus, extends not quite to apex of segment 10 excluding appendages. Ventral spine of segment 8 black or dark brown, sharp.

Measurements: Total length to apex of segment 10, exclusive of appendages: 26.8-28.2 mm.; length of abdomen: 21.0-22.2 mm.; length of front wing: 16.1-18.0 mm.; length of hind wing: 14.7-16.9 mm. Taken from four Cape Cod specimens and one from Long Island. The Long Island specimen is represented in each measurement by the smaller extreme.

Described from 11 specimens from the following localities: Flax Pond, North Falmouth, Mass., June 17, 1951 (3), June 16, 1953 (5), and Jabinette's Pond, West Yarmouth, Mass., June 13, 1953 (1), all collected by the writer; and Riverhead, Long Island, New York, May 29, 1953 (1), June 2, 1953 (1), collected by Mr. Roy Latham.

Key to Females of Ten Species of *Enallagma* Based Principally on Mesostigmal Laminae

In the key which follows, the females of ten species of *Enallagma* are compared. These ten comprise those which might be confused for one reason or another, or which may be closely related to *laterale* or *recurvatum*. Relationships among the species of *Enallagma* are difficult to determine and, to date, have been largely based on the form of the anal appendages of the male. It has been almost impossible to divide the females into logical groups. Mention of the males of the species being compared, then, may make clearer the reason for comparing their females.

Enallagma laterale would appear, from gross examination of the male genitalia, to be close to *E. piscinarium, E. davisi*, and *E. boreale*, and perhaps to *E. minusculum* (Westfall, 1943). In these species the superior anal appendage is shorter than segment 10 and ranges from bluntly rounded to deeply, but narrowly, cleft. *E. minusculum* is most like *davisi*, but the lower arm of the superior anal appendage of the former appears prominently circular in lateral view.

The male of *E. recurvatum* bears a superficial resemblance to *E. vernale*, but the latter species is believed by Mrs. Gloyd (1943) and by Walker (1953) to be more closely related to *cyathigerum*. The recurved superior anal appendages of *recurvatum* are somewhat similar to those of *E. hageni*, which, however, are straight as viewed laterally. Both *laterale* and *davisi* males are characterized by a lateral black mark on the eighth abdominal segment. Several *recurvatum* from Cape Cod also show this mark, although it is not commonly present.

The caudal lamellae of the nymphs of *E. ebrium* and *E. geminatum* resemble those of *laterale* (Howe, 1921), indicating possible relationship. The nymph of *recurvatum* is unknown, and that of *laterale* has never been adequately described.

The form of the mesostigmal laminae may prove to be indicative of relationships among the females of *Enallagma*. At any rate, the laminae are by far the best means for identifying the species. If Byers (1927) had possessed females of both *hageni* and *recurvatum*, he could have recognized them both immediately by a glance at the laminae. In the key this character will play a prominent part. For illustrations of the mesostigmal laminae of most of the keyed species, I recommend the beautiful plates in Walker (1953). Those of *laterale, recurvatum*, and *davisi* (from the allotype) are figured in the present paper, along with that of *minusculum*. The latter is included because Walker's illustration is somewhat deceptive. The resemblance is obvious, but I have found the lateral ends bluntly pointed, not rounded, and the diagonal ridge which runs antero-laterally from the postero-mesal region is diagnostic.

1 — Lamina more than half as wide as long 2
— Lamina less than half as wide as long 3

2 (1) Lamina widest mesally, gradually narrowing laterally for two-thirds of length, rapidly narrowing in lateral one-third to form an antero-lateral blunt point, postero-lateral edge not curled upward; dorsum of abdominal segment one entirely black, connected to an apical ring .... *ebrium*
— Lamina widest about midway to lateral end, the postero-lateral edge curled upward, often extremely so, a blunt point formed antero-laterally; dorsum of segment one with a black basal spot and an apical spot on each side .... *hageni*

3 (1) Lamina with a mesal enclosed concavity formed by the high antero-mesal corner and the raised or thickened postero-mesal edge 4
— No such concavity present; edges may be curled to form a shallow basin or cavity may be formed by anterior corner and be open posteriorly 8

4 (3) Postero-mesal margin of lamina tilted .... *vernale*
— Postero-mesal margin of lamina not tilted, but may be thickened 5

5 (4) Lamina twisted so that entire lateral half is greatly tilted 6
— Entire lateral half of lamina not up tilted; antero-lateral margin may be raised 7

6 (5) Twisted lateral portion of lamina bent posteriorly; lamina well-demarcated from thorax by a posterior groove for its entire length; prothoracic pits absent; segment one with dorsum entirely black, connected to apical ring; black of segment 8 not narrowed; black of segments 9 and 10 extending far laterad .... *minusculum*

— Twisted lateral portion of lamina not bent posteriorly; lamina definitely demarcated only in lateral half; prothoracic pits present; segment one with a black basal spot, lateral apical spots; segment 8 with black slightly narrowed anteriorly; black of segments 9 and 10 not extending much beyond a mid-lateral point .... *laterale*

7(5) Mesal edge of lamina at about 30 degree angle to mid-dorsal carina; postero-mesal corner much more thickened than antero-mesal, posterior edge broadly curved in mesal half, mesal half much broader than lateral half; pit in frame rather wide; prothoracic pits present; black of segment 8 constricted in basal half, no lateral stripe present on 2 or 8 ... *recurvatum*

— Mesal edge of lamina nearly parallel to mid-dorsal carina; antero-mesal corner more thickened than postero-mesal, posterior edge nearly straight, mesal half not greatly broader than lateral half; pit in frame rather small; prothoracic pits absent (sometimes a deceptive set of shallow areas present); a lateral black stripe present on segment 2; black of segment 8 narrow dorsally, a black lateral stripe present, the two black portions enclosing a blue spot on each side .... *geminatum*

8(3) Lamina nearly flat except tilted antero-lateral margin; prothoracic pits present .... *davisi*

— Lamina not flat; anterior open concavity present; prothoracic pits absent 9

9(8) Mesal edge of lamina at about a 30 degree angle to mid-dorsal carina; postero-mesal margin sharply delimited from the thorax by a groove ...... *cyathigerum*

— Mesal edge of lamina nearly parallel to mid-dorsal carina; postero-mesal margin not clearly demarcated from thorax .... *boreale*

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A NEW SPECIES OF ANT BELONGING TO THE *PHEIDOLE PILIFERA* COMPLEX (HYMENOPTERA: FORMICIDAE)

By Robert E. Gregg

Department of Biology, University of Colorado

A small collection of ants representing the genus *Pheidole* from several localities in Western United States was given to me recently by Dr. W. S. Creighton. Among these specimens are samples of several colonies from Oregon which prove to be a new species. The description of this ant follows herewith.

Pheidole creightoni sp. nov.

Soldier: Length, 3.75 mm.; head index, 0.94; head length, 1.33 mm.; thorax length, 1.00 mm.

Head subquadrate, slightly longer than broad, with prominent occipital corners and a deep occipital emargination leading to a pronounced cephalic sulcus. In profile, the occipital border is flat and slopes forward, but joins the vertex in a rounded though noticeable angle rather than through a continuous curve. Anterior clypeal border broadly emarginate in the center, the lateral borders nearly straight. Frontal carinae flat and slightly divergent. Frontal area well-defined and in the shape of an isosceles triangle. Eyes lateral and placed distinctly anterior to the middle of the head. Antennae 12-segmented, with a club composed of the last three articles; funicular segments 5 to 8, slightly longer than broad; antennal scape distinctly bent at the base, with only a faint indication of flattening, and with its distal portion definitely wider than the basal portion. The scape extends posteriorly a little less than one-half the distance from its insertion to the occipital corner of the head. Mandibles heavy, abruptly convex, and provided with two very blunt teeth at the apex; remainder of the cutting border entire.

Thorax convex, with well-marked humeral angles; promesonotum does not descend before reaching the mesoëpinotal suture; suture deep but narrow; epinotal spines projecting upward and outward, blunt, about one-half as long as the distance separating their bases. Petiolar peduncle long, node narrow in the antero-posterior direction and shallowly emarginate on the crest. Postpetiole twice as wide as the petiole, lenticular in shape from above as a result of pronounced lateral conules which are convex anteriorly and concave posteriorly.

Abdomen elliptical and somewhat depressed; of the shape usually characteristic for the genus.

Sculpture: Pronounced transverse rugae on the occiput, extending into and across the cephalic furrow, but fading out on the vertex; finer, longitudinal rugae on the frons, anterior surfaces of the genae, and on the clypeus; inter-rugal striations and granules very fine, so that the sculptured areas of the head are shining; non-sculptured regions (vertex, gula, and frontal area) are exceedingly smooth and shining; mandibles striate and shining. Thorax glabrous and shining except the granular mesopleurae and epinotal pleurae; basal face of the epinotum between the spines for the most part smooth; mesoëpinotal suture cross-striate. Petiole and postpetiole finely granular, almost smooth. Gaster smooth and shining.

Pilosity: Head, thorax, petiole, postpetiole, gaster, legs, funiculi, and scapes covered with long, finely pointed hairs of varying length.

Color: Head yellowish red, mandibles brown, thorax brownish red, gaster dark brown, legs and antennae light brown.

Worker: Length, 2.08 mm.; head index, 0.86; head length, 0.58 mm.; thorax length, 0.67 mm.

Head subquadrate, occipital border slightly emarginate. Genae striate between eyes and mandibular insertions, otherwise smooth and shining. Thorax smooth and shining except mesopleurae and the dorsum and sides of the epinotum which are granular; interspinal space and declivity smooth. Petiole and postpetiole shagreened. Epinotal

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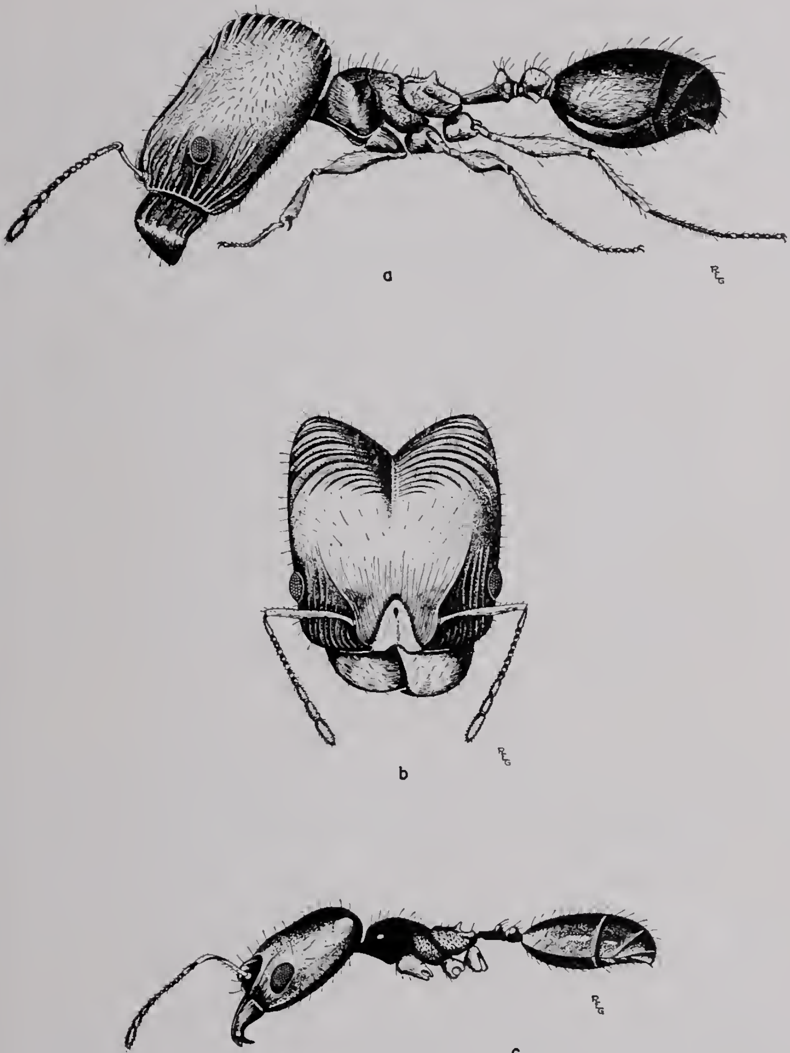
EXPLANATION OF PLATE 2

Pheidole creightoni, a. soldier; b. head of soldier; c. worker. All figures are drawn to the same scale.



Gregg — Pheidole creightoni

TABLE I — SO

Character	*Pheidole creightoni*	*Pheidole pilifera*	*Pheidol*
Cephalic sculpture	Heavy transverse occipital rugae; vertex smooth; frons longitudinally striated to finely rugulose; brightly shining	Coarse longitudinal striations or rugae cross whole length of head; become reticulate on occiput; opaque	Longitudi on vertex, punctures; shining; o ticulate
Body sculpture	Almost completely shining; thoracic sculpture only on mesopleurae and epinotal pleurae; gaster shining, smooth	Interrugal sculpture granulate; thorax, petiole, postpetiole opaque; gaster granulate, weakly shining	Opaque; typical *pil*
Measurements	Length, 3.80 mm. Head index, 0.92 (average 10 individuals)	Length, 4.47 mm. Head index, 0.95 (average 10 individuals)	Length, 3. Head ind (1 individ
Humeral angles	Well-developed in most individuals	Prominent; marked by fine rugae	Well-devel fine rugae
Postpetiole	Conules prominent and sharp	Conules present but blunt	Conules li *fera*
Clypeal notch	Well-marked; concave	Shallow and V-shaped	Very shall
Color	Head bright yellowish red; thorax brownish red; gaster dark brown	All reddish brown; frons and vertex slightly redder	Dark reddi

TABL

Body sculpture	Entire body brightly shining; only mesopleurae and epinotal pleurae slightly granular	Head granulate and finely longitudinally striate, opaque; thorax, petiole and postpetiole granulate; gaster shagreened but shining	Sculpture that of pil promesono pleurae ar ing
Postpetiole	Postpetiole broad, twice as wide as petiole	Postpetiole broad, about 2¼ times as wide as petiole	Postpetiol

* Specimens not seen. The species is known only from types in the American Museum Natural History, the Museum of Comparative Zoology, and the collection of W. Creighton. Data were obtained from the literature and from Dr. Creighton.

OR WORKERS)

Pheidole p. coloradensis	*Pheidole p. pacifica**	*Pheidole senex*
Strong longitudinal rugae fading out toward occiput; entire head finely granulate; vertex and occiput with coarse piligerous foveolae; opaque	Feeble transverse occipital striae, confined to the top of the occiput; vertex strongly shining	Longitudinal rugae on frons; transverse rugae on occiput converging to furrow; interrugae granulate, subopaque; vertex smooth and shining
Thorax granulate; faint irregular rugae; opaque; gaster shagreened but slightly shining	Dorsum of the pronotum smooth and shining, pleurae finely rugulose; epinotum, petiole and postpetiole punctate	Thorax opaque; pleural rugae longitudinal, dorsal rugae transverse to irregular; petiole, postpetiole, gaster granulate
Length, 4.67 mm. Head index, 0.94	Length, 4.50 mm. Head index, 0.93	Length, 5.41 mm. Head index, 0.91
(average 10 individuals)	(2 individuals)	(average 10 individuals)
Prominent	Prominent	Very prominent
Conules prominent and sharp	Conules present but blunt	Conules decidedly prominent, sharp
Very shallow	Shallow and concave	Shallow and concave
Body dark reddish brown, head and gaster somewhat lighter	Head yellowish red with a brown spot on vertex; thorax and gaster brown	Head brownish red; thorax dark brown; gaster light brown

ERS

Entire head, thorax, and petiole granulate; head also with fine, longitudinal rugulae, opaque; postpetiole smooth dorsally; gaster shagreened	Head finely, longitudinally rugulose and punctate; subopaque	Very similar to *coloradensis* except postpetiole granulate dorsally
Postpetiole narrow, 1½ times as wide as petiole		

spines short and triangular, but sharp. Scapes reach to the occipital corners of the head. Gaster glabrous and shining. Color of entire body dark brown, legs and antennae light brown.

Female: Length, 5.25 mm.; head index, 1.0; head length, 1.10 mm.; thorax length, 1.58 mm.

Resembles soldier in most respects, but differs from that caste in the following ways. Body size larger, head quadrate, frontal area level with the general surface of the head (not depressed), compound eyes large and occupying a proportionately greater area on the sides of the head, vertex with three prominent ocelli, occipital lobes are not as pronounced and the furrow is shallower, scapes reach approximately half way from their insertions to the corners of the lobes, and the mandibular teeth are sharper and more distinct. Entire dorsal and lateral surfaces of the head covered with rugae which are longitudinal on the frons and genae, but curve to parallel the occipital lobes, bend centrally and become transverse on the occiput and in the furrow. Interrugal sculpture consists of fine striae, granules, and large dimples or foveae. Surface shining despite the sculpture but less so than in the soldier.

Thorax flat except where mesonotum descends abruptly to the pronotum; dorsum of pronotum, mesonotum, and metanotum shining and smooth except for piligerous punctures; propleurae and epinotal pleurae with parallel rugulose sculpture, subopaque; epinotal base rugulose, declivity smooth; epinotal spines short, conical, and half as long as their interbasal distance. Petiole and postpetiole like those of the soldier, opaque; lateral conules of the postpetiole very prominent and bluntly rounded at the tips. Gaster sharply truncate at the base, anterior margin straight. Wings transparent, stigma pale brown, one discal cell. Head and mandibles reddish brown, thorax darker, gaster dark brown, legs and antennae light brown.

Male: Length, 4.08 mm.; head index, 1.14; head length, 0.58 mm.; thorax length, 1.58 mm.

EXPLANATION OF PLATE 3

Pheidole creightoni, a female (deälate); b. male; c. head of male. All figures are drawn to the same scale.

Gregg — *Pheidole creightoni*

Head wider than long, obovate, anterior end broader. Compound eyes large and occupying fully half the sides of the head; three ocelli situated on prominent elevations of the vertex which cause the head to appear produced dorsally. Clypeus convex, anterior border entire. Mandibles small, narrow, with one apical tooth and two minute denticles. Frontal area broadly triangular. Antennae 13-segmented; scape short, equal to the combined length of the first two funicular segments; first funicular segment globular.

Thorax almost 1½ times as wide as the head. Mesonotum flat dorsally, scutellum convex; Mayrian furrows present except for the medial stem which is almost obsolete; parapsidal furrows or sutures absent; epinotum descends rapidly to the petiolar junction, epinotal spines absent. Petiolar node low and rounded, except for slight superior angles. Postpetiole broad and subquadrate, lateral conules very short and blunt. Gaster of the usual elliptical shape. Stipites convex, curved medially and bulbous at the apex; cerci minute and cylindrical.

Head coriaceous, sculpture consisting of fine striations and granules, subopaque. Thorax shining except for fine striae on the anterior vertical border of the mesonotum; entire metathorax and propodium finely granular, opaque. Petiole, postpetiole and gaster smooth and shining. Fine, pointed hairs cover all surfaces of the body and appendages except the scapes and funiculi. Head black, mandibles and antennae yellow, thorax, abdomen and legs brown. Wings transparent, stigma pale brown, one discal cell.
Holotype: soldier, located in the author's collection.
Paratypes: 219 soldiers, 379 workers, 4 females, and 40 males, deposited in the author's collection, and the collections of W. S. Creighton, the American Museum of Natural History, the Museum of Comparative Zoology, and the United States National Museum.
Type locality: Three miles east of Applegate, Oregon; elevation 1500 feet. This town is about 20 miles west of Medford, on the northern slope of the Siskiyou Mountains, in southwestern Oregon.
Material examined: The specimens upon which this

species is based represent nine separate colonies collected on July 24, August 12, August 16, September 18, and September 22, 1952. They were all secured by Dr. and Mrs. Creighton from the same place (type locality), and winged castes were present in the colonies obtained on August 12, September 18 and 22.[1]

Variation in type material: About one-third of the soldiers have the vertex very smooth and absolutely devoid of sculpture save for minute piligerous punctures, the remainder showing exceedingly fine striations confluent with the rugae on other parts of the head. This delicate sculpture, however, does not reduce the brilliant surface of the vertex in the specimens to hand. Soldier mandibles may have the two apical teeth absent or nearly so, and give the appearance of having been worn down by long continued use. One soldier showed vestiges of the two lateral ocelli, and one colony contained 15 soldiers in which the postpetiolar conules were so reduced as to be nearly absent. Worker scapes just reach the occipital corners or very slightly surpass them. There are elusive differences in color among the many specimens seen, some being slightly darker in over-all tone, but these fluctuations are regarded as inconsequential.

Affinities: This ant is closely related to members of the *pilifera* complex, and in fact runs out to this group in Creighton's recent key (1950), but fails to fit any of the forms treated. Perusal of the accompanying tables (Table I and Table II) will help to distinguish the new ant, *creightoni*, from its relatives for the important diagnostic features have been emphasized, especially of the soldier caste. Of these, it has been found that the most valuable characteristics for separating *creightoni* from other forms of the *pilifera* group are, (1) its small size (except for *artemisia*), (2) the nature and distribution of particularly

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[1] Since this paper was submitted, Dr. A. C. Cole very kindly sent me a sample of *Ph. creightoni* containing four soldiers and numerous workers which he collected at Winnemucca, Nevada, elevation 4334 feet, on July 8, 1954 (Cole Collection # 212). The specimens appear in every way to be conspecific with the types of the new species, and this opinion has been confirmed both by Dr. Cole and by Dr. M. R. Smith.

the cephalic sculpture, together with the weakness of the interrugal sculpture which leaves the whole surface very shining, (3) the clypeal notch which is very well-developed, and (4) the color which is yellowish red in large part as compared to the reddish brown to brown color of the other species.

Dr. Creighton has also supplied pertinent field notes concerning the new species which give interesting information about the biology of this ant. The nests are populous and are surrounded by large amounts of chaff. Both workers and majors forage for food and move in files. The ants are not only granivorous but carnivorous as well, for the blood and tissues of purposely shot ground squirrels, placed nearby, were accepted as food. About eighteen colonies were seen altogether, and it is said that the nests are frequently excavated near those of *Veromessor andrei.* Males and females of *creightoni* emerge in small numbers (approximately two dozen) each day about one hour before sunset. The worker ants remain in the nest most of the day, but they become active in the late afternoon before the flight takes place. The marriage flights which were observed lasted from September 15 to September 21.

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SPECIES OF THE *AMATA* (*SYNTOMIS*) *PFEIFFERAE* GROUP (LEPIDOPTERA: CTENUCHIDAE)[1]

By Nicholas S. Obraztsov

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This paper deals with a small group of moths, closely related to *Amata* (*Syntomis*) *pfeifferae* (Moore) and occurring in Borneo, Sumatra and Java. For this study I have examined the collections of the Rijksmuseum van Natuurlijke Historie (Leiden, The Netherlands) and the Museum of Comparative Zoology at Harvard College. At first sight, the species of this group give the impression of being merely individual forms of a single species, and this similarity gave Hampson (1898) occasion to consider *Amata* (*Syntomis*) *acuminata* (Snell.) a synonym of *pfeifferae.* To avoid further misidentification, the present paper describes the most important characters of the three species already known and one new one.

The author acknowledges with thanks the cooperation of Dr. A. N. Diakonoff and Dr. P. J. Darlington, Jr., in placing the materials of the above-mentioned museums at his disposal and thanks to Dr. W. L. Brown, Jr., for reading the English text of the manuscript.

Amata (*Syntomis*) *pfeifferae* (Moore)

Fig. 1

Syntomis pfeifferae Moore (& Horrfield), 1859, Cat. Lep. Ins. East India House, Vol. 2, (1858-59), p. 324; Moore, 1859, Proc. Zool. Soc. London, p. 198, pl. 60, fig. 5; Walker, 1864, List Spec. Lep. Ins. B. M., pars 31, p. 64; Hampson, 1898, Cat. Lep. Phal., Vol. 1, p. 88; Snellen, 1904, Tijdschr. v. Ent., Vol. 47, p. 55; Zerny, 1912, Wagner's Lep. Cat., pars 7, p. 55; Seitz, 1913, Gross-Schm. Erde, Vol. 10, p. 78, pl. 11 f [figs. 4-5].

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

Zygaena pfeifferae Kirby, 1892, Synon. Cat. Lep. Het., Vol. 1, p. 96.

The redescription of this species published by Hampson (1898) is quite accurate. The figures given by Moore (1859) and Seitz (1913) are exact except for the number of the yellow abdominal girdles. Actually, there are seven such girdles in the male, six in the female.

MALE GENITALIA (fig. 1): Uncus moderately thickened, not too long, slightly curved downward. Tegumen with short, equal lateral appendages. Valvae subtrapezoidal, the right one rather broader; processus basalis of the right valva curved caudad, that of the left valva directed upward. Aedoeagus moderately long, rather thick, with a row of small cornuti.

SPECIMENS EXAMINED: three males and two females, Java; one male, Tjampea, Java, 1892; one male, Tagal, Java; one female, Ardjouno, Neeb leg.; one female, Padang, Sumatra (Rijksmuseum van Natuurlijke Historie, Leiden).

Amata (*Syntomis*) *quadripunctata* Rothsch.

Fig. 2

Amata quadripunctata Rothschild, 1910, Novit. Zool., Vol. 17, p. 433; 1913, ibid., Vol. 19, (1912), p. 375, pl. 3, fig. 36; Hampson, 1914, Cat. Lep. Phal., Suppl., Vol. 1, p. 31.

Syntomis quadripunctata Zerny, 1912, Wagner's Lep. Cat., pars 7, p. 25; Seitz, 1913, Gross-Schm. Erde, Vol. 10, p. 78, pl. 11 k, [fig. 3].

The whole appearance of this moth, described as an independent species, is that of an aberration of *pfeifferae* with reduced spots. The single male specimen examined by the author is very like that of *quadripunctata* figured by Rothschild (1913) except for the forewing spots (especially m_3, m_5 and m_6) which are somewhat larger, and a distal spot occurring in the hind wing. The middle cell of the hind wing orange as in *pfeifferae,* and the specimen examined otherwise identical to *pfeifferae* in the markings of the head and body.

MALE GENITALIA (fig. 2): Uncus somewhat more slender and longer than in *pfeifferae.* The left lateral appendage of the tegumen longer than the right one. The left valva narrow, with a rounded tip; the right valva broad, with an irregularly curved upper edge, an acute tip and a very undulate lower edge; processus basales as in *pfeifferae*, but the right one dilated at the base and the left one narrower.

SPECIMEN EXAMINED: one male, Telokbetong, Kali Anda. Sumatra, 1928 (Rijksmuseum van Natuurlijke Historie, Leiden).

Amata (*Syntomis*) *acuminata* (Snell.)
Fig. 3

Syntomis acuminata Snellen, 1881, Veth's Midden Sumatra, Vol. 4, pars 1, div. 2, p. 31, pl. 3, fig. 5; Van Eecke, 1920, Zool. Meded. Leiden, Vol. 5, p. 116.

Zygaena acuminata Kirby 1892, Synon. Cat. Lep. Het., Vol. 1, p. 96.

Syntomis pfeifferae (part.) Hampson, 1898, Cat. Lep. Phal., Vol. 1, p. 88; Snellen, 1904, Tijdschr. v. Ent., Vol. 47, p. 55; Zerny, 1912, Wagner's Lep. Cat., pars 7, p. 25.

Syntomis pfeifferae ab. *acuminata* Seitz 1913, Gross-Schm. Erde, Vol. 10, p. 78.

This species, relegated by Hampson (1898) to the synonymy of *pfeifferae*, was recognized by Van Eecke (1920) as independent, although this latter author did not publish any argument supporting his point of view. The following notes are based on an examination of the male holotype of *acuminata*.

The figure published by Snellen (1881) is excellent. The thorax of *acuminata* is not spotted by orange at the middle as in *pfeifferae*, the forewing has no supradorsal orange streak, and the spot m_3 is narrower and pointed above. In the hind wing there is only a broad basal spot with an external tooth joined to it (= rudiment of a distal spot), but not two spots. Abdomen with six yellow abdominal girdles; Snellen described the female as having five such girdles.

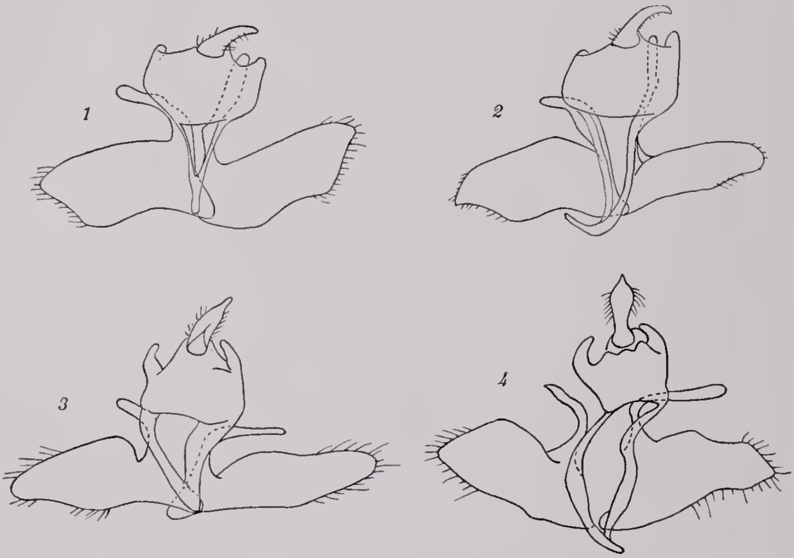
MALE GENITALIA (fig. 3): Uncus broad at the base, narrowed at the tip. The lateral appendages of the tegumen rather long, longer and narrower than in *pfeifferae*. The left valva narrow, the right one lancet-shaped. Processus basales of both valvae shorter, the left one directed caudad but not upward as in *pfeifferae*. The right valva deeply excavate before the processus basalis.

SPECIMEN EXAMINED: male, holotype, Bedar Alam, Sumatra, December 10, 1877 (Rijksmuseum van Natuurlijke Historie, Leiden).

Amata (Syntomis) borneogena, new species

Fig. 4

MALE: Antennae simple, black, white at tips. Head black, frons yellow; palpi brown. Patagia orange; tegulae black, orange-edged. Thorax (damaged!) with orange scales at the middle and posterior edge; pectus with two orange patches on each side. Abdomen black; first tergite



Text-figures 1 to 4. Anterior view of the spread male genitalia: 1 — *Amata* (*Syntomis*) *pfeifferae* (Moore), Java (Rijksmuseum, preparation No. Ct. 7); 2 — *A.* (*S.*) *quadripunctata* Rothsch., Telokbetong, Sumatra (Rijksmuseum, prep. No. Ct. 10); 3 — *A.* (*S.*) *acuminata* (Snell.), holotype, Bedar Alam, Sumatra (Rijksmuseum, prep. No. Ct. 8); 4 — *A.* (*S.*) *borneogena,* new species, holotype, Lundu Mt., Borneo (Mus. Comp. Zool., prep. No. 3, Obr.).

orange, third and fourth tergites with præsegmental girdles of the same coloring, fifth tergite entirely orange; the corresponding sternites with somewhat paler, almost yellow girdles; second sternite with yellowish scaling on the whole surface. Legs brown, only the bases of the interior side of the coxae yellow. Wings black-brown, shot with dark violet; spots orange. Length of the forewing: 14 mm.

Forewing with six spots: one subtrapezoidal spot (m_1) at the wing base supradorsad; a subquadrate spot (m_2) at the end of the middle cell; a larger, rhomboidal spot (m_3) below it; an elongate-ovoid spot (m_4) between the veins R_5 and M_1 near their base; the spots (m_5 and m_6) on both sides of the vein M_3 form a common roundish spot divided by the diffusely black-scaled vein. Hind wing with a basal spot stretching band-like from costa to dorsum; this band reaches about to the middle of the wing (in the middle cell about to its middle) and joins the distal spot which looks like an exterior tooth of the basal spot and occupies the small area below the middle cell and between the veins Cu_1 and Cu_2. The lower vein of the middle cell black-scaled; a diffuse blackish dot in the orange spot, below the middle cell and separate from it.

MALE GENITALIA (fig. 4): Uncus swollen before the pointed tip. Tegumen with the two large lateral appendages curved inward. The left valva with an undulate upper edge, a separate and angled apical part, the right one subtrapezoidal, shorter and much broader; both processus basales curved caudad, the left one much longer.

TYPE: male, holotype, Lundu Mt., Kuching, Sarawak, Borneo, July 15, 1920, H. W. Smith leg. (Museum of Comparative Zoology).

From all known species of the *pfeifferae* group, *borneogena* differs in number of abdominal girdles, and also in genitalia. The forewing spots m_1 and m_3 of the new species are more widely separated than in *pfeifferae*, and the orange supradorsal streak is absent. The hind wing spots of *borneogena* are like those of *acuminata*, but not like those of *pfeifferae*, which latter has two distinct spots. The truncate tooth formed by the distal spot of the hind wing of *borneogena* differs from the more acute tooth in *acuminata*, and the forewing spots m_1, m_2 and m_4 of the new species are shorter. From *quadripunctata* the new species differs in having all wing spots better developed.

BREPHIDIUM BARBOURI CLENCH A SYNONYM OF BREPHIDIUM EXILIS ISOPHTHALMA (HERRICH-SCHAFFER) (LEPIDOPTERA: LYCAENIDAE).

Lycaena isophthalma Herrich-Schaffer, 1862, Corresp.-Blatt. zool.-min. Ver. Regensburg, 16:141, sex not stated. Type locality: Cuba.

Brephidium barbouri Clench, "1942" [1943] Psyche, 49:58, two males. Type locality: Great Inagua Island, Bahamas. NEW SYNONYMY.

An examination of the holotype and paratype males of *Brephidium barbouri* reveals that they are identical with *isophthalma* for the following reasons. In the first place, microscopic examination of the anal angle of the forewing fringe reveals that the white patch supposedly differentiating *isophthalma* from the dark fringed *barbouri* can be present in all intergradient degrees. One specimen of *isophthalma* examined had a well defined white patch on one wing and practically none on the other. Secondly, *barbouri* is supposedly darker both above and below than *isophthalma*. This appears to be the case if one compares the types of *barbouri* with the Nassau specimens of *isophthalma* in the Museum of Comparative Zoology, and apparently this is what Clench did. However, the Nassau specimens were collected in 1897, while the types of *barbouri* were collected in 1934. Therefore it seems quite likely that the difference in color is merely due to fading. Lastly, my comparison of the genitalia of the types of *barbouri* with those of *isophthalma* failed to reveal any differences in structure. — NICHOLAS W. GILLHAM, Harvard University, Cambridge.

TYLOTHRIPS BRUESI, A NEW THYSANOPTERON FROM FLORIDA

BY J. DOUGLAS HOOD

Cornell University

The following species was taken within a few miles of Professor Charles T. Brues' home on the St. Johns River, in Florida, shortly after we had collected together and renewed an acquaintance which apparently began very nearly fifty years ago, long before he became Professor of Entomology at Harvard University and Editor of Psyche.

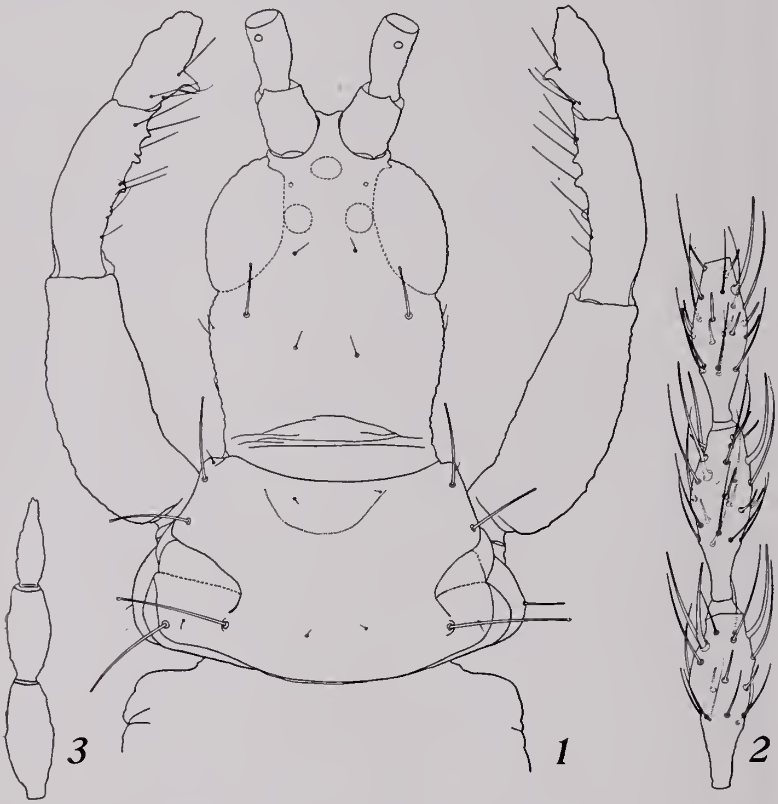
Tylothrips bruesi, sp. nov.

Text-figures 1 to 3.

Like the Peruvian *concolor* Hood, the type of the genus and only known congener, in coloration and most structural features, but (1) head about 1.4 (instead of scarcely 1.2) times as long as width across eyes, (2) last two antennal segments much narrowed basally, thus not forming with segment VI a terminal club, (3) segment III of antennae longer (instead of much shorter) than IV, and with several of its more apical setae as long as the neighboring sense-cones, (4) fore tibiae, only (instead of all three pairs), tuberculate along inner surface, (5) tube fully 2.3 (instead of less than twice) as long as its greatest subbasal width, and (6) major setae dull, or blunt, or very slightly dilated at tip (rather than broadly expanded).

♀ (macropterous). — *Color* of entire body, legs, and antennae blackish brown, with pedicel of antennal segment III and tip of tube somewhat paler and yellowish, IV-VI narrowly whitish just beyond the dark extreme base; internal pigmentation bright crimson-red, abundant in thorax and abdomen (exclusive of tube), sparse in head and first antennal segment; fore wings brown, darkest in anal area and with a dark median streak, which is narrowly edged with paler, extending to tip, the posterior margin pale between anal area and first fringing hair;

major setae pale and yellowish, excepting the wing-retaining setae and the terminal ones, which are brown.



Text-figures 1 to 3.

Tylothrips bruesi, sp. nov., ♀, holotype. Fig. 1.—Head and prothorax, x 176. (All setae omitted from femora, antennal segments, and outer surfaces of tibiae and tarsi; sculpture largely omitted; slight inaccuracies are to be expected in such details as the outlines of ocelli and of inner margins of eyes, because of the opacity of the specimen. It will be noted that the type lacks the right epimeral and left coxal setae.) Fig. 2.—Segments III-V, left antenna, x 236 (all setae shown). Fig. 3.—Segments VI-VIII, right antenna, x 236 (all setae omitted).

The cost of the line engraving was borne by Cornell University through its Committee on Faculty Research Grants.

Head (Fig. 1) slightly produced between eyes and antennae, fully 1.4 times as long as greatest width across eyes, this width somewhat greater than that across cheeks slightly behind eyes; sides of head incised at posterior margin of eyes; cheeks rounded and converging to near base, where the least width is about 0.86 the width across eyes, serrate as seen from above because of rather heavy anastomosing lines; frontal costa with a shallow rounded groove; postocular setae approximately 45 microns long, 121 microns apart, slightly dilated at tip. *Eyes* prominent, large, protruding, slightly less than one-half the length of head, their dorsal length 106 microns. *Median ocellus* with front margin on line with that of eyes. *Antennae* long and slender, about 2.24 times the length of head, their last three segments (Fig. 3) not at all united, the pedicels of VII and VIII not broad; III somewhat longer than either IV or V (Fig. 2), with several very fine, indistinct, transverse lines of sculpture on pedicel; major sense-cones long and slender, disposed as follows on inner (and outer) surfaces of segments: III 1(2), IV 1(2), V 1(1), VI 1(1), VII 1 dorsal; III and IV with several additional minor sense-cones; major antennal setae long and pointed, those associated with the major sense-cones about equal to them in length. *Mouthcone* short, nearly semicircularly rounded at tip, extending about 70 microns beyond posterior dorsal margin of head.

Prothorax (Fig. 1), along median line of pronotum, about 0.63 the length of head and one-half the width across fore coxae, its surface nearly smooth but with a few faint lines of sculpture near posterior margin; posterior half of epimera fused with pronotum; antero-marginal setae very minute, the other usual setae long, moderately heavy, and very slightly widened at tip, the antero-angulars and midlaterals about 73 microns, epimerals and postero-marginals 87-91, coxals about 33. *Pterothorax* rather long, wider than prothorax across coxae; metanotal plate in basal half, shield-shaped and roundly elevated, its posterior part without distinct foveae at sides, the single pair of major setae pointed, 43 microns long and 78 microns apart. *Legs* moderately long and slender, the fore tibiae (Fig. 1) with several strong tubercles from each of which arises a long pointed seta, mid and hind tibiae without much tubercles; fore tarsi with a strong and somewhat recurved tooth on inner surface. *Fore wings* straight, narrowed slightly and evenly to tip, not closely fringed, without accessory setae on posterior margin, the subbasal setae blunt (asymmetrically disposed in type).

Abdomen without distinct sculpture; major setae mostly slightly broadened at tip (excepting the wing-retaining ones, seta III on IX, and the terminal ones, all of which are pointed), I on IX 103 microns, II 132, III 109, terminal 120; tube (X, only) about 0.7 the length of head and fully 2.3 times as long as greatest subbasal width, its sides slightly concave beyond base, then straightly converging to tip.

Measurements of ♀ (holotype), in mm.: Length about 1.9 (fully distended, 2.43); head, total length 0.258, width across eyes 0.182, least width behind eyes 0.164, greatest width across cheeks 0.179, least width near base 0.158, width in front of eyes 0.093; pronotum, median length 0.154; prothorax, width across fore coxae 0.304; mesothorax, width across anterior angles 0.305; metathorax, greatest width 0.325; fore wings, length 0.962, width at middle 0.061; abdomen, greatest width (at segment IV) 0.354; tube (segment X, only), length 0.178, greatest subbasal width 0.077, width at apex 0.041.

Antennal segments:	I	II	III	IV	V	VI	VII	VIII
Length (microns):	49	63	101	97	93	68	54	53
Width (microns):	44	30	36	36	32	27	25	17

Total length of antennae, 0.578 mm.

FLORIDA: Welaka (Conservation Reserve, University of Florida), August 12, 1954, J. D. H., 1 ♀ (holotype), from dead fallen branches of Turkey Oak (*Quercus laevis*), in open sandy woods.

This is the second species of the genus *Tylothrips*, which the writer erected in 1937 for a Peruvian species that came from dead branches and leaves. The two are almost identical in color and general appearance and could easily be confused with each other.

AN EOCENE BITTACUS (MECOPTERA)[1]

By F. M. Carpenter

Harvard University

In 1928[2] I described, as *Palaeobittacus eocenicus*, a species of the family Bittacidae from Eocene strata in Colorado. This has been the only representative of the Mecoptera in Eocene deposits and the earliest unquestionable record of a living family of the order. A second Eocene bittacid has now turned up, this time among an extensive collection of insects which Dr. Carl Parsons and I made nearly twenty years ago in Utah. It appears to be a true Bittacus with characteristic wing venation and body features.

Genus *Bittacus* Latr.

Bittacus egestionis, n. sp.

(Figures 1 and 2)

Fore wing: 8 mm. long; maximum width, 2 mm.; antennae 2 mm. long; body 7 mm. long; wings without markings; venation and wing form as shown in figure 2; cubital cross-vein below the first fork of M; two pterostigmal cross-veins apparently present; hing wings somewhat more slender than fore wings.

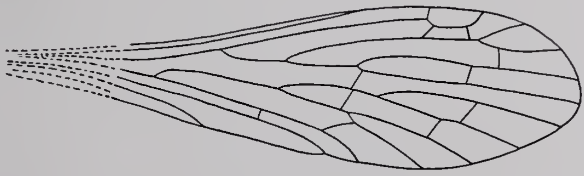


Figure 1. Drawing of fore wing of *Bittacus egestionis*, n. sp.

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

[2] A Scorpion-fly from the Green River Eocene. Annals Carnegie Museum, 28: 240-249. 1928.

Holotype: Museum of Comparative Zoology, No. 4921; collected by F. M. Carpenter and C. T. Parsons in the Evacuation Creek Formation, Green River Shales, about ten miles west of Evacuation Creek and the town of Watson, Utah. The fossil is very well preserved, showing antennae, legs, and all four wings; one pair of wings (fore and hind) rest together along the abdomen, but the other two extend below the body and are separated. The bases of the wings are partially concealed by the body of the insect and the veins there are not clearly preserved. The absence of copuloli and paraprocts shows that the specimen is a female.

Figure 2. Photograph of *Bittacus egestionis,* n. sp., from the Eocene of Utah. Length of fore wing, 8 mm.

Aside from generic differences this species differs from *P. eocenicus* by its more robust facies and smaller size. Its venation is typical of that of Bittacus, but the species is smaller than any other known in the family, so far as I am aware. In my account of the Baltic amber Mecoptera[3], I pointed out that one of the amber species, *Bittacus* *minimus,* with a fore wing length of 11.5 mm., was the smallest bittacid known; *egestionis,* with a fore wing 8 mm. long, is even smaller. However, the other amber bittacids, as well as *Palaeobittacus,* show that not all of the early Tertiary Bittacidae were small; the range in size of these fossils is more an indication of the extent of the diversity of the family during Tertiary times.

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[3] The Baltic Amber Mecoptera. Psyche, 61: 31-40. 1954.

THE SOUTHWESTERN RESEARCH STATION OF THE AMERICAN MUSEUM OF NATURAL HISTORY — The American Museum of Natural History has announced the establishment of The Southwestern Research Station. It is located on the eastern slope of the Chiricahua Mountains, near Portal, Cochise County, in southeastern Arizona. The property is within the limits of the Coronado National Forest at an elevation of 5400 feet.

The station was established for the purpose of making available research facilities for scientists and students in all branches of science, who have problems that can be investigated through the utilization of the faunal, floral and geological features of the area. It will be open during the entire year.

It is operated by the American Museum of Natural History, Central Park West at 79th Street, New York 24, New York and under the direction of Dr. Mont A. Cazier, Chairman and Curator of the Department of Insects and Spiders, to whom all inquiries should be addressed. Anyone interested in the station should write to the above named individual for the booklet which gives the details of the operation and a general description of the area.

AN ODONATE FOSSIL WING FROM THE OLIGOCENE OF OREGON[1]

BY LT. COL. F. C. FRASER, I.M.S., RETD.

Bournemouth, England

I am indebted to Professor Frank M. Carpenter for generously delegating to me the task of describing an interesting odonate wing from the Eugene Formation of the the middle Oligocene of Oregon. The specimen was collected by Mr. Chester W. Washburne in 1900 and is one of the insects mentioned by Washburne in his account of the geology of the Eugene Formation.[2]

The specimen, which consists of a complete fore wing, is contained in a tuffaceous mudstone, a medium which makes for wonderful preservation of even the most minute details of venation; only the middle third of the space between the nodus and the pterostigma is damaged but this is just the part which is of the least importance and which can be restored with a minimum of error. The actual outlines of the wing are so intact that both the length and breadth can be given with the greatest accuracy. The wing belongs to a species of the family Epallagidae and with a few adjustments, might well be placed in the genus *Euphaea* Selys. The fossil, which consists of obverse and reverse impressions, is deeply stained a dull warm brown, agreeing in this respect with fragments of leaves and plants among which the wing had come to rest; thus I am of the opinion that this apparent pigmentation is only the result of staining or some later chemical reaction. This opinion is supported by a broad apical dark band which is present on the reverse impression but absent on the obverse; on the latter a convex crack runs across the apex of the wing and a tracing made of this served to show that

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

[2] Reconnaissance of the Geology and Oil Prospects of Northwestern Oregon, 1914, Bull. U. S. Geol. Surv., 590:100.

it corresponded exactly with the curved outline of the dark apical band.

Order ODONATA, Suborder Zygoptera
Family Epallagidae
Genus **Litheuphaea** nov.

Venational characters of the wing similar to those of genus *Euphaea* Selys, differing only as follows: Nodus situated rather more basally (although the level of this differs within limits in both subgenera and species of *Euphaea;* the present specimen conforms in this respect most closely to *Anisophaea* Fraser); pterostigma much larger than in any recent species of *Euphaea*, very acute proximally, as in many species of the Megapodagriidae, and fusiform in shape, followed by two rows of cells distally between the costa and radius; discoidal cell entire and very short in view of the length of the wing; anal-vein, 1A, extending beyond the level of nodus; anal field immediately posterior to the discoidal cell made up of three rows of cells (only a single row at this level in *Euphaea*), the rows of cells separated by an irregular zigzagged vein which is evidently a vestigial recurrent anal-vein (absent or entirely vestigial in *Euphaea* but becoming strongly developed in the more recent Agriidae. (In this respect, the new genus establishes a link between the Epallagidae and Agriidae.) Other characters are as follows: Antenodals numerous and with their costal and subcostal portions in strict alignment; Rii not approximated nor confluent with the radius at its origin; Riii in continuation with the subnodus; longitudinal veins rather flat and not curved abrupt-

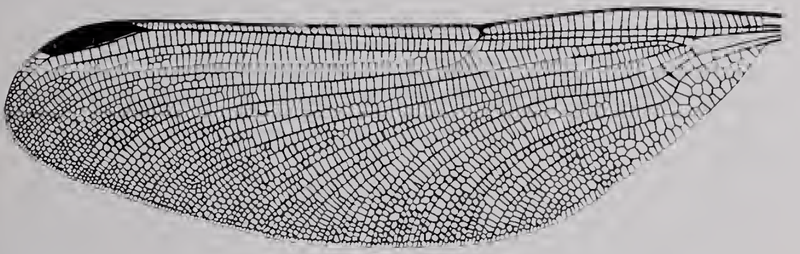

Fig. 1. Drawing of fore wing of *Litheuphaea carpenteri* n. sp.

ly towards the wing border near their terminations, excepting CuP which is strongly convex and 1A which is markedly sinuous; four or more cubital cross-veins, two of which traverse the subdiscoidal cell and one of which forms its base. Medio-anal link very strongly developed and a conspicuous feature of the wing.

Type species of the genus, *Litheuphaea carpenteri* sp. nov.

Litheuphaea carpenteri sp. nov.

Fig. 1

Fore wing 34 mm in length; nodus situated 12 mm from base of wing; greatest breadth of wing 10.5 mm at level of distal end of anal vein. Pterostigma 5.15 mm. Antenodals 37; postnodals 50 ca. Two rows of cells between Rii and Riii beginning quite near the subnodus; intercalaries numerous; reticulation close. Anal vein highly convex and with a maximum of nine rows of cells between it and the border of wing; 2A strongly developed distal to the anal-link.

Above the impression of the wing, at about the central point of the antenodal portion of the wing, is to be seen a deep impression, in the bottom of which, in the obverse impression is the distinct outline of the lower jaw, so that it is evident that the impression represents the head of the insect upside down. The formation of the jaw is entirely similar to that of *Euphaea* with the median fissure as deep as half or more of the jaw and the palps of the same length and rounded outwardly. The impression of the rest of the head is to be seen only vaguely.

This species agrees with *Epallage* by the entire discoidal cell; with *Euphaea* by the position of the nodus, whilst the development of the anal field proximal to the level of the anal-link is found only in the recent *Dysphaea gloriosa* Fraser from Laos (Siam).

Holotype: Museum of Comparative Zoology, No. 4895ab, from the Eugene Formation (middle Oligocene), 3 miles north of Goshen, Oregon, collected by C. W. Washburne.

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PSYCHE

Vol. 62 June, 1955 No. 2

THE REDISCOVERY OF *VEROMESSOR LOBOGNATHUS* (ANDREWS) (HYMENOPTERA: FORMICIDAE)[1]

By Robert E. Gregg

Department of Biology, University of Colorado

This species of ant is exceedingly rare, and some conception of its scarcity may be gained from the fact that it was described from four worker specimens taken in 1916 and has been known primarily from these cotypes ever since. The species was collected by Professor T. D. A. Cockerell at Glenwood Springs, Colorado, and the description was drawn up by one of his students, Hazel Andrews. One of the cotypes is in the Wheeler Collection at Harvard and of the remaining three, two only are now present in the Collection of the University of Colorado Museum.

According to Creighton (1950) three specimens were examined by him which supposedly came from Missouri, but he strongly doubts the validity of the record. Recent correspondence, however, with Dr. Creighton and with Dr. W. L. Brown at the Museum of Comparative Zoology, has supplied the following information about the Missouri record. Several specimens of *V. lobognathus* were collected in Barton County, Missouri in May 1920, by J. W. Chapman. At least this is in accordance with the labels on the specimens, but Dr. Chapman denies having been in Barton County at the time indicated. His inability to remember the incident may be due to the long period which has since

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

elapsed. In the Museum of Comparative Zoology there are, at present, two of Dr. Chapman's specimens. Three others are in the collection of Dr. Creighton. One of the specimens in the M. C. Z. collection bears the label "*V. lobognathus* new subsp." and this notation is attributable to Creighton (ca. 1938) who now states that he does not believe that it is a valid new subspecies. The writer concurs in this conclusion, especially because we know so little concerning the distribution and the variability of the typical form of *lobognathus*. Furthermore, the Missouri specimens are smaller than the types and the Colorado sample recently brought to light, and in this and other respects they give the impression of having come from an incipient nest. To base a new subspecies on such material is quite inadvisable.

It may seem that the record from Missouri is too far east to be credited with any assurance, especially when even the Colorado records are so far removed from the main range of the genus *Veromessor*. But it is not an impossible occurrence, since Barton County is in the southwestern section of Missouri, on the northern edge of the Ozark Plateau, where tall grass prairie and oak-hickory vegetation interdigitate.

There is the possibility that Chapman's locality may have been a Barton County in another state, and with this in mind, I have searched the maps of the following thirteen states: Iowa, Arkansas, Louisiana, Nebraska, Kansas, Oklahoma, Texas, Colorado, New Mexico, Utah, Arizona, Nevada and California, as any of these states might be included in the range of the species. Of these only Kansas possesses a Barton County and it is situated almost in the geographic center of the state. If Barton County, Kansas, is the correct location for Chapman's specimens, it is more plausible than the Missouri record, but it is still a long way east of Colorado, and for this reason extremely interesting.

The confusion which is detailed in the foregoing paragraphs serves to place in bold relief the dangers attendant upon the attachment of locality labels and the citation of such. The most meticulous care is not too much to exercise in the recording of geographical data and always, it seems to this author, a locality should be given that is more precise than a mere county record. Some counties in western states are larger in area than whole eastern states and, moreover, they frequently encompass tremendous altitudinal changes. Anything less than the nearest large town, mountain peak, large lake, canyon, distance in highway miles, elevation or other means of pinpointing a site on a large scale map is to be deplored and should be accepted only with caution.

In 1953 Creighton suggested that the locality labels of the cotypes of *V. lobognathus* may be incorrect. While this possibility has not been overlooked, I feel that the recent rediscovery of the species in Colorado, even though at a widely separated station, lends credence to Cockerell's Glenwood Springs labels, and we now have little reason for doubting their validity.

On July 22, 1952, thirty-six years after its original discovery, *Veromessor lobognathus* was retaken by me at Owl Canyon, Colorado, approximately twenty miles northwest of Fort Collins. The nest was situated under a rock in pinyon-cedar woodland at an elevation of 6,100 feet. From the colony, 85 workers with brood were obtained, and the ants have been compared with the cotypes of *lobognathus* in the museum and found to be unquestionably conspecific with them. Only insignificant differences between them could be detected. No winged castes were secured.

On casual examination, the specimens look so much like *Pogonomyrmex occidentalis*, that until they were brought back to the laboratory, they were mistaken for that species. However, the reticulate nature of the thoracic and the cephalic sculpture, the spatulate proximal end of the scape, the pronounced saddle-like depression of the meso-epinotal suture, and the broad, sessile postpetiole easily differentiate *V. lobognathus* from *P. occidentalis*. It is the similarity in stature, in pilosity, in color, and the possession of a psammophore in both species that may confuse the unwary. Without magnification, the sculpture of these ants is also astonishingly similar. Wheeler and Creighton

(1934) briefly discuss this close correspondence, and conclude correctly that the resemblance is superficial and due to convergence. The ants are obviously in separate genera. They consider the possibility of mimicry, with *occidentalis* serving as the model. I have exserted the stings of both ants, and while that of *Pogonomyrmex* is much stouter and from appearances more powerful and effective as an organ of defense, it is not possible with the still meagre amount of information we have to say that mimicry is involved. The rarity of *lobognathus*, its distributional characters, and its superficial divergence from other species in its genus do conform to Wallace's Rules for Batesian Mimicry, but it would be premature to label the case as one of mimicry at this time. It may be legitimate to ask whether the weak stings of other myrmicine ants are equally ineffectual for defense, and also what reasons might be deduced to explain why the other members of *Veromessor* which occur in the same habitats as forms of *Pogonomyrmex* more pugnacious than *occidentalis* do not show a defensive convergence towards these latter species?

The distribution of *V. lobognathus* is distinctly unorthodox, almost all the rest of the species in the genus being confined to the southwestern deserts of Arizona, California (including the Central Valley), Lower California, and western Mexico. A gap of several hundred miles exists between the previously known records of *Veromessor* and Glenwood Springs, the type locality of *lobognathus*. Several years ago, Dr. M. R. Smith (1951) described a new form of this group, *V. lariversi*, which had been secured near Pyramid Lake, Nevada, and since then Dr. Creighton has found the species near Lone Pine, California, Wagner, Nevada, and Goldfield, Nevada. Thus the genus is now known to extend further east in the northern part of its range than heretofore. But this extension makes no significant change in the status of *lobognathus* whose most western station is in the upper reaches of the Colorado River Canyon at an altitude of 5,750 feet (Glenwood Springs), with its most recent occurence now recorded from the eastern slope of the Rocky Mountains at an elevation of 6,100 feet. From the nature of the genus and the species which compose it, it may be taken as certain that a distributional gap exists between these two sites, as far as *V. lobognathus* is concerned, which is imposed by the lofty heights of the continental divide. It seems extremely improbable that future collecting will demonstrate a pattern of dispersal around the southern end of the Rockies, for if such existed, the species should find itself in a much more congenial environment in the south and should have turned up as a fairly common ant in collections from such areas. The possibility of a connection across a low pass during a remote period cannot as yet be ruled out, however.

In her description of *lobognathus,* Miss Andrews includes no mention of the habitat in which the ants were found. I have found no additional ecological information upon examining the original hand-written notes. In the writer's experience, the hills and canyon walls near Glenwood Springs are covered with scrub oaks, and the river bottom, where wide enough, has meadows with some willow and cottonwood. A small amount of pinyon and cedar is also known to be present. It is not known whether the types were obtained from natural vegetation or the altered conditions in the town. The specimens collected at Owl Canyon were definitely living under natural conditions in a stand of pinyon and cedar. This is an isolated woodland (though some of the pinyons are extremely old and very large for the species), whose nearest approach of similar vegetation containing pinyons is about 160 miles south near Colorado Springs, in the Garden of the Gods. The stand is, moreover, surrounded by plains vegetation of grassland and sagebrush, and by mountain mahogany which is a foothills plant. Varying explanations have been suggested to account for the presence of these conifers near Owl Canyon in view of the fact that pinyon, while occurring far north on the west side of the divide, stops at Colorado Springs on the east. It would appear that the most plausible diagnosis is the one offered by some botanists to the effect that we are confronted with a relict stand. If this is true, the known distribution of *V. lobognathus* coincides quite well with it, for its pattern looks like that of a relict species — rare, patchy in distribution, disconnected with its relatives, and correlated with a similar distribution of other taxonomically unrelated organisms. The cause of such a relict distribution in this case is not immediately evident, and it seems best not to speculate on this phase of the problem. On the other hand, the Owl Canyon pinyons may not be true relicts of a former more widespread vegetation type on the east slope because none of the herbaceous flora commonly associated with pinyons is present[2]. Also, one difficulty with a relict interpretation of the Glenwood Springs record of *lobognathus,* is that while pinyon does grow in the area, it is in no way a relict stand.

Control of distribution by a soil factor deserves consideration. Both the Owl Canyon site and the Glenwood Springs area have limestone outcroppings. Surface exposures of this rock are not abundant in Colorado, and some plants seem to show a correlation with those that do exist. Whether we can extend this reasoning to ants, and the particuar case in question, is highly uncertain. In general, ants do not show the correlations with the chemical constitution of the soil that is so often true of plants. Their protoplasm is relatively protected and insulated from direct soil contact as opposed to the roots of plants. Some soil-ant relationships have been observed, however, but in such cases the effect on the ants seems to be that of the physical nature (texture) of the soil particles.

It is hoped that when the localities where *V. lobognathus* occurs are revisited, it will be possible to find the species again and study the behavior of this singular ant. At least it will be easier in the future to detect its presence in a habitat, and this may lead to the discovery of additional records. Until then, the distribution of this insect remains very problematical.

Specimens of the ant have been deposited in the collections of W. S. Creighton, the United States National Museum, and the Museum of Comparative Zoology.

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[2] Information was secured from Dr. William A. Weber.

POSTSCRIPT

Since this paper first went to press, some important new data have come to light. Dr. Dallas Sutton, while collecting a few ants for me, obtained specimens of *V. lobognathus* in pinyon-cedar woodland with sagebrush, at 6,500 feet, twenty miles southwest of Rangely, Colorado, on August 26, 1952. As he was unaware of the nature of his find, no other data are available. An additional record also has been kindly reported in correspondence by Dr. A. C. Cole. The ants were secured during the summer of 1954 at a point forty-five miles west of Ely, Nevada, in sagebrush desert, and according to Dr. Cole, occupied a small pebble mound nest.

These two records are extremely valuable not only because they extend the known distribution of *lobognathus* hundreds of miles beyond its previous boundaries, but serve to establish possible connections with other members of the genus, notably *V. lariversi* in eastern California and western Nevada. Thus the most western station for *lobognathus* is now in eastern Nevada (near Ely), and it is not observed again until the localities in northwestern, western, and northern Colorado are reached. Finally, it reappears in southwestern Missouri. Wherever else the species may be discovered, it seems safe to predict that it should exist in some parts of Utah and of Kansas, but such a pattern if filled out would not correlate with any major natural features of the continent, such as mountains, desert basins, or prairies. Rather, it would cut across these features. The species may prove eventually to have a wide but very local and patchy type of distribution, the elucidation of which will require extensive search and many more records.

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The Ant Cerapachys rufithorax and its Synonyms — Dr. J. W. Chapman has given me a series of *Cerapachys* taken as a uninidal lot in the Cuernos Mountains, near Dumaguete, Negros Or., Philippine Islands, and has kindly called my attention to the remarkable variation in size and form shown by its members. This variation is clearly allometric, and affects most importantly the profile of the alitrunk and thickness of the petiole and postpetiole. *C. rufithorax, C. negrosensis* and *C. nitida,* all described from the Cuernos Mts. (450-700 M. altitude) by Wheeler and Chapman (types in Museum of Comparative Zoology) were found to correspond to different segments of the uninidal sample as arranged according to size, so that it is evident that the three names represent size-classes of a single species. Formal synonymy follows.

Cerapachys rufithorax Wheeler and Chapman

Cerapachys rufithorax Wheeler and Chapman, 1925, Philippine Jour. Sci., 28: 50, pl. 1, figs. 5, 6, 7, worker.

Cerapachys negrosensis Wheeler and Chapman, 1925, ibid., p. 51, pl. 1, fig. 8, worker. **New synonymy.**

Cerapachys nitida Wheeler and Chapman, 1925, idem, p. 52, pl. 1, figs. 9, 10, worker. **New synonymy.**

Size differences with allometry serve as specific differences to separate other Cerapachyinae, so that we may expect further synonymic reduction as adequate series become available. — William L. Brown, Jr., Museum of Comparative Zoology.

FURTHER NOTES ON THE HABITS OF *GEOTRUPES* (COLEOPTERA: GEOTRUPIDAE)

BY F. N. YOUNG[1], T. H. HUBBELL[2], and D. W. HAYNE[2]

A previous note (Psyche, 57 (3) : 88-92) records observations on the habits and habitat of *"Geotrupes chalybaeus"* from an atypical scrub area near Interlachen, Putnam County, Florida. Dr. Henry F. Howden informs us that these notes apply to an undescribed species. The following observations made in early March, 1935, apparently apply to *Geotrupes* (*Peltotrupes*) *profundus* Howden (= *chalybaeus* LeConte, not Mulsant.)

Thirteen holes, thought to be mouse burrows, were excavated in the turkey-oak high-pine area (*Quercus laevis-Pinus palustris* associes) west of Lake Newnan, Alachua County, Florida. The soil in this area is largely Lakeland sand ("Norfolk sand") or similar dry sands, which usually have a white or very light surface layer and yellowish sand beneath. Such sands are somewhat more compact and have a denser layer of tree roots closer to the surface than the St. Lucie sand in which burrows were excavated near Interlachen. Here, as elsewhere, the "throwups" or mounds were largely in groups.

Burrows were traced by inserting a wire in the hole beneath the "throwup", and digging along it with a trowel. Some burrows could be traced by a blackened ring around the inside, apparently due to deposits of organic substances from material carried down by the beetles. The depth to the apparent bottom of the burrows varied from 10″ to 66″, but no beetles were found in any not excavated below 48″. The diameter of the burrows was rather constant at about ½″. Several of the burrows did not descend straight down as was usually the case near Interlachen, but deviated at various angles and then straightened again at

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various depths. A short lateral burrow beneath the mound was observed in three cases. It is possible that some of the shallow burrows excavated were in the process of being dug by the beetles or had been abandoned.

Material found in underground chambers connected with the burrows or in the burrows themselves was largely the surface "duff" of the turkey oak woods. Acorn cups, grass, live oak leaves (partly eaten?), leaf debris, pine needles, bark, and twigs were encountered along with some insect fragments. One burrow ended at 66″ in a horizontal chamber about 6″ long and 1½″ wide. This chamber was filled with leaf debris, cut-up grass, and other material. Another ended at 48″ in a chamber about the size of a golf-ball and completely filled with dry sand.

In the burrow which ended in a chamber at 66″ two beetles were found: one in the burrow at 48″ and another in the chamber. The latter was apparently in a death-feint, but recovered the next morning, and was observed to make a rasping sound, probably with the hind coxae and the 1st abdominal segment as in other *Geotrupes*. A similar sound was heard while one burrow was being excavated, but was mistaken for a mouse "clicking" its teeth.

The stridulation (presumably of the male) which does not seem to have been previously noted, together with the discovery of two beetles (probably the male and female) in the same burrow, strengthens the supposition that these beetles show some sort of subsocial activity.

INTRA-UTERINE NUTRITION OF THE "BEETLE-ROACH" *DIPLOPTERA DYTISCOIDES* (SERV.)[1] DURING EMBRYOGENESIS, WITH NOTES ON ITS BIOLOGY IN THE LABORATORY (BLATTARIA: DIPLOPTERIDAE)

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Diploptera dytiscoides is a common viviparous cockroach that injures the bark of several kinds of trees in Hawaii and other Pacific Islands (Fullaway and Krauss, 1945). Its embryology has been extensively studied by Hagan (1951) who indicated that the embryo increases over five times in size during development. This growth was not accompanied by a decrease in yolk, and Hagan suggested that the developing embryo acquired nutriment from another source. The embryos have greatly elongated pleuropodia to which Hagan (1939, 1951) tentatively ascribed nutritional or respiratory functions, or both. Because of the embryo's increase in size and its modified pleuropodia, Hagan (1951) cited *D. dytiscoides* as the one example of pseudoplacental viviparity among cockroaches. Although Hagan's suggestion is a logical hypothesis, the acquisition of nutriment by the embryo has never been examined experimentally.

The eggs of the false ovoviviparous cockroach, *Nauphoeta cinerea* (Oliv.), also increase in size during embryogenesis; this increase is closely correlated with absorption of water, whereas solids are slowly lost until hatching (Roth and Willis, 1955). In order to determine whether

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[1] We are greatly indebted to the United States Department of Agriculture for permission to import this species, and to Mr. Fred A. Bianchi of the Hawaiian Sugar Planters Association, who kindly sent us several hundred living specimens of *Diploptera*. The insects were cultured on Purina dog chow checkers.

absorption of water alone could account for the increase in the size of *Diploptera* eggs, we have studied the changes, with age, in wet weight and in dry matter and water content of the developing eggs.

Female *Diploptera* were removed from the cultures, anesthetized with CO_2, and their oöthecae were expelled by finger pressure against the base of the abdomen. Because oötheca formation was rarely observed, the exact age of the eggs was unknown. Therefore, the length of an end egg in each oötheca was measured with an ocular micrometer and its size was used in lieu of age. All weights were determined on torsion balances sensitive to 0.01 and 0.05 mg. Oöthecae were air-oven dried at about 100°C. to constant weight. All determinations were made on eggs enclosed in oöthecae (rather than on individual eggs), but calculations are presented on a per egg basis. The oötheca itself (fig. 5, arrow) is so reduced in this species that its inclusion in the calculations is a negligible factor, particularly with older eggs which have greatly increased in size. Sometimes an oötheca contained one or two eggs which failed to develop; these were easily removed without damage to the remaining eggs and were not included in the weight determinations. The usual number of eggs in an oötheca is 12 (Hagan, 1941); of 51 oöthecae examined by us, the number of eggs ranged from 9 to 13 (including undeveloped eggs), with a mean of 11.4 per oötheca. Hagan (1954) thinks that this average may be due to altered environment, food, and captivity. In Hawaii he seldom found less than 12 eggs per oötheca and usually more than that number, although he did not record the data.

EXPLANATION OF PLATE 4

Figures 2-4. *Diploptera dytiscoides*. Fig. 2. Female with an everted uterus (as a result of once having had her abdomen squeezed to remove an oötheca) and a recently formed oötheca (arrow) which she extruded because it could not be retracted into the brood sac (×3.8). Fig. 3. Female, after accidentally being exposed to high temperatures, prematurely aborting an oötheca containing well-developed embryos (×3.8). Fig. 4. End view of abdomen of female; genital segments separated to show 4 embryos visible in the brood sac. Note eye (arrow) of embryo (×7.5).


2


3


4

ROTH AND WILLIS — DIPLOPTERA DYTISCOIDES

Evidence for Intra-uterine Nutrition

The weight, water, and dry matter changes which accompanied the increase in egg size are shown in figure 1; a series of oöthecae containing eggs of different sizes are shown in figures 5-9. The smallest eggs (0.93 mm.) undoubtedly were from a very recently formed oötheca. Hagan (1951) stated that the freshly deposited egg is approximately 1.20 mm. long. The largest eggs (6.9 mm.) represent fully matured embryos, inasmuch as some of the eggs in this oötheca began to hatch shortly after they were manually extruded from the female (figs. 9-13). The difference in size between the smallest and largest eggs represents more than a seven-fold increase during embryogenesis. The size and weight of the eggs increase with acquisition of both water and solids. However, most of the weight increase arises from absorption of water. From the smallest to the largest eggs there was an increase of about 50 times in the amount of dry matter and about 85 times in water content. Visible differentiation was accompanied by the first observed increase in dry matter (fig. 1, arrow). Prior to differentiation the eggs absorbed water only, and the dry matter content dropped from about 34% to about 26%. After differentiation became visible, the dry matter content remained at approximately 26% throughout development. The increase in the size of the egg, as Hagan (1951) pointed out, cannot arise from the small amount of yolk available, nor could the increase in dry weight be interpreted on this basis. Obviously, additional nutriment is supplied by the mother to the eggs in the brood sac. The exact source of this nutriment is not known; Hagan (1941) suggested that nutriment may be secreted by the maternal accessory (colleterial) glands.

Diploptera is unique among cockroaches in gaining solid matter from the mother during embryonic development. In oviparous cockroaches (*Blatta orientalis* L., *Blattella vaga* Heb., *Blattella germanica* (L.)) and false ovoviviparous species (*Nauphoeta cinerea, Pycnoscelus surinamensis* (L.), and *Leucophaea maderae* (F.)) solid matter is lost during embryogenesis, although water is absorbed from the oötheca or directly from the mother (Roth and

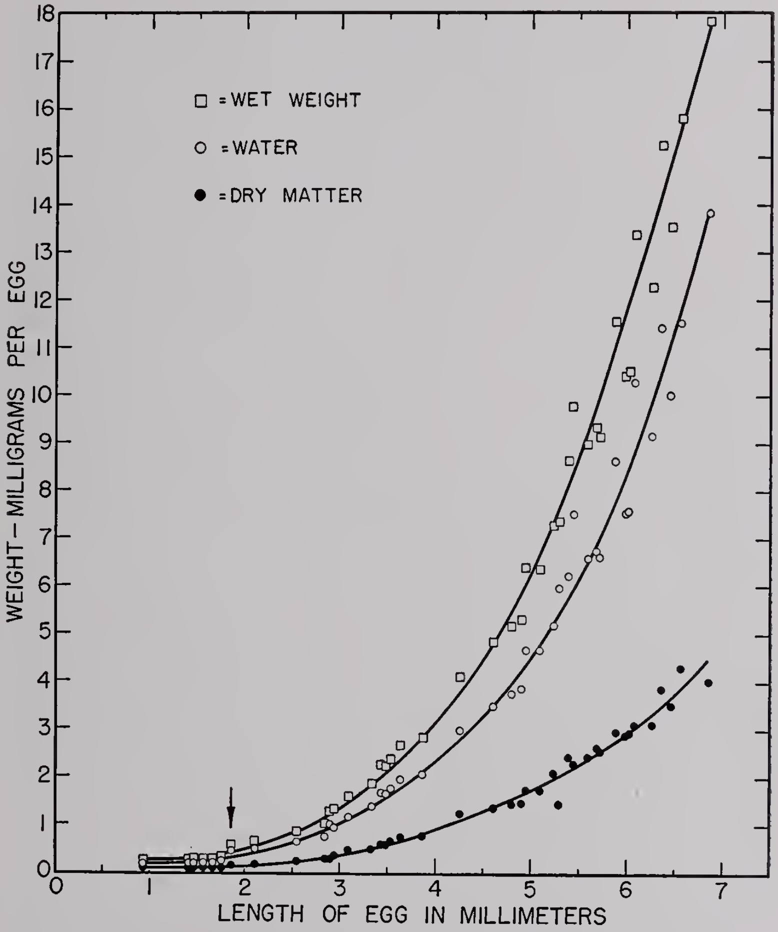

Figure 1. Wet weight, water, and dry matter changes of the eggs of *Diploptera dytiscoides* with increasing age (as indicated by increase in size). All determinations were made on oöthecae containing 9 to 13 eggs, but the data are plotted on a per-eggs basis and include the weights of the oöthecae. Arrow indicates first sign of visible differentiation of the embryo.

Willis, 1955). The gain or loss in water or solids by the eggs of various cockroaches during embryogenesis is compared in table 1. Only the egg of *Diploptera* changes greatly with a truly tremendous gain in water and solids.

And yet, morphologically, the reproductive system of *Diploptera* is comparable to that of *Blatta orientalis,* although some of the structures in *Diploptera* have become modified with its altered physiology (Hagan, 1941).

TABLE 1

Changes in wet weight, water, and solids of the eggs of several species of cockroaches during embryogenesis[1]

Species	Factors by which initial weights changed, per egg[2]		
	Wet weight	*Water*	*Solids*
Blatta orientalis[3]	1.21	1.35	0.96
Blattella vaga	1.12	1.32	0.81
Blattella germanica	1.21	1.49	0.74
Nauphoeta cinerea	2.11	4.62	0.81
Diploptera dytiscoides	73.47	85.80	49.28

Of all the viviparous cockroaches, *Diploptera* is the most highly evolved: the oöthecal covering is reduced, and the small size and number of eggs and the comparatively large size of the vestibule apparently make it possible for the female to transfer the oötheca into her brood sac without exposing the majority of eggs outside her body. Strictly speaking, *Diploptera* may be the only known case of true viviparity among cockroaches, in that the eggs are apparently rarely extruded beyond the vestibule and the embryos derive nourishment (other than yolk or water) from the female.

BIOLOGICAL OBSERVATIONS

We have frequently observed courtship and copulation.

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[1] The data for species other than *Diploptera* were computed from Roth and Willis (1955).

[2] Except for *B. orientalis* (see footnote 3), the weights of the oöthecae were included in the computations, and therefore the actual changes would be somewhat larger; the youngest eggs had been recently deposited and the oldest were about ready to hatch. Factors less than unity indicate a decrease in weight.

[3] Based on eggs removed from the oötheca; the youngest eggs were 11 days old and the oldest 32 days old (about 1 week prior to hatching), so that the changes might have been somewhat higher if recently laid and fully developed eggs had been used.

The active male follows the female and palpates her body or genital region. He then partly raises and flutters his wings, turns his terminal abdominal segments toward the female, pushes backward under her and grasps her genitalia. Once they are hooked together, the male swings around into the typical opposed position with his head 180° from the female's. Newly emerged, teneral females are very attractive to, and are courted by, older males; 2 males were attracted to a female that was only partly out of its last nymphal skin and went through weak courting movements. Surprisingly, these young females mate normally (fig. 14) and in laboratory cultures the mating of teneral females is a common occurrence. According to Hagan (1951, p. 320), sexual maturity in *Diploptera* ". . . follows physical maturity rather promptly, if the presence of well developed follicles in the last nymphal instar is any criterion." Teneral females have been seen in copula before their wings had become fully extended; examination of one such female, after she had been in copula for more than an hour and had separated from the male, showed that she had received a spermatophore (fig. 15). Another teneral female, isolated while still in copula, separated from the male about 30 minutes after isolation. Sixty-seven days later, she give birth to 13 nymphs; temperature and humidity were uncontrolled during the gestation period.

We have observed four females forming oöthecae. When the first female was seen, her terminal abdominal segments were slightly separated. We anesthetized the insect and, upon microscopic examination, found about 6 eggs aligned vertically in a double row in her vestibule. After the female had recovered, she began pulsating movements, expanding and telescoping the end segments of her abdomen. While viewing the posterior end of the female during these movements, we could see the first egg through a hand lens. None of the eggs protruded completely beyond her body. About three hours after the female ceased her ovipositing motions, she was dissected. The oötheca, containing 10 eggs, had rotated (micropyles to the left) and it lay partly in the vestibule and partly in the brood sac.

The other three females were discovered in the stock colony by Dr. Barbara Stay of our laboratory. Two of these were observed expanding the end of the abdomen. Although the oöthecae did not protrude beyond the ends of the abdomens, the distal ends of the oöthecae could easily be seen in profile as the females separated their genital segments. The axes of the eggs were vertical at this time. These oöthecae were rotated a short time later, cephalic ends of the eggs to the females' left, and retracted into the brood sac. The females were then dissected; the oöthecae contained 11 and 10 eggs, respectively.

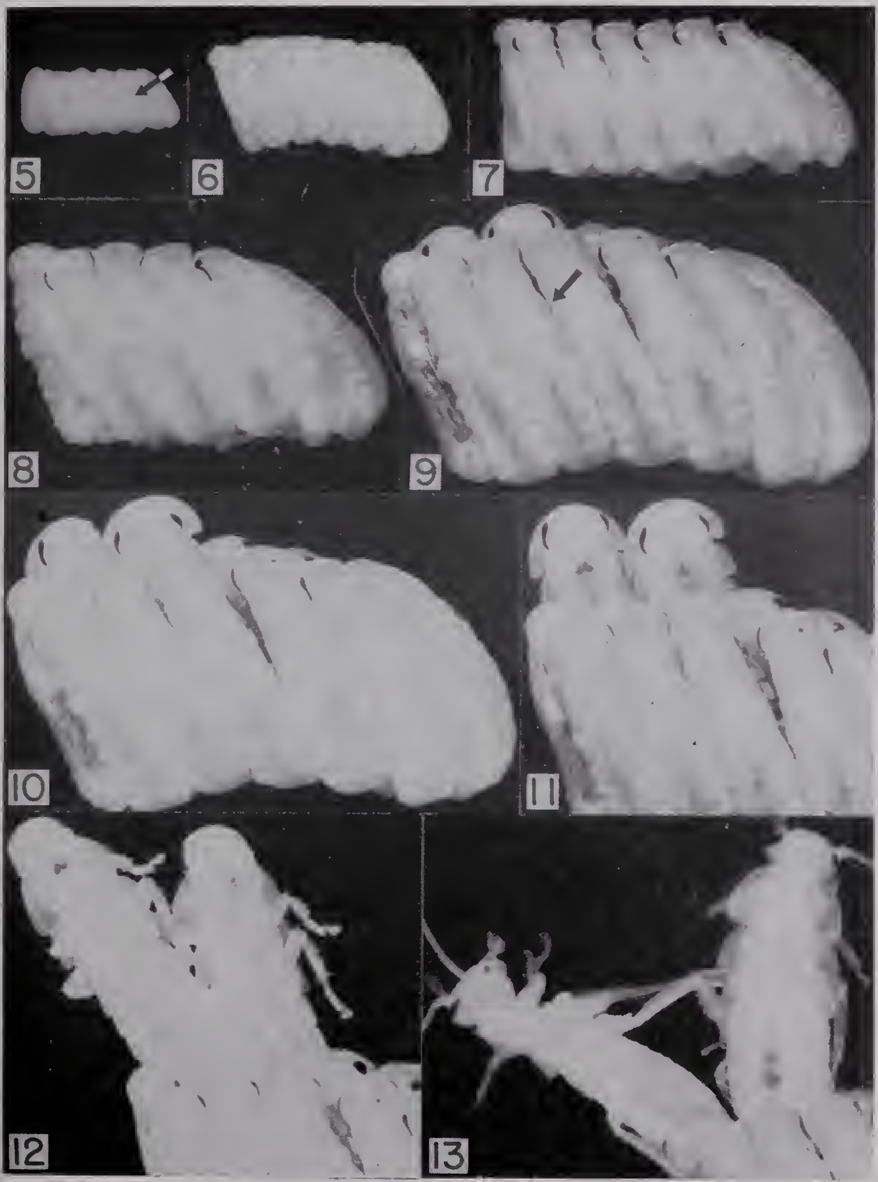
The fourth female was seen with the first egg and parts of the succeeding two eggs protruding beyond the end of her abdomen. The axes of the eggs were vertical, but within a few minutes the female rotated the oötheca, as above, and retracted it. This oötheca was later found to contain 13 eggs and the female's right ovary had seven and the left six ovarioles. These observations show that our a priori hypothesis of oöthecal formation in *Diploptera* (Roth & Willis, 1954) is correct, being similar to that found in other cockroaches.

Protrusion of eggs beyond the end of the abdomen during oöthecal formation apparently depends on such factors as size and number of eggs and size of the female. From our observations, it seems likely that few eggs protrude beyond the female's body and that protrusion occurs rather infrequently.

Since writing the above we have seen oviposition several more times; ovipositing females were recognized when they repeatedly expanded and contracted their genital segments. The first laid egg was visible for only a short time from behind or from the side. Rotation and retraction of the oötheca occurred rapidly, in a matter of minutes.

Explanation of Plate 5

Figures 5-13. Eggs of *Diploptera dytiscoides* (×5). Figs. 5-9. Eggs of various ages showing increase in size. Actual lengths of the eggs as follows: fig. 5. 1.7 mm. (note lack of visible differentiation; upper limit of thin oöthecal membrane indicated by arrow); fig. 6. 3.1 mm.; fig. 7. 4.3 mm.; fig. 8. 5.7 mm.; fig. 9. 6.9 mm. (arrow indicates a strand of greatly stretched, perforated oöthecal membrane). Figs. 10-13. Sequence showing hatching of 2 eggs from oötheca shown in figure 9; hatching occurred within 3-minute period.



ROTH AND WILLIS — DIPLOPTERA DYTISCOIDES

The rapidity of the ovipositional sequence explains why oviposition had not been seen previously in *Diploptera*.

In only one instance did we see a newly formed oötheca completely extruded by a female. We had previously removed an oötheca from this female by finger pressure against her abdomen; apparently this manipulation had damaged her reproductive organs and she was unable to direct the subsequently formed oötheca into her brood sac (fig. 2). A similar abnormality has been observed in *Nauphoeta cinerea* (Roth and Willis, 1955). Females of *Diploptera* that were accidentally exposed to temperatures above 100°F. were seen to abort oöthecae containing apparently dead eggs in various stages of development (fig. 3); this effect of high temperature has been observed in *Pycnoscelus surinamensis* by Roeser (1940).

Kotinsky (1909) found a female of *Diploptera dytiscoides* which, upon being captured, dropped a "batch of embryos" which had been projecting from her abdomen; he concluded from this that the species is viviparous. In *Diploptera,* the fully developed eggs lie diagonally in the brood sac with their cephalic ends pointed posterio-laterally. The head of the full-grown embryo nearest the genital opening of the female may protrude slightly from the brood sac; if the female's genital segments are spread apart, the embryo's head may be readily seen (fig. 4). We have observed hatching of *Diploptera* several times. The abdomens of females carrying fully developed embryos become so distended that the intersegmental membranes between the abdominal sternites are visible. The mature embryos are extruded head first (figs. 16-18). They appear by pairs, swallowing air, the heads of successive pairs

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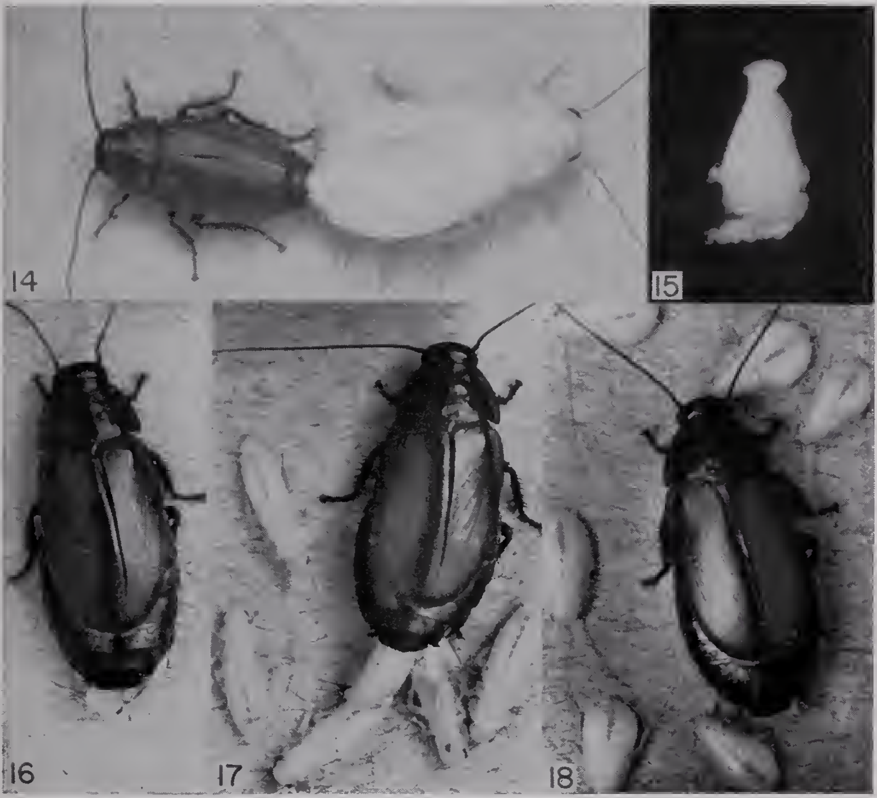
EXPLANATION OF PLATE 6

Figures 14-18. *Diploptera dytiscoides.* Fig. 14. Older, dark-colored male in copula with a recently emerged, teneral female. Fig. 15. Spermatophore (narrow region is the anterior part) removed from a mated teneral female. Figs. 16-18. Female giving birth; time interval between figures 16 and 17 was 9 minutes; that between 17 and 18 was 22 minutes. This female gave birth to only 6 individuals; the others of the brood failed to emerge from the uterus. (Figure 15 about ×13; all other figures about twice natural size.)



Roth and Willis — Diploptera dytiscoides

appearing before the preceding pair has completely freed themselves from their embryonic membranes. The embryonic membranes slip back toward the nymphs' caudal segments while they are still held by the genital segments of the female. When the nymphs drop from the mother and move off, the membranes are left behind attached to the vestigial oötheca in the posterior part of the female's genital cavity. The oötheca and embryonic membranes adhere to the female until all the eggs hatch, after which the female expels them, if necessary, with the aid of her hind legs. Thus, the birth product of *Diploptera* is an embryo devoid of a chorion, oötheca, and even the embryonic membrane. This type of birth is characteristic of truly viviparous insects (Hagan, 1951). In *Nauphoeta* and a number of other so-called ovoviviparous species the final birth product is frequently, if not always, the oötheca containing fully matured embryos which begin to hatch after the oötheca has passed beyond the caudal extremity of the female (Roth and Willis, 1954). We have found the pleuropodia of the embryos left behind with the oötheca and embryonic membranes; apparently the pleuropodia are severed from the body at or before hatching time.

We (1954) have questioned whether the so-called ovoviviparous cockroaches are truly viviparous because their oöthecae are first extruded externally during formation and then retracted into the brood sac. Hagan (1954) suggests that the extrusion and retraction of the oötheca into a brood sac represents ". . . a special case of maternal care of the oötheca and its ova." Some oviparous Homoptera place their eggs in a fold in the hypodermis, a location foreign to the reproductive system, until they hatch (Hagan, 1953). The extrusion and retraction of the eggs of the so-called ovoviviparous cockroaches is comparable to the homopteran behavior, with the exception that the oviposition site is a brood sac within the reproductive system.

When the new-born nymphs of *Diploptera* eliminate the air which distends their bodies (fig. 18), they may eat the embryonic membranes and sometimes the oötheca as well. These first instar nymphs are unduly large in comparison with the nymphs of other species of cockroaches, even those with adults twice the size of the adult *Diploptera.*

Mr. George Riser, formerly of our laboratory, working on the life history of *Diploptera,* has found that at 85°F. eggs hatch about 58 days after the female has mated; allowing about a week after copulation for oöthecal formation, embryogenesis takes about 50 days. He also found that nymphal development took about 38 days for males (9 individuals) which molted only 3 times; females (13 individuals) took about 50 days to mature and underwent 4 molts. Molted skins are not eaten by nymphs or adults.

We thank Dr. Harold Hagan for his interest and for critically reading the manuscript.

SUMMARY

The eggs of the viviparous cockroach *Diploptera dytiscoides* absorb both water and solid matter from the female. During embryogenesis, dry matter in the eggs may increase about 50 times and the water content may increase about 85 times. In its embryonic development, *Diploptera* is unique among cockroaches in that the embryo gains solids from the mother in addition to the yolk initially present in the egg.

In laboratory colonies, teneral females mate normally with older males. The oötheca is formed as in other species of cockroaches: the eggs are extruded from the oviduct and arranged vertically in an oötheca within the vestibule. Sometimes one egg (the first laid) may protrude beyond the end of the abdomen, but most of the eggs remain within the vestibule while the female rotates the oötheca and starts retracting it into her brood sac.

The number of eggs per oötheca ranged from 9 to 13, with a mean of 11.4. Embryogenesis takes 50 or more days. The embryos hatch in pairs, being extruded head first from the female. Male nymphs took about 38 days to mature, molting 3 times; females became adults after about 50 days, molting 4 times.

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REDESCRIPTION OF *SPILOCONIS PICTICORNIS* BANKS (NEUROPTERA: CONIOPTERYGIDAE)[1]

By F. M. Carpenter
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Within the past two years several lots of specimens of *Spiloconis picticornis* Banks have been sent to me from the Department of Biological Control at the Citrus Experiment Station, California. Some of these were secured on Hong Kong, China, by Dr. S. Flanders; but most of them were reared at the Citrus Experiment Station from stock obtained on Hong Kong. This extensive series of specimens has made possible the preparation of a more detailed description of the species than could be achieved from the unique female type on which the species was originally based.

I am indebted to M. E. Badgley, C. A. Fleschner, and J. C. Hall, all of the Citrus Experiment Station, for providing me with specimens used in this study. An account of the biology of *picticornis* by these investigators follows in the present issue of Psyche; it is a significant account, since little is known about the biology of the coniopterygids in general and nothing at all has previously been known about the life history of any species of *Spiloconis*.

The genus *Spiloconis* was erected by Enderlein in 1907, within the subfamily Aleuropteryginae, to include two species. One of these, *sexguttata* Enderlein (genotype), was known only from Japan, though Enderlein later (1908) recorded it from Formosa as well; the other was *maculata* Enderlein, from New South Wales, originally described (1906) in *Helicoconis*. A third species, *interrupta*, was described from Mindanao (Philippines) by Banks, in 1937. A fourth species, *picticornis*, was described from Hainan, by the same author, in 1939. Finally, Banks (1939) trans-

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

ferred to *Spiloconis* Hagen's *cerata* from Ceylon, originally assigned to *Coniopteryx*.[2] Up to the present time, therefore, the genus has been known from Australia and five islands in the Asiatic region. The specimens of *picticornis* from Hong Kong are the first of the genus recorded from the Asiatic continent.

The outstanding characteristic assigned to *Spiloconis* by Enderlein is the unusual length of the first two antennal segments, both of which are several times as long as wide; in other genera of the family these segments are about as broad as long. Knowing only *sexguttata* and *maculata* at the time of the description of *Spiloconis,* Enderlein was led to believe that the genus might also be characterized by maculations on the fore wings, but *picticornis, interrupta* and apparently *cerata* have unmarked wings. In all probability the most significant generic features will be found in the terminal abdominal segments of both sexes. An account of these terminal structures in *picticornis* is given in detail below, but until equivalent structures are known in other species, we cannot propose their generic application.

The redescription of *picticornis* included below is based in part on the type, which is in the Museum of Comparative Zoology, but largely on eighty-five additional specimens. as follows: 3 ♂, 3 ♀, Taipo, Hong Kong, China, Jan. 1, 1954, ex citrus (Flanders); 2 ♂, 1 ♀, Fanling, Hong Kong, Nov. 16 and 25, 1953 (Flanders); 23 ♂, 19 ♀, bred from Hong Kong stock at Riverside, California, Dec. 20, 1954; 20 ♂, 10 ♀, same, May 7, 1954; 4 ♂, 3 ♀, same, April 17, 1955. All of this material is preserved in alcohol and is deposited in the Museum of Comparative Zoology.

The fore wing of the type is 2.3 mm. long and 1 m. wide (maximum); in other specimens which I have examined it ranges from 2.5 to 1.9 mm. long, and from 1.1 to .8 mm. wide. The general body color of living or alcoholic specimens is pale yellow; that of dried specimens is much darker. The frons is light yellow, occipital and genal areas brown. The antennae in all specimens which I have seen,

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[2] *Spiloconis rufa* Nakahara, originally described from Japan in 1913, is now considered by its author to be a synonym of *sexguttata* (*in litt.*).

including the type[3], consist of 18 segments; the scape is about six times as long as any segment of the flagellum, and the pedicel is about four times as long. The proximal eight segments are light yellow, though the 8th is sometimes partially gray; the next two (9th and 10th) are either black or dark gray; the next two (11th and 12th) light yellow; and the distal six (13th through 18th) black or nearly so. This pattern of coloration is uniform in all specimens which I have seen, though the intensity of pigmentation in segments 9 and 10 varies somewhat. The maxillary and labial palps are black or nearly so on the outer surfaces, but lighter on the inner. The thorax and abdomen are pale yellow, except for the dark brown lines which mark the apodemes; the legs are pale yellow, but with some light tint of gray on the femora. The wings are smoky brown and lack maculations; certain cross-veins and parts of some main veins are obsolescent, their positions being indicated by white streaks in the wings. The venation, shown in figure 6, is typical of that of the Aleuropteryginae; I have seen no obvious variations in the venational pattern of either wing. The pattern is like that of *sexguttata,* except that the bases of the macrotrichia are more conspicuous and are proximal to the middle of the wing.

The terminal abdominal segments of *picticornis* differ greatly from those of the species of the Coniopteryginae and Aleuropteryx. Since I have had no opportunity to make a comparative study of the terminalia of other species of *Spiloconis,* I am unable to indicate which characteristics are generic and which are specific. The most striking peculiarity of the male abdomen is the reduction of the ninth tergite and sternite. Although the sclerotization of the abdomen is weak, the first eight segments are readily distinguished, each bearing a pair of spiracles; segments 3-6 also have the evaginable sacs peculiar to the Aleuropteryginae. The tenth tergite is distinct but the ninth appears to be fused with the eighth, presumably bearing

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[3] Banks' statement that there are 20 antennal segments in the type was apparently an error. His description of the color pattern was also incorrect, probably as a result of his mistake in counting the segments.

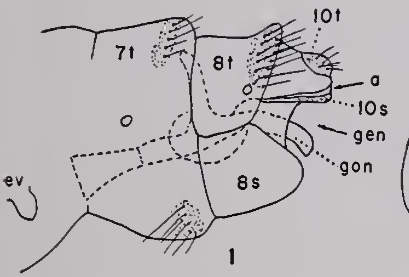
the distal row of macrotrichia. The anus is clearly seen just above the strap-shaped tenth sternite, which forms the roof of the genital opening; at the base of the tenth sternite is a complicated supporting structure into which the parameeres and aedeagus extend; this supporting structure is apparently the gonarcus, described in the Coniopteryginae by Tjeder[4]. The parameeres are fused together to form a cylindrical body, with a terminal and a subterminal hook distally (possibly the aedeagus) and a pair of divergent arm-like processes dorsally. The gonarcus and parameeres showed no obvious variations in the fifteen specimens of *picticornis* which I dissected. The parameeres are apparently not attached to the gonarcus, but the distal end of the fused parameeres extend into the gonarcus a short distance; in figure 2 the parameeres are shown slightly removed from their normal position in the gonarcus. The triangular and curved tips of the gonarcus project slightly from the genital opening and can readily be seen when the abdomen is observed from the side (figure 1). There is no indication of a ninth sternite or of the hypandrium, which is well developed in the Coniopteryginae. The floor of the genital opening consists of the eighth sternite; this is directly ventral to the corresponding tergite.

In the female, the ninth abdominal tergite is apparently fused with the eighth; between the eighth tergite, which bears spiracles, and the anus, there is only a single

[4] It is probably a derivative of the tenth sternite (Killington, 1936).

EXPLANATION OF PLATE 7

Spiloconis picticornis Banks. Fig. 1. Terminal abdominal segments of male, drawn from reared specimens (lateral view); 7t, 8t, 9t, 10t, tergites; 8s, 10s, sternites; a, anus; gen, genital opening; gon, gonarcus; ev, evaginable sac. The parameeres and internal portions of the gonarcus are shown by dotted lines. Fig. 2. Gonarcus (top) and parameeres (bottom), dorsal view. Fig. 3. Terminal abdominal segments of female, drawn from type (lateral view); gph, gonapophysis; other lettering as in figure 1. Fig. 4. Gonapophysis of ninth segment of female, drawn from reared specimens (ventral view). Fig. 5. Venation of fore and hind wings; the dotted lines indicate obsolescent parts of veins.



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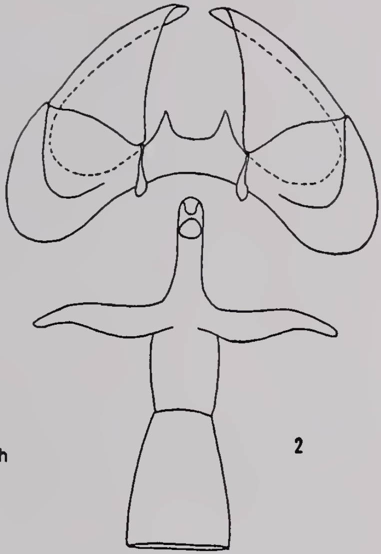

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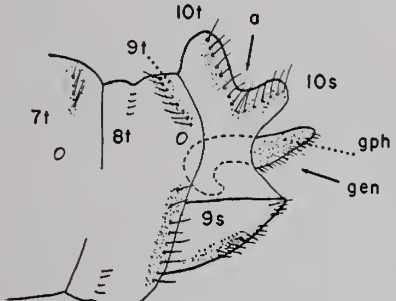

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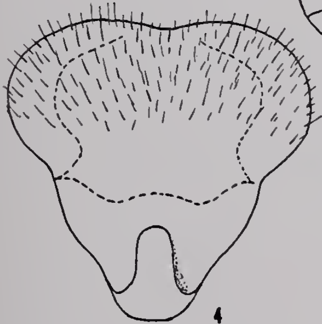

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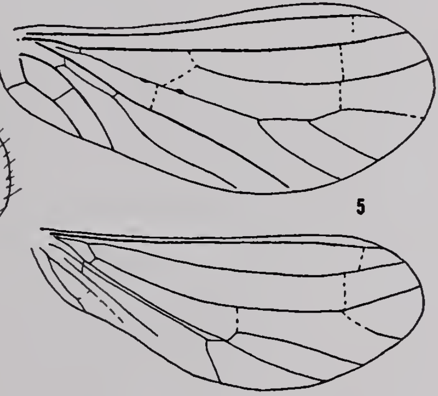

5

CARPENTER — SPILOCONIS PICTICORNIS

tergite, which I interpret as the tenth; beneath the tenth sternite, which forms the roof of the genital chamber, is a flat plate, presumably a derivative of the ninth sternite; this gonapophysis appears as a hairy, oval disc, when observed from a ventral-posterior direction; internally, it narrows and recurves ventrally. Below this plate is one distinct sclerite, which appears to be the ninth sternite, although it resembles the eighth sternite of the Coniopteryginae in form and could be a derivative of that sclerite.

S. picticornis is most readily recognized by the antennae, the color pattern of which is unlike that of any other species of the genus.

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THE BIOLOGY OF *SPILOCONIS PICTICORNIS* BANKS (NEUROPTERA: CONIOPTERYGIDAE)

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The dustywing *Spiloconis picticornis* Banks was introduced into California from Taipo, Hong Kong, in 1953 by S. E. Flanders. As it is predaceous on plant feeding mites and scale insects, attempts are now being made to establish it in citrus and avocado groves in southern California. For this reason *S. picticornis* is being reared in large numbers by the Department of Biological Control, University of California Citrus Experiment Station at Riverside. Thousands of individuals of *S. picticornis* have already been released in southern California citrus and avocado groves and many thousands more will be released during the coming season. The following information on the life history and feeding habits of *S. picticornis* was obtained during the process of developing a mass production program for this predator.

Procedure.—These studies were made in a darkened insectary room having a temperature of 80°F. with the relative humidity between 50 and 60 per cent. Adults were kept in 8 dram vials. Each vial was placed over a detached leaf of *Pittosporum Tobira* Ait., the petiole of which was inserted in a ¼ dram vial filled with water and held in place with cotton. The leaves were infested with crawlers of the soft (brown) scale, *Coccus hesperidum* Linn. one to two days before they were to be used. Red scale crawlers, *Aonidiella aurantii* (Mask), were placed on the leaf just prior to insertion into the vial containing the dustywings. Each vial was supplied with a fresh leaf daily.

Egg.—The eggs are irregularly ellipsoidal in outline, approximately 0.53 mm. long and 0.34 mm. wide. They

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are flat and scale-like. The chorion is strongly reticulate. The reticulations are often stretched and even obliterated during deposition if the egg is not supported. In many instances the eggs follow the contour of the surface upon which they are laid, and are thus distorted from the usual shape. The color of the eggs varies from straw-yellow to pink or pale purple. The straw-yellow colored eggs usually turn pinkish between 12 and 14 days after deposition. The pink or light purple eggs show no change except for the appearance of the eye spots which begin to show up 10 to 12 days after deposition. The length of the egg stage is rather consistent at 16 days.

Larvae.—As in most Neuroptera the larvae emerge from the egg by means of an egg burster. In this species the egg burster is attached to the hatching membrane which is shed immediately after the egg is broken. While still in the egg the larva is lying on its back with the head curved forward and down between the legs. The egg burster is located on the top of the head and projects upward over the mouthparts. Hatching is facilitated by the movement of the head, which manipulates the egg burster, thus breaking the chorion. The hatching membrane remains attached to the inside of the egg.

The larvae are shortly fusiform, the widest part being the thorax. In color they vary from creamy white to pink. The darker characteristic color pattern is confined to the lateral margins of the body (see fig. 1). The mature larvae are generally more uniformly pinkish-purple with small white markings as well as the dark lateral areas. The gut contents are clearly visible as a central, reddish-brown stripe. The integument of the dorsum of the body and head is very minutely muricate, the points being four and five sided. The venter is nearly smooth. Each abdominal segment bears eight pairs of minute squamiform setae (fig. 2) in addition to two pairs of simple setae;

EXPLANATION OF PLATE 8

Figure 1. Mature fourth instar larva of *S. picticornis.* Figure 2. Enlarged drawing of a dorsal squamiform setae. Figure 3. Exarate pupa of *S. picticornis* showing the attached last larval molt skin.

Badgley, Fleschner, and Hall — Spiloconis picticornis laterally there are two pairs of squamiform setae; ventrally there are four pairs of simple setae on each segment.

The thoracic segment bears eight to ten pairs of dorsal squamiform setae. The head bears six pairs of squamiform setae and four pairs of serrated setae. The antennae are three-segmented and sparsely covered with setae of unequal length; three or four of the basal setae are serrated, the others comparatively smooth. The labial palpi are two-segmented, the second segment being much longer than the first and rather fleshy and swollen. The mandibles and maxillae together form a hollow tube through which the food is ingested. When not feeding, the mouth parts are held in a forward projecting position with the two mandibles and maxillae appearing as a single unit.

S. picticornis larvae pass through four instars. This is in contradiction to the findings of Killington (1936) concerning British Neuroptera. Killington found that all British Neuroptera underwent only three larval molts. The first larval molt of *S. picticornis* occurs one to three days after hatching; the second molt four to seven days later; the third molt takes place five to seven days after the second; and the last or fourth molt occurs within five to eight days. The last instar larva moves about freely for from one to seven days. At the end of its feeding period it seeks a place in which to spin a cocoon. From five to eight days are spent in this fourth instar as a prepupa before the final molt to the pupal stage. The larval skin remains attached to the pupa, usually on the back towards the posterior end (fig. 3). In these studies the total elapsed time in the larval state varied from 16 to 32 days.

The larvae have been observed to feed only upon the scale insects of the diaspine and lecanine groups. The preferred stage of the scale appears to be the younger settled scale, although all stages have been attacked from the crawlers to the second instar. The lecanine scales are more easily consumed than the diaspine scales. In the former group the dustywing larva may make only one feeding puncture, this is through the dorsum of the scale; while in the latter group the larva very often is unable to pierce the scale cover and after several attempts will move to the edge of the scale and insert the mandibles between the cover and the substrate.

When ready to pupate the fourth instar larva selects a crevice or crack in which to spin the cocoon. Contrary to the usual occurrence of two envelopes, it has been found that there are three distinct layers which make up the cocoon. The first or outer layer is loose and lace-like and is mostly the framework by which the cocoon is held in place. The second layer is also lace-like but it has a more definite vertical wall-like construction. The third or innermost layer is thick and closely woven. This last layer is the toughest of the three and is appressed to the pupa contained therein. The whole cocoon is irregularly circular, 2.5 mm. to 3 mm. in diameter, and flattened, approximately 0.5 mm. high.

After the cocoon is spun the larva turns on its side and becomes quiescent. This quiescent prepupal period lasts from five to eight days. At the end of this period the larval skin is shed and the exarate pupa is exposed (fig. 3). The pupal stage lasts from eleven to twenty days. When the adult is ready to emerge the pupa cuts an irregular opening in the cocoon and crawls out, leaving the posterior abdominal segments in the cocoon to act as an anchor. Occasionally the pupa will crawl completely out of the cocoon. In this case emergence of the adult is completed with a great deal of difficulty.

Adult.—Upon completion of emergence the adults are grayish in appearance, they remain in this state until the secretion of the wax-like coating completely covers the body and wings. It has been observed that a period as long as 48 hours may elapse before the adult begins to secrete the wax-like covering.

Mating has not been observed to take place prior to three or four days after emergence. This period is presumed to be the length of time required for the ovaries to mature. The pre-oviposition period varies from four to ten days. Oviposition rarely occurs before mating and when it does the eggs are nonviable. An occasional female has been observed to mate more than once after oviposition has commenced but the necessity for repeated impregnation has not been determined. Within one day after mating the female begins depositing eggs. As many as 20 eggs have been obtained from a single female within a twenty-four hour period, but this is an extreme; the average number of eggs laid during this period has been approximately ten.

The females prefer a rough surface, with many depressions or crevices, for oviposition. In many cases the females will not oviposit if they are not provided with a suitable ovipositional substrate. The eggs are laid singly, but quite often large numbers will be found in a favorable location. Most of the oviposition takes place at night, there being little or no activity during the day.

The length of life of the adults provided with an adequate diet varied from 49 to 63 days. The length of life from the time of egg deposition until death of the adult varied from 92 to 131 days; the average being approximately 110 days under insectary conditions.

Hosts.—While the results obtained and the list of species tested as hosts are not complete, they do indicate the type of food required for development and egg production. As mentioned above the larvae were observed to feed only upon the young scale of the diaspine and lecanine groups. The adults have been observed to feed upon the citrus red mite, *Metatetranychus citri* (McG.) and the citrus rust mite, *Phyllocoptruta oleivora* (Ashm.) in addition to the scale insects. In order to promote egg production and also lengthen the life of the adults, honey and water are necessary. As shown in table 1 the diet which proved to be the most sufficient as to length of life consisted of water, honey and scale crawlers. The length of life of dustywing adults which fed on citrus red mites or citrus rust mites, with honey and water added in each case, was similar to that obtained with a diet of scale crawlers, honey and water.

Table 1 shows that when adults of *Spiloconis picticornis* were fed only citrus red mites or scale crawlers the maximum length of life was four days. When fed only honey, water, or citrus rust mites the maximum length of life was six days. When fed rust mites and water the maximum life period was seven days. When water was added to the scale crawler diet the maximum life period was 18 days. When honey was added to the scale crawler diet the maximum life period was thirty-five days. When both honey and water were added to the scale crawler diet the maximum life period was extended to sixty-three days. When both honey and water were added to the mite diet similar results were obtained.

Table 1

Number of Days Adults of *Spiloconis picticornis* Lived When Fed Various Foods or Combinations of Foods.

FOOD	**Number of Adults Tested**	**No. of Days for 50% Mortality**	**No. of Days for 100% Mortality**
Scale Crawlers[1]	26	2	4
Red Mites[2]	10	2	4
Honey	10	5	6
Water	36	3	6
Rust Mites[3]	40	2	6
Rust Mites, Water	30	4	7
Scale Crawlers, Water	6	16	18
Scale Crawlers, Honey	30	18	35
Scale Crawlers, Honey, Water	30	45	63

[1] *Aspidiotus hederae* (Vallot)
[2] *Metatetranychus citri* (McG.)
[3] *Phyllocoptruta oleivora* (Ashm.)

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ECOLOGY AND BEHAVIOR OF THE ANT *BELONOPELTA DELETRIX* MANN (HYMENOPTERA: FORMICIDAE)

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Belonopelta Mayr is a little-known genus of ponerine ants represented by two species, *B. attenuata* Mayr of Colombia and *B. deletrix* Mann, the latter hitherto recorded from Honduras and Chiapas (Wheeler, 1935; Brown, 1950). It is of more than usual interest because of the aberrant, presumably raptorial modification of the mandibles. To the present time only several specimens have been mentioned in the literature, and nothing has been recorded concerning its biology.

B. deletrix was recently encountered by the present author near the village of Pueblo Nuevo, Veracruz, in the Cosolapa Valley ten miles south of Cosolapa. This record represents a considerable northwestward extension of the range of the genus. The Cosolapa Valley, like most of this part of Mexico, is under heavy cultivation, and the native forest is limited to precarious sanctuaries on the steep slopes of numerous hills and mountains which rise from the valley floor. Pueblo Nuevo is located in the saddle of a pass through one of the lower hill ranges. To the northwest, and across the nearby Cosolapa River, there is a large tract of true rainforest, i.e., a forest in which the trees are several-storied, with a few "emergents" over 100 feet in height, and heavily festooned in the upper reaches by lianas and epiphytes. The upper stratum forms a closed canopy in the undisturbed portions, and herbaceous undergrowth is very sparse. The forest is being continuously high-graded by crude native lumbering methods, and as a result clearings and patches of scrubby second growth occur throughout. The prevalent ant genera in the leaf litter and soil, as indicated by repeated Berlese funnel samples, are *Wasmannia, Solenopsis* (*Diplorhoptrum*), *Pheidole, Prionopelta, Pyramicus, Neo-*

struma, Rogeria, Strumigenys, Paratrechina (*Nylanderia*), *Octostruma,* and *Odontomachus,* approximately in that order. *Apterostigma, Apsychomyrmex,* and *Glamyromyrmex* are among the less common but zoogeographically distinctive ground elements. *Wasmannia, Azteca, Pseudomyrmex,* and *Paracryptocerus* predominate in the arboreal fauna.

B. deletrix was found on two occasions during ten days' collecting in this forest. First, a single worker was discovered in a rotting, but still firm, section of tree branch, two inches in diameter, buried in deep leaf litter between the buttresses of a large tree. It was in a flat, rectangular, preformed cavity which opened to the soil below by a broad gallery. Six eggs, six larvae, and three worker cocoons were also present, but conscientious search in the immediate vicinity failed to reveal other adults. Later, a complete colony, undoubtedly independent of the first, was discovered nesting several hundred yards away in a rotting branch, of the same dimensions as the first and also buried in leaf litter between the buttresses of a large tree. This colony consisted of ten workers, a dealate queen, ten eggs, twenty larvae of various sizes, and eight cocoons. It occupied a small cavity the diameter of a pencil and six inches long in the center of the branch.

A third collection of the species was made to the east of Pueblo Nuevo in what might best be described as "tropical evergreen" forest (see Leopold, 1950). The soil was drier and rockier than in the rainforest, and the trees formed a single, often-broken canopy with few lianas and epiphytes. The ant fauna in general appeared to be little more than a depauperate extension of the rainforest fauna. A colony fragment of *Belonopelta deletrix,* consisting of three workers, four eggs, and several larvae, occupied a pencil-width cavity in a very rotten, crumbling tree branch three to four inches in diameter lying on the ground and partly covered by rather dry leaf litter. The surface soil and leaf litter in the immediate vicinity were collected in bags, sorted through manually, and then processed in Berlese funnels, but no more adults or brood could be found.

From the limited data given above it is evident that *Belonopelta deletrix*, like many other endemic Neotropical species, can live in more than one type of habitat, despite the fact that it is primarily a rainforest dweller. It is of interest also that groups of workers and brood can exist apart from a queen, although there is no way of knowing whether these groups are fragments of a larger colony or independent colonies founded by workers.

The queen of *Belonopelta deletrix* is a normal female (figs. 1, 3), a fact by itself of considerable significance, since Borgmeier (1950) has shown that the queen of the closely related genus *Simopelta* [*S. pergandei* (Forel)] is dichthadiiform. Not only does this add a large morphological difference between the two genera, but it may foreshadow a fundamental difference in behavior; i.e., *Belonopelta* leads a "typical" sedentary life, while *Simopelta* may be nomadic.

The rainforest colony and larger colony fragment were maintained in artificial nests during a month's period for studies on food habits and behavior. In the field, a worker had been found on the undersurface of a limb near the rainforest colony carrying a dead or paralyzed campodeid in its mandibles. In captivity, other campodeids, as well as a single japygid, were quickly captured by the workers and fed to the larvae. Small geophilid centipedes and a single small cicadellid were also accepted and eaten, but a larger lithobiid centipede was discarded after capture, and other larger centipedes were completely avoided. Termites of the genus *Nasutitermes* were generally avoided in the first weeks, at the most stung to death and then abandoned, but later, after a month's confinement and transfer to the United States, the rainforest colony accepted workers of *Reticulitermes*. Beetle larvae and adults, moth larvae, millipedes, and isopods were avoided. The general impression received is that only a few kinds of small arthropods are readily accepted, and of these, the

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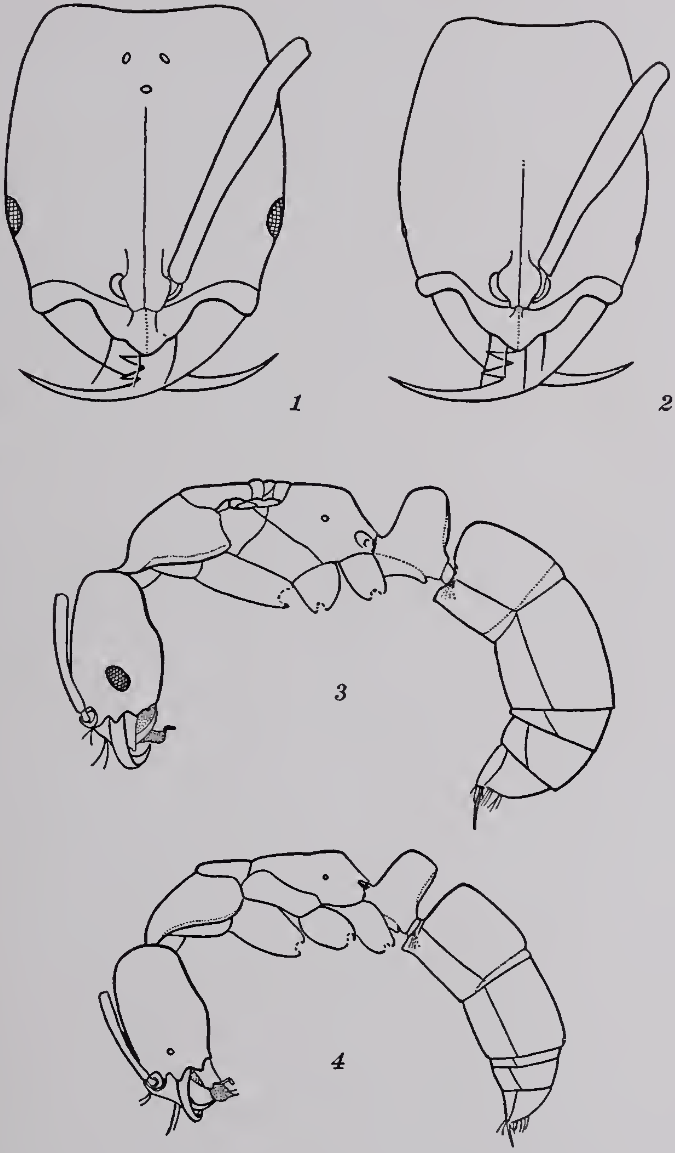
EXPLANATION OF PLATE 9

Figs. 1-4, *Belonopelta deletrix* Mann. 1, head of queen. 2, head of worker. 3, queen, side view. 4, worker, side view.



Wilson — Belonopelta deletrix

entotrophan families Campodeidae and Japygidae are the preferred prey. In the Pueblo Nuevo forests, campodeids are abundant (many were on the limb housing the rainforest colony), and they may well form the principal food supply. Honey was ignored by the workers, although available in the artificial nest for at least two weeks.

Despite the rather spectacular development of its mandibles, there does not appear to be anything really unusual about this species' method of catching prey, although it is admitted that the workers were never seen in the act of hunting uninjured entotrophans, the presumed usual prey. When a brood of newly hatched geophilid centipedes was placed in the food chamber, the ants rushed them immediately, seized them with their mandibles, and shook them back and forth with a forward bobbing motion of the head. Only one individual was stung, in addition, before being carried back to the brood. The *Belonopelta,* when hunting or fighting intruders, do not open their mandibles more than is usual for other Ponerini. Also, the mandibles are not handled like traps as in other long-jawed groups such as the Odontomachini and Dacetini, nor does their strike have the stunning effect sometimes observed in these groups. My own interpretation is that their peculiar shape is a special adaptation for pinning entotrophans, which insects are very active and agile, and difficult for most ants to hold and sting.

My *Belonopelta* were generally very timid, in most instances fleeing frantically from arthropods not sought as prey, including the docile *Nasutitermes* workers. Their mandibles crossed one another at rest as shown in figures 1 and 2 and were never opened to threaten intruders. When the workers transported larvae, they cradled them between the concave masticatory borders and avoided using the needle-like apical teeth.

The *Belonopelta* larvae were very active; when disturbed they thrashed violently back and forth in the manner of injured earthworms, but showed no capacity for directed locomotion. Insect prey were fed to them in typical ponerine fashion on their "laps", either entire or cut up into large pieces. The cicadellid mentioned above was placed entire across the laps of two large larvae lying side by side.

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NAME CHANGES IN COCCINELLIDAE. — Among the names proposed by E. Mulsant in his 1850 work on the family Coccinellidae several were preoccupied. Three of these, of interest to students of the neotropical fauna, seem not to have been corrected.

Neopalla new name

Pelina Mulsant, 1850, Species Trimères Sécuripalpes, p. 229, 271; not *Pelina* Curtis, 1838, Guide Brit. Ins., ed. 2, p. 291; not *Pelina* Haliday, 1839, Ann. Mag. Nat. Hist., (1), vol. 3, p. 407.

Palla Mulsant, 1850, loc. cit., p. 273; not *Palla* Hübner, 1819, Verz. bekannt. Schmett., (3), p. 47; not *Palla* Billberg, 1820, Enum. Ins. Mus. Billberg, p. 90.

Type of genus—*Pelina* (*Palla*) *hydropica* Muls.

The genus Pelina was set up by Mulsant for two species, *Pelina lebasi* n. sp. and *P. hydropica* n. sp. For the second of these he proposed a separate subgenus, under the name of *Palla*. Unfortunately, both of these names were preoccupied. The writer has studied the anatomy of both species and does not believe that they should be separated subgenerically. The species, with synonymy, will stand as follows —

Neopalla hydropica (Muls.)
Neopalla lebasi (Muls.)
Syn. *Neda murilloi* Chpn.

Dargo new name

Oeneis Mulsant, 1850, loc. cit., p. 497, 500; not *Oeneis* Hübner, 1819, Verz. bekannt. Schmett., (4), p. 58.

Type of genus — *Oeneis nigrans* Muls.

Mulsant proposed the genus *Oeneis* for two Brazilian species, *Oeneis obscura* n. sp. and *O. nigrans* n. sp. Crotch, in his Revision of Coccinellidae, 1874, p. 206, selected *O. nigrans* Muls. as genotype and at the same time suppressed the genus as a synonym of *Cryptognatha* Muls. This may have been an unfortunate selection, for a study of the types of the two species may very well show that the two species are not congeneric and that *O. nigrans* Muls. belongs in what is now known as *Delphastus* Casey. If my supposition is correct, *Dargo* will fall as a synonym of *Delphastus* and a new genus will have to be defined for *O. obscura* Muls. and its allies. — EDWARD A. CHAPIN, Museum of Comparative Zoology, Harvard College.

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1874

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PSYCHE

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STUDIES ON THE DISTRIBUTION OF THE GENUS NOVOMESSOR (HYMENOPTERA: FORMICIDAE)

By Wm. S. Creighton

Department of Biology, City College, New York.

During recent years the writer has taken specimens of *Novomessor albisetosus* or *N. cockerelli* at seventy-three stations[1]. As more than half of these were in northern Mexico it seems advisable to review the distribution of both species. When W. M. Wheeler and the writer monographed the genus *Novomessor* in 1934 (1) there were no Mexican records for *albisetosus* and only four for *cockerelli.* In the intervening twenty years this situation has changed scarcely at all. There are still no published records for *albisetosus* from Mexico and only one additional one for *cockerelli.* This last is, however, a most interesting record. In 1954 (2) Kannowski, in his important account of the habits of *N. manni,* noted that Cantrall has recently taken specimens of *cockerelli* at Rincon de Romos (6100′) in the state of Aguascalientes. Cantrall's record establishes the fact that the range of *cockerelli* extends into the tropics, but it should be clear that, because of the lack of published data, the distribution of *albisetosus* and *cockerelli* in northern Mexico has remained largely conjectural.

On the following pages I have presented not only records from Mexico but also a number from the United States. This is necessary to demonstrate the significant difference

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[1] Field work done on a Guggenheim Fellowship.

in the response of the two species to elevation. Dr. Wheeler and the writer failed to appreciate this difference in 1934 and, in consequence, gave a very unsatisfactory account of the vertical range of the two species. It now appears that response to elevation is what mainly determines the range of each species. The figures for elevation which follow were secured from altimeter readings made at the station and checked then or later against topographic sheets.

Novomessor albisetosus:

TEXAS: Davis Mountains, Limpia Canyon (4800′), 2 miles south of Indian Hill (5300′); Chinati Mountains, Arsarca Canyon (4800′).

ARIZONA: Huachuca Mountains, Garden Canyon (5800′) Carr Canyon (5000′), Ft. Huachuca (5100′); Dragoon Mountains, Cochise Stronghold (5200′); Peloncillo Mountains, Cottonwood Canyon (4800′); Baboquivari Mountains, Forestry Cabin (3500′), Brown Canyon (3900′); Chiricahua Mountains, Nat. Mon. Camp Ground (5200′); Pima County, Total Wreck Mine (4400′), 30 miles east of Sells (2800′); Santa Cruz County, 5 miles north of Nogales, (3900′), Pena Blaca Springs (3700′), Ruby (4600′); Hasayampa River, 5 miles south of Wickenberg (1800′); 5 miles south of Clifton (3200′).

SONORA: Cerro San Jose, 10 miles southwest of Naco (5100′); 5 miles north of Santa Cruz (4700′); Cibula (3600′); La Casita (3400′); 5 miles north of Imuris (3100′).

CHIHUAHUA: Sierra de en Medio, Nogales Ranch (5000′); 9 miles north of El Sauz (4900′); 13 and 18 miles west of Chihuahua City (5100′, 5400′); 16 miles east of Cuauhtemoc (5900′); Bachimba (4200′); 2, 17 and 22 miles south of Parral (5500′).

DURANGO: Villa Ocampo (5700′); 22 miles south of Villa Ocampo (5700′).

Novomessor cockerelli:

NEVADA: 9 miles north of Searchlight (3200′).

TEXAS: Palo Duro Canyon (3000′).

ARIZONA: Whetstone Mountains, Dry Canyon (5000′); Plains west of the Baboquivari Mountains (3000′); Organpipe Cactus National Monument, Headquarters (1600′), Dripping Springs (1700′), Quitobaquito (900′); 25 miles east of Douglas (4000′); 20 miles east of Gila Bend (2700′); 8 miles north of Casa Grande (1300′); 7 miles east of Aguila (2200′); Safford (3000′); 15 miles north of Wilcox (4100′).

SONORA: 3 and 8 miles south of Sasabe (3400′); 2 and 10 miles south of Sonoita (1300′, 1400′); Campamto (1400′); Santa Ana and five miles south of Santa Ana (2500′); 6 miles south of Imuris (3200′); 10 miles south of Hermosillo (700′).

CHIHUAHUA: Plains east of the Sierra de en Medio (4700′); El Pueblito (4900′); 6 miles south of Gallego (5100′); 5 miles north of Ojo Laguna (4800′); 7 miles north of Chihuahua City (4700′); Jiminez (4300′); 2, 34 and 38 miles south of Parral (5500-5800′).

COAHUILA: Nava (1000′); 20 miles north of Saltillo (4000′); Sierra de la Paila (4800′); 22 miles west of Saltillo (5000′).

DURANGO: 12 miles south of Villa Ocampo (5600′); 17 miles south of Rodeo (5500′); 5 and 6 miles east of San Lucas (6100′); 17 miles south of Durango City (6400′).

ZACATECAS: 30 miles east of Sombrerete (6900′).

The table below shows the relationship of latitude to elevational range in the two species. It is based on the records just given plus about thirty older ones for which elevational data was available or could be assigned with acceptable accuracy. The numbers in parentheses are the totals of the records involved.

Latitude	Elevational Range *N. cockerelli*	Elevational Range *N. albisetosus*
36°-34°	(3) 3000-3300′	no records
34°-32°	(16) 1000-4500′	(8) 1800-5200′
32°-30°	(20) 1300-5000′	(22) 3100-5800′
30°-28°	(10) 700-5100′	(7) 2600-5900′
28°-26°	(5) 4300-5800′	(5) 5500-5700′
26°-24°	(5) 4000-6100′	no records
24°-22°	(5) 6100-7000′	no records

The following points in the above table should be noted:

1. The range of *cockerelli* extends further north and much further south than does that of *albisetosus*. There are no records for the latter species north of Latitude 34° or south of Latitude 26°.

2. The effect of latitude on the upper limit of the elevational range is different in the two species. From Latitude 34° to Latitude 26°, where they occur together, the rise in the upper elevational limit is 700 feet for *albisetosus* against 1300 feet for *cockerelli*. Over the entire range of *cockerelli* the rise is almost 4000 feet.

3. In the northern part of the common range the upper elevational limit of *cockerelli* is approximately 1000 feet below that of *albisetosus*. But because this limit rises more rapidly in the case of *cockerelli*, the two species have the same upper limit about Latitude 26°. South of that latitude the upper limit of the vertical range of *cockerelli* continues to rise, but, since *albisetosus* does not occur south of Latitude 26°, the records for *cockerelli* from stations above 6000 feet cannot properly be compared with those for *albisetosus*.

4. In the common range there is a considerable area of overlap in the vertical ranges of the two species. The two vertical ranges are never identical, however, for although the upper limits may coincide, the lower limit of *cockerelli* always descends below that of *albisetosus*. This difference is at least 800 feet and often much more.

It goes without saying that this response to elevation has a direct connection with the topography of the regions in which the two species occur. In subsequent pages the writer has discussed some of the topographic features which affect the distribution of the two species. The most extensive of these is the Sierra Madre Occidental, which determines the western limit of the range of both species for several hundred miles in northern Mexico. Most cartographers show the Sierra Madre Occidental as a continuous rampart which extends from Zacatecas northwestward to the southern border of Arizona. In the opinion of the writer it may be doubted that the highlands of Zacatecas ought to be considered as a part of the Sierra. At least they are cut off from the rest of the Sierra by the valley of the Rio Mezquital, which rises on the Plateau in southern Durango and flows westward to the Pacific. A similar gap, leading south to Aguascalientes, occurs at the eastern end of the highlands of Zacatecas. But proceeding northward from the valley of the Rio Mezquital to Latitude 30° the main chain of the Sierra presents an unbroken barrier whose crest varies between 8000 and 9500 feet. It should be noted that there are few peaks in this region and none of them are high. Nevertheless the Sierra forms an effective barrier to any species whose vertical range is below the 8000 foot level. Both *albisetosus* and *cockerelli* appear to be held to the eastern side of the Sierra until its topography changes in northwestern Chihuahua. North of Latitude 30° the Sierra breaks up into a number of scattered ranges, few of which show elevations in excess of 7500 feet. Between these ranges are broad valleys which communicate on the east with the Mexican Plateau and on the west with the narrow Sonoran coastal plain. From east to west the elevation of these valleys gradually descends from 5000 to 1000 feet. There is no barrier here comparable to the main chain of the Sierra further south and both *albisetosus* and *cockerelli* occur widely in this region. The range of *cockerelli* is, however, more extensive than that of *albisetosus*. The latter species does not descend below 2500 feet in this region, while *cockerelli* occurs at elevations down to 700 feet. It follows that *cockerelli* occasionally nests on the inner edge of the coastal plain while *albisetosus* rarely gets within fifty miles of it. The range of *cockerelli* follows the inner border of the Sonoran coastal plain as far as Quitobaquito, where it turns north through the Growler Mountains in Arizona and thence to the Gila Bend Mountains. As far as the writer could determine the insect is not present in the Gran Desierto in northwestern Sonora, nor in the mountains immediately north of it in western Arizona. Records for both species from stations northwest of the Gila Bend Mountains are scarce. The range of *albisetosus* appears to terminate near Wickenberg, that of *cockerelli* procedes into southern Nevada.

The presence of *cockerelli* in southern Nevada leads to the vexing question as to whether or not this insect occurs in California. In the writer's opinion there is no proof at present that *cockerelli* occurs west of Nevada. To date all California records for *cockerelli* are demonstrably incorrect[2] or suspect. In 1934 Cole (3) published the statement that *cockerelli* is "rather common" near Barstow, Ludlow and Tehachapi. The first two stations are on the Mojave Desert, the last one is at the southern end of the San Joaquin Valley. Although the writer doubted the Tehachapi record from the start, there seemed little reason to question the Barstow and Ludlow records until the spring of 1951. In April of that year a series of exceptionally favorable climatic conditions resulted in a magnificent display of ephemeral flowers on the Mojave Desert. This extraordinary burst of bloom (said to have been the best in a period of twenty years) was accompanied by a corresponding burst of foraging activity on the part of the ants in that area. At this time the writer was

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[2] In his recent book on California ants T. W. Cook states (p. 115) that he took a colony of *N. cockerelli* on the Mills College campus at Oakland. The explanation for this record is quite simple; what Cook had was a colony of *Veromessor andrei.* There can be no doubt of this, for the three illustrations of the worker that Cook presented as that of *"Novomessor cockerelli"* are drawn from a small worker of *Veromessor andrei.* It is unpleasant to have to add that most of Cook's misguided efforts with the California ants are little better than his fumbling treatment of *cockerelli.*

collecting daily in the area between Barstow and Tehachapi. Yet not a single colony of *cockerelli* was encountered.

There seemed to be only two possibilities here. Either *cockerelli* had notably decreased in abundance in the western Mojave Desert since 1934 or Dr. Cole's records were incorrect. In the hope of clarifying this point I wrote to Dr. Cole for further information on his 1934 records. Dr. Cole replied that there were no specimens of *cockerelli* from California in his collection at present. It seems virtually certain, therefore, that the above records were based on field identification only. The writer believes that they were the result of the misidentification of abandoned nests of *Veromessor pergandei.* This ant is abundant in most parts of the Mojave Desert. It makes nests which might be mistaken for those of *cockerelli* and it often abandons them. Whether this explanation is correct or not, it should be clear that at present there is no reliable evidence to show that *cockerelli* occurs in California. If it does so, it seems certain that its occurrence in that state will be limited to the eastern end of the Mojave Desert. In the writer's opinion it is safe to conclude that none of the range of *cockerelli* lies west of Longitude 115° and only a very small part of it lies west of Longitude 114°.

The northern limit of the range of both *cockerelli* and *albisetosus* seems largely determined by the inability of either species to occupy highland areas in northern and central Arizona and New Mexico. Southeast of Wickenberg, Arizona, the range of both *cockerelli* and *albisetosus* runs along the southern end of the region where the rise to the Mogollon Mesa begins. This area is much broken up by valleys and canyons and it seems certain that the northern limit of the range is much more irregular in this area than our present records indicate. For most of these have come from the easily accessible southern end of the area. The Mogollon Mesa itself forms an effective northern barrier, for its elevation is too great to permit either *cockerelli* or *albisetosus* to reach the top of the plateau. In eastern Arizona and western New Mexico the limit of the range dips even further to the south, passing below the southern end of the Blue Mountains in Arizona and the Black Range in New Mexico. Further east in New Mexico the range swings north again in the Rio Grande Valley and the Tularosa Valley. The range in southeastern New Mexico is at present conjectural, for there are no published records for New Mexico east of Alamogordo. But the presence of *cockerelli* in Palo Duro Canyon in the Texas Panhandle makes it seem likely that the range runs northeastward through the Staked Plain region.

The eastern boundary of the range of *albisetosus* is very little known but it seems safe to say that it does not coincide at all with that of *cockerelli.* The easternmost record for *albisetosus* to date seems to be the colony which the writer took in 1933 at Cernas Ranch in the Chisos Mountains of Texas. This station lies about ten miles west of Longitude 103°. The Chisos Mountains are so close to the Sierra del Carmen and the Serranias del Burro in northern Coahuila, that *albisetosus* can scarcely be absent in the Mexican ranges. But that it extends far south in Coahuila seems very doubtful. We failed to take it in the Sierra Hermosa de Santa Rosa, a small range which lies just south of those previously mentioned. Neither was *albisetosus* secured in the mountains around Saltillo, although *cockerelli* was taken there. Since the collections around Saltillo were carried up to the 7200 foot level, the vertical range of *albisetosus* was more than covered. It is hard to see why the insect should be absent in the mountains of southern Coahuila, but this appears to be the case.

The eastern boundary of the range of *cockerelli* is much better known. There are at present seven records extending from Palo Duro Canyon, Texas (Lat. 35°), almost to Saltillo, Coahuila (Lat. 26°). Six of these records are within twenty-five miles of Longitude 101°, the seventh is only ten miles west of Longitude 102°. This comparatively smooth eastern boundary is certainly not determined by topography. Two of the stations are on the Edwards Plateau, three in the Rio Grande Valley and two in the mountains of southern Coahuila. Since *cockerelli* can occur in the Rio Grande Valley at elevations of 1000 feet (Del

Rio, Texas, and Nava, Coahuila) the writer fails to see why it has not been taken in northern Nuevo Leon. North of Monterrey are a number of mountains which rise from a base plain about 1400 feet high. The valleys between these mountains seem ideal for *cockerelli* and the writer feels sure that it will ultimately be taken there.

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OBITUARY NOTICE

Professor Charles T. Brues, for many years an active member of the Cambridge Entomological Club and Editor of PSYCHE for thirty-seven years, died at his home in Crescent City, Florida, on July 22, 1955. A future issue of PSYCHE will contain a biographical account of Professor Brues and a list of his publications.

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THE IDENTITY OF *MACROCEPHALUS BIDENS* OLIVIER, 1795, WITH A REVIEW OF THE GENUS *TOXONOTUS* LACORDAIRE (COLEOPTERA: ANTHRIBIDAE)[1]

By Barry D. Valentine

Mississippi Southern College, Hattiesburg

Recently, while checking the descriptions and figures of Anthribid weevils in Olivier's Entomologie, my attention was drawn to an unfamiliar name. A check of some other important anthribid literature revealed that in the one hundred and fifty-nine years since Olivier's description and figures were published, the name, *Macrocephalus bidens*, has vanished from the pertinent anthribid literature of the world with the single exception of Schönherr's Genera et Species Curculionidum, where in volumes one and five (1833, 1839) it is listed in *"incerti generis, species mihi invisae"*. It is not mentioned in Lacordaire (1866), Bovie's catalogue (1906), Wolfrum's paper on West Indian anthribids (1930), the anthribid portion and supplement of the Coleopterorum Catalogus (Wolfrum, 1929, 1953), or Blackwelder's catalogue (1947).

Actually, *Macrocephalus bidens* Olivier should not be dropped from the lists, for it is a recognizable species. It is restricted to this hemisphere by its type locality "Saint Domingue" which has gradually changed through Saint Dominique, Santo Domingo, and Dominican Republic, and at the time of Olivier's description, referred to all, or part, of the island of Hispaniola. Once a Caribbean locality is established, the description and figures characterize *bidens* as having a short, wide rostrum, three transversely arranged "tubercles" on the disc of the prothorax, more "tubercles" on the elytra, and very hairy legs. This combination of features immediately rules out all New World genera except *Neanthribus* Jordan and *Toxonotus* Lacordaire. The two genera in question both occur on His-

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

paniola; however, Olivier mentions nothing which might help to decide between them. The two are differentiated by the presence of a tarsal spine, long male antennae, and emarginate eyes in *Toxonotus,* while *Neanthribus* has no tarsal spine, short male antennae, and truncate eyes. Of these, the tarsal spine is not visible on the plates, but neither was it mentioned in the original description of the generitypic species of *Toxonotus, T. fascicularis.* As a matter of fact, it was not mentioned at all until 1866, thirty-three years after Schönherr's description of *fascicularis,* and seventy-one years after the description of *bidens.* The antennae, as figured, could be those of *Neanthribus* or a female *Toxonotus,* and the eyes are so poorly illustrated that it is difficult to be certain of their shape, although one gets the impression that they might be entire. Since there are no diagnostic generic criteria available, the only recourse is to attempt identification of the species *bidens* itself. The written description is again useless, but Olivier's plate shows a unicolored brownish insect, with the exception of the pale declivity of the elytra, paler head, and slender, hairy, red legs. I know of no *Neanthribus* species which fits this description; however, a few weeks ago, I gave a manuscript name to a species of *Toxonotus* from Hispaniola which, at the time, I thought was undescribed, and which matches this color scheme perfectly. I haven't the slightest doubt that this species is, in reality, Olivier's *bidens,* and it should therefore be known as **Toxonotus bidens** (Olivier), new combination.

In order to avoid any possibility of confusion, the following review of *Toxonotus* is presented.

Genus *Toxonotus* Lacordaire, 1866

Toxonotus Lacordaire, 1866, Gen. Coleop. vol. 7, p. 575. Generitype: *Anthribus fascicularis* Schönherr, 1833, by original designation and monotypy.

As far as known, this is the only genus in the world fauna which has a long, slender spine on the dorsal, apical margin of all first tarsal segments. This spine extends half-way over the second segment, and is sometimes partially obscured by long pubescence. To my knowledge, there is only one other anthribid which ever has a spine on the first tarsal segment. It occurs in some males of *Piesocorynus mixtus* Leconte; however, in this species the spine, when present, is on the ventral surface, and is usually subapical in position. The genus is further characterized as follows: rostrum and interocular area with a median carina which is interrupted by a deep, sharply limited pit located opposite the lower limit of the eyes; transverse carina of prothorax basal, fitting against the biconvex basal margin of the elytra; dorsal surface of the prothorax and elytra ornamented with tufts of erect pubescence and a lateral fringe; tibiae with long, erect, pale pubescence giving a bottle-brush effect; tarsi with the above-mentioned spine on the first segment, and the third segment not conspicuously dilated into a broad pad, the lobes free, not conate; antennae of males three-fourths to one and one-half times the total length of the body, of females up to one-half the length of the body; eyes with the margin adjacent to the antennal scrobes strongly emarginate.

The relationships between *Toxonotus* and the related genera *Neanthribus, Phoenicobiella,* and *Platystomos* are extremely complex. It is evident from a study of all four genera and many species that three distinct evolutionary lines are present, plus several connecting forms. The three lines are climaxed by *Platystomos* in the Old World, and *Neanthribus* and *Phoenicobiella* in the New, with such forms as the two *Toxonotus* species and *"Neanthribus" lividus* Lec. and *trituberculatus* Suffr. as the intermediate links. There are several other intermediate forms also, but it is not my intention to discuss them here; at least one is still undescribed, and the subject will be covered in detail in a generic revision of the North American fauna soon to be ready for publication. I have mentioned this complex now only so that other coleopterists familiar with the group might see the problem too, and perhaps lend pertinent material, for I particularly need Antillean specimens and exotic *Neanthribus* and *Platystomos* species. As a matter of fact, even locality records and biological data for United States species would help considerably in deciphering the complex zoogeography and relationships.

The species described as *Toxonotus trituberculatus* Suffrian, 1870, has been transferred to *Neanthribus* by Wolfrum (1930). Judging by Suffrian's description, the species properly belongs in *Phoenicobiella* or in a new genus. It is obviously one of the key species in the intergrading generic complex mentioned above. The two remaining species of *Toxonotus* can be distinguished by the following key and short diagnoses.

1. Apex of prothorax with two patches of extremely dense, pale, brown pubescence, one on either side of the median line; elytral pubescence striped, even-numbered interspaces bluish gray, odd-numbered ones brown or brown flecked with white ....*Toxonotus fascicularis* (Schön.)
2. Apex of prothorax without patches of denser pubescence, instead with two short, curving, white lines; elytral pubescence not striped, brown to brownish gray .... *Toxonotus bidens* (Olivier)

Toxonotus fascicularis (Schönherr)

Anthribus fascicularis Schönherr, 1833, Genera et Species Curculionidum 1(1) :132. Type locality: Cuba.

Integument dark brown to black except for antennae, apices of femora, tibiae, and tarsi which are paler. Pubescence very short; on prothorax variegate with gray and brown, two large patches of dense pale brown extending from lateral discal tufts to apex; on elytra sparse, striped with gray and brown as mentioned in key, sometimes with first three interspaces heavily dusted with white, declivity with a sharply contrasting, dense white patch which attains the apical margin only along the suture, this sutural connection sometimes partially or completely interrupted; on metasternum gray to white. Antennae with segments 11, 10, and the distal portion of 9 dark brown to black, contrasting sharply with the remainder which is gray.

This species ranges throughout southern Florida and Cuba. The northernmost locality known to me is Enterprise, Volusia County, Florida. Two hundred and eight specimens examined; of these, two from Baragua, Cuba, were colleced at light by L. C. Scaramuzza in May. No other biological data available.

Toxonotus bidens (Olivier) new combination

Macrocephalus bidens Olivier, 1795, Entomologie, vol. 4, genus no. 80, p. 14, Pl. 2, fig. 18a, b. Type locality: Saint Domingue.

Identical with *T. fascicularis* (Schön.) with the exception of the color and vestiture. Integument varying from dark red to a startlingly clear, pale red, the latter especially on the appendages. Pubescence long and coarse, appearing shaggy and unkempt beside the trim-looking *T. fascicularis;* on prothorax unicolored brown, with no dense apical patches; instead with two arcuate lines of coarse white bristles which originate just laterad of each of the two small apical tufts, and run posteriad for a short distance before curving laterally and ending midway between the lateral discal tufts and the pronotal apex; on elytra pale brown to almost gray, not conspicuously striped, apical declivity with coarse, dirty white bristles, slightly denser than elsewhere, but not short as in *fascicularis*, and not sharply demarcated; on metasternum dirty yellow. Antennae unicolored gray, the last three segments not contrasting sharply with the remainder.

Three specimens known to me; a pair in the Museum of Comparative Zoology, the male labeled, "Ennery, Haiti, nr. 1000 ft., Sept. 6-11, 1934, (Darlington)", the female simply, "S. Dom.", and the third, of undetermined sex, in the American Museum of Natural History labeled, "San Lcrenzo [sic], R. Dom. vi-27-29-15". The M.C.Z. female is considerably paler than the other two specimens. Its clear red, hairy legs leave an indelible impression.

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THE ANT CENTROMYRMEX DONISTHORPEI MENOZZI, A SYNONYM. — Menozzi described *Centromyrmex donisthorpei* in 1925 (Philippine Jour. Sci., 28:443, pl. 1, figs. 4a, 4b, female) from two specimens. One of these, here designated as lectotype, is from Iligan, Mindanao, and is now on deposit in the Museum of Comparative Zoology. While slightly darker than the average specimen of *Centromyrmex feae* (Emery) (1889, Ann. Mus. Civ. Stor. Nat. Genova, 27: 491, pl. 10, figs. 11-15, worker), originally cited from Burma, I can detect no taxonomically important differences between it and female specimens (alate and dealate) taken with workers of the common *C. feae* at several widely separated southeast Asian localities. A **new synonymy** is indicated. — W. L. BROWN, JR., Museum of Comparative Zoology.

A GYNANDROMORPH OF *MELANOPLUS MEXICANUS MEXICANUS* (SAUSSURE) EXTREME MIGRATORY PHASE (ORTHOPTERA: ACRIDIDAE)[1]

By H. C. Severin

South Dakota State College, Brookings, South Dakota

The gynandromorph described in this paper was loaned the author by Dr. Roscoe E. Hill, Chairman of the Department of Entomology, University of Nebraska. The specimen was taken from the collections of the University of Nebraska State Museum and was returned to the Museum of that University. The specimen was collected at or near Pine Ridge, Nebraska, in July. No further definite data regarding the origin of the specimen was available such as year when the specimen was collected or the name of the collector. For purposes of comparison the author of this paper borrowed from the Nebraska State Museum through Dr. Hill a normal male and a normal female specimen of *Melanoplus mexicanus mexicanus* (Saussure) *Extreme Migratory Phase.* These specimens were collected at or near West Point, Nebraska. Neither of these specimens had a date label attached to them but one of the specimens had a label attached to it with the following data printed in ink, by hand: *Melanoplus spretus* Thos. (Det. L. Bruner).

Since the gynandromorph and the borrowed male and female grasshoppers were apparently old, it is reasonable to believe that Professor L. Bruner might have been the collector not only of the normal grasshopper but of the

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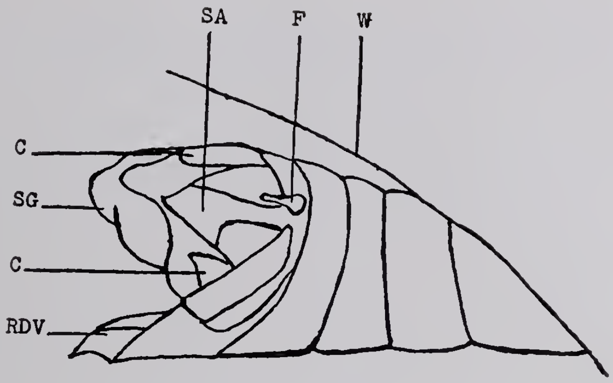
[1] Approved for publication by the Director of the South Dakota Agricultural Experiment Station as Journal Series No. 322.

Explanation of Plate 10

1. Dorsal view of posterior part of abdomen; 2. lateral aspect of right side of posterior part of abdomen; 3. ventral view of posterior part of abdomen. C. cercus; EG, egg guide; F, furculum; RDV, right dorsal valve of ovipositor; RVV, right ventral valve of ovipositor; SA, supra-anal plate; SG, subgenital plate; W, margin of tegmen.



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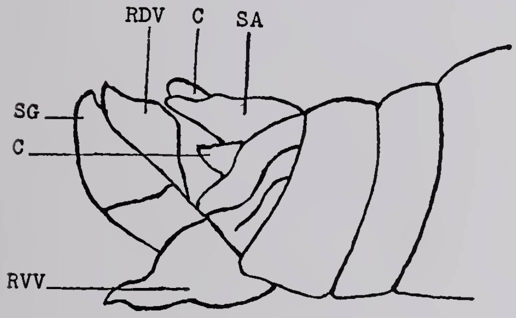

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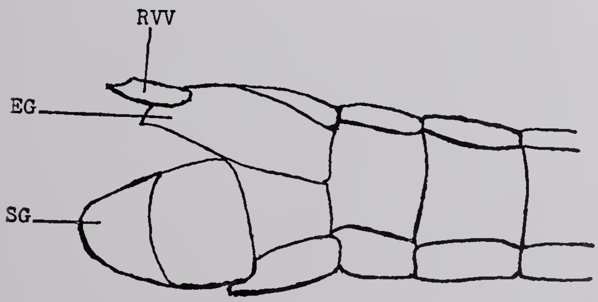

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Severin — Melanoplus mexicanus mexicanus gynandromorph as well. The author wishes to thank Dr. Hill for the privilege of studying the grasshoppers loaned him.

Melanoplus mexicanus phase *spretus* (Walsh) is regarded by most entomologists as a phase of *Melanoplus mexicanus mexicanus* (Saussure) and is looked upon by most Orthopterists as the Rocky Mountain Locust which was so prevalent and destructive in the United States from 1862 to 1876.

The author of this paper described a gynandromorph of *Melanoplus mexicanus mexicanus* (Sauss.)[2] but this description of the morphology is quite different from the description of the gynandromorph of *M. m. mexicanus* (Sauss.) *Extreme Migratory Phase* presently to be described.

Description of the Gynandromorph of *M. m. mexicanus* (Sauss.) Extreme Migratory Phase.

This gynandromorph is typically female in structure including the body morphology and the appendages except for the posterior end of the abdomen which is typically male in the left half and mostly typically female in the right half.

The lateral carinae of the fastigium of the head, are not prominent and the fastigeal depression is shallow. These characters are typical of normal female specimens. The interocular space is wide as in normal female specimens.

The tubercle on the mesosternum, which is very well developed in normal male specimens and only faintly indicated or entirely absent in normal females, is lacking in the gynandromorph. The femora and tibiae of the first two pairs of legs of the gynandromorph are less heavily constructed than in the normal males and in this respect resemble the femora and tibiae of typical females. The arolia of the tarsi of the gynandromorph are small and resemble those of a normal female.

The left half of the posterior end of the abdomen is typically male in structure with very little distortion. The

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[2] Severin, H. C. 1943. A Study of a Gynandromorph of *Melanoplus mexicanus mexicanus* (Sauss.) (Orthoptera) 1943. Journal of New York Entomological Society Vol. LI., pp 179-183.

right half, however, is female with some distortion. A normal appearing upper and lower valve of an ovipositor are present on the right side. The right cercus is female in shape, while the left resembles the cercus of a male. The furculum on the left side is absent while on the right it is present and resembles in size and shape the furculum of the typical male. The supra-anal plate is bilaterally symmetrical and resembles rather closely the supra-anal plate of a male except for a transverse ridge extending across the right half of it. A subgenital plate is present but only the left half is developed. Consequently the terminal notch present in normal males is lacking in this gynandromorph. On the right side a terminal abdominal sternite resembling one-half of the end sternite of a female abdomen is present. Even one-half of the so-called egg-guide terminates this sternite (see figures 1, 2, 3).

REVISIONARY NOTES ON THE SANGUINEA AND NEOGAGATES GROUPS OF THE ANT GENUS FORMICA[1]

By E. O. Wilson and W. L. Brown, Jr.

Harvard University

In recent years, specialists engaged in ecological and regional studies of North American ants have repeatedly called upon us to check species identification against types and other "historic" material in the Museum of Comparative Zoology (MCZ). The specialist working away from such a collection is likely to assume that the difficulty can readily be cleared up by mere comparison of his fresh material against the Museum series; unfortunately, such comparison by itself rarely produces satisfactory results. Of the groups arriving at the MCZ, one causing repeated difficulty is the so-called subgenus *Raptiformica* of *Formica.* In many ways, it exemplifies the current taxonomic conditions within many of our commonest groups of ants.

The principal fault of the accepted *Raptiformica* arrangement lies in an excessive unrecognized synonymy, which in turn stems from past failure to appreciate the extent of allometric and other normal expressions of intraspecific variation. Species such as *pergandei* and *rubicunda* have been founded in large part on supposed differences in head shape, but closer examination shows these and other cases to be nothing more than size variants along the same general allometric gradient. Trivial variations in pilosity, sculpturing, and color have also been much overworked in separating "species"; examination of enough material soon reveals most such variation as continuously intergradient and broadly bridging the old gaps.

Another situation bound to give continuing trouble in the future concerns the elusiveness of presumed sibling species such as *F. parcipappa, F. curiosa* and *F. wheeleri* —

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[1] Published with a grant from the Museum of Comparative Zoology at Harvard College.

we have been unable to find reliable and convincing characters marking the worker caste of these three forms. We are keenly aware that lack of material may have caused us to overlook other full but more or less cryptic species.

The original and present goals of this study are the elimination through synonymy of those names which cannot be supported by all available evidence, correction of certain inconsistencies in previous revisions (see literature cited at end of paper), and construction of a new key based on the present revision. After the majority of the work had been completed, however, another important consideration arose.

It had become apparent early in the task that *Raptiformica* included two species-groups, termed by us respectively "*sanguinea* complex" and "*obtusopilosa* complex."

The *sanguinea* complex is distinguished by the following assemblage of characters:

(1) The workers of all of the species usually have the gasters black and the remainder of the body red, except *F. parcipappa*, which is concolorous reddish yellow.

(2) The workers average large in size for *Formica*, are robust, and have a well-defined metathorax.

(3) The propodeum is short, with a well-defined angle, and the petiolar scale is high and thin.

(4) The gastric pubescence is dense and the body pilosity generally sparse. Hairs are never present on the dorsal face of the propodeum anterior to the propodeal angle.

(5) The sculpture is generally opaque, or at most rather weakly shining.

(6) The male has relatively broad parameres and a subgenital plate of a particular conformation (figs. 3, 5).

(7) All of the species take slaves, at least facultatively, except *F. parcipappa,* which is known only from limited cabinet material.

(8) The complex as a whole prefers mesic habitats.

The *obtusopilosa* complex, perhaps wrongly named at the outset because *obtusopilosa* is the least typical and most poorly known of the species, offers the following characters:

(1) The worker coloration shows much interspecific variation, ranging from concolorous yellowish red to concolorous black or red and black.

(2) The workers average smaller in size than in the *sanguinea* complex, are more slender in body form, and have a poorly defined metanotum.

(3) The propodeum is proportionately longer and more rounded, with little or no angle between dorsum and declivity.

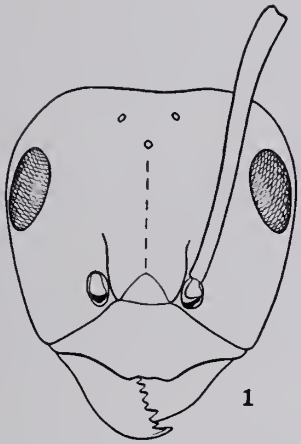
(4) The gastric pubescence is very sparse (except in *obtusopilosa*) and the body pilosity generally abundant. Hairs are usually present, and often abundant, on the dorsal face of the propodeum anterior to the propodeal angle.

(5) The sculpture is usually feeble and the integument therefore more shining.

(6) The male has relatively slender parameres and a subgenital plate of a distinctive conformation (figs. 4, 6).

Explanation of Plate 11

Fig. 1. Head of *F. subintegra* worker from University of Michigan Biological Station, Douglas Lake, Cheboygan Co., Mich. (P. B. Kannowski). Head width 1.71 mm. Fig. 2. Head of putative *F. curiosa* worker from Culbertson, Roosevelt Co., Mont. (E. O. Wilson). Head width the same as in *subintegra*; specimen of fig. 1. Fig. 3. Left paramere of *F. subnuda* male from Woodland Park, Teller Co., Colo. (W. M. Wheeler). Fig. 4. Left paramere of *F. perpilosa* male from Ft. Davis, Texas (W. M. Wheeler). Fig. 5. Posterior border of subgenital plate of same specimen as in fig. 3 (*F. subnuda*). Fig. 6. Posterior border of subgenital plate of same specimen as in fig. 4 (*F. perpilosa*). Fig. 7. Left side view of petiole of *F. subintegra* worker from Rogers City, Presque Isle Co., Mich. (P. B. Kannowski). Head width 1.63 mm. Fig. 8. Left side view of petiole of *F. subnuda* worker from Kiowa, Glacier Co., Mont. (E. O. Wilson). Head width 1.76 mm.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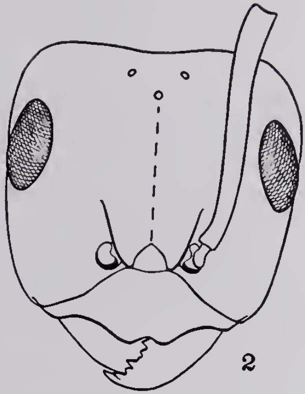
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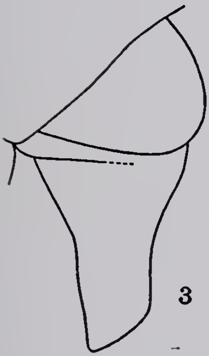
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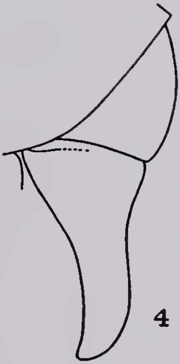
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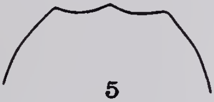
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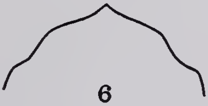
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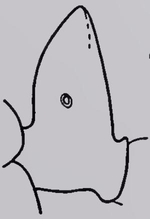
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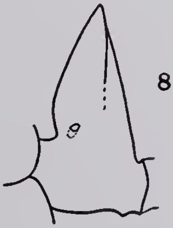
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Wilson and Brown — Formica

(7) So far as is known, none of the species ever take slaves.

(8) The complex as a whole is limited mostly to xeric habitats in western North America.

The only species placed in the *obtusopilosa* complex with reservations is *obtusopilosa* itself. In body form, pilosity, ethology, and habitat preference, it resembles the rest of the complex. But it also possesses coloration and gastric pubescence characteristic of the *sanguinea* complex. The male genitalia could add weighty and possibly decisive evidence, but unfortunately no *obtusopilosa* males seem to be available in any collection at the present time.

Both complexes share the clypeal notch character diagnostic of *Raptiformica,* although in general this seems better developed in the *sanguinea* complex. Despite the presence of the notch, we felt that the two groups were very discrete from one another, casting doubt on the validity of *Raptiformica* as a natural grouping. At a late moment, we were led by a chance remark by Dr. Creighton (*in litt.*) to reconsider certain views expressed to us in an all-but-forgotten letter received in 1953 from Dr. W. F. Buren. Buren's opinion then was that synonymy should bracket no less a pair of forms than *Formica* (*Raptiformica*) *bradleyi* Wheeler and *Formica* (*Proformica*) *neogagates* var. *morbida* Wheeler. Further, Buren implied that the taxonomic standing of *Raptiformica* and the Nearctic representatives of *Proformica* is due for reconsideration in the light of this synonymy[2].

Checking the type material involved in this important finding, we can only agree with Buren's suggested synonymy, which certainly will have a far-reaching effect in the simplification of the taxonomy of the genus *Formica.* We are not prepared to enter extensively into the taxonomy of the "*Proformica* complex" at this time, but a few of our observations bearing on group interrelationships are offered as follows:

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[2] See Acknowledgements at the end of this paper.

(1) In habitus of all castes of both sexes, and in details of worker-queen sculpture, pilosity, and form of propodeum and petiole, members of the *obtusopilosa* complex and the Nearctic species of *"Proformica"* (*neogagates* group) are obviously similar.

(2) The diagnostic *Proformica* character involving proportions of the first three funicular segments, never a very happy distinction, appears to grade through in the *sanguinea-obtusopilosa* series.

(3) The clypeal notch, supposedly characteristic of *Raptiformica*, is as well (or better) developed in many *F. neogagates* specimens as it is in those of some species customarily placed in *Raptiformica* (e. g. *bradleyi*, or even *subnuda*). The notch in *neogagates* and *bradleyi* is more properly described as a "vaulting" of the median clypeal margin as seen from an adoral view, but the effect is the same from full-face view, and the difference from the condition of *subnuda* is trifling, not to say academic. In *neogagates*, which appears to be a species distinct from *bradleyi* (= *morbida*) on the basis of color and pilosity characters, variation in clypeal vaulting is considerable. Most western samples show stronger vaulting, frequently equalling *bradleyi*, while some eastern samples have a flattened border like that of *lasioides*.

(4) The parameres and subgenital plate of the male in *neogagates*, *bradleyi*, and *perpilosa* are very similar (see figs. 4, 6).

(5) Many of the Palaearctic species of *Proformica*, including the subgeneritype *F. nasuta* Nylander, differ markedly from the Nearctic species (typified by *neogagates*) in characters involving degree of worker polymorphism, and in worker-queen mandibular dentition. In addition, the male genitalia are very distinctive in the one species, *nasuta*, in which males have been examined. These species seem to form a monophyletic group easily separated from the Nearctic *neogagates* group as well as from all Nearctic *Formica*.

Conclusions drawn from these facts are: (1) the *obtu-*

sopilosa complex is closest to, in fact coextensive with, the *neogagates* group (= Nearctic "*Proformica*") and probably has no direct connection with the *sanguinea* group; (2) the *neogagates* group, including the *obtusopilosa* complex, should be transferred to *Formica s. str.*; (3) unless species annectant to *Formica* or *Cataglyphis* can be demonstrated, the true *Proformica* of the Old World, with *nasuta* as its type, probably rates full generic rank; (4) the subgeneric name *Raptiformica,* having lost its morphological associations, should be put into synonymy until evidence is forthcoming for the need to recognize more than "species groups" in *Formica.*

The changes discussed in this work as they affect the old "Raptiformica" complex are outlined in the following synopsis. In this paper, only new synonymy will be cited formally; for additional synonymy and other references, see Creighton, 1950, pp. 460-472. The treatment of the *sanguinea* group here together with the *obtusopilosa* complex no longer implies natural connection between these two assemblages of species.

sanguinea group

curiosa Creighton
parcipappa Cole
sanguinea Latreille (with "varieties")
subintegra Emery
    = *pergandei* Emery (n. syn.)
    = *puberula* Emery (n. syn.)
    = *rubicunda* Emery (n. syn.)
    = *sublucida* Wheeler (n. syn.)
subnuda Emery (n. status)
    = *emeryi* Wheeler (n. syn.)
wheeleri Creighton

obtusopilosa complex of *neogagates* group

bradleyi Wheeler
    = *neogagates* var. *morbida* Wheeler (n. syn., W. F. Buren *in litt.*)
manni Wheeler
    = *oregonensis* Cole (n. syn.)

obtusopilosa Emery
    = *obtusopilosa alticola* Wheeler (n. syn.)
perpilosa Wheeler

SPECIES IN THE SANGUINEA GROUP PROPER

In our study of *sanguinea* and relatives, we have been engaged chiefly with the Nearctic forms. It will be noticed that where Creighton recognized ten Nearctic species in the true *sanguinea* group, we retain only half that number, and of these five names, we can recognize only two as representing solidly verified and distinct species: *subintegra* and *subnuda*. The three forms *curiosa*, *parcipappa* and *wheeleri* were all described from very limited material, and all are close to, if not synonymous with, the extremely variable *subintegra*. All three are western in distribution, and significantly it is in the west that *subintegra* reaches its peak variability, in an area where a wide range of differing habitats is available to influence variation. It is also possible that these slave-makers respond in some way to the characteristics of the available slave species of *Formica*, which in general are more diverse in the western part of North America.

As work on the *sanguinea* group progressed, we solicited the aid of several of our North American colleagues with respect to problems met. While comments and material received in the ensuing exchange were often very helpful, we have been surprised at the vigor of the opposition aroused by some of our synonymic proposals. Unfortunately, the evidence for such opposed viewpoints did not match the conviction with which they were sometimes expressed. Despite requests on our part for further particulars, we have received no evidence to indicate that anything is amiss with our synonymy. We are assuming that all important relevant data have now been forwarded for our consideration in the preparation of this paper.

The couplet offered below will serve to separate workers of *subnuda* from those of *subintegra*.

A. Gula completely bare of standing hairs in all of the workers of a nest series; dorsal petiolar margin completely lacking hairs, or at most with one or two inconspicuous hairs less than 0.03 mm in length; hairs almost never present on propodeum; petiolar scale in side view nearly always thin and with a sharp crest (see fig. 7). (Boreal-alpine North America) .... *subnuda* Emery

B. At least one or two long, coarse, standing hairs normally present on the gula of a majority of the workers of a nest series; in those individuals with pronotal width of 1.0 mm or greater, and frequently in all of the nest members, the dorsal petiolar margin bears at least two or three hairs 0.05 mm or more in length; hairs frequently present on the propodeum at the junction of the dorsal and declivitous faces; petiolar scale in view usually relatively thicker and with a blunt crest (see fig. 8). (Widespread in temperate N. America) .... *subintegra* Emery

For comments dealing with the separation of *curiosa, parcipappa,* and *wheeleri* from *subintegra,* see the discussions under the individual species headings below.

Formica sanguinea Latreille

Formica sanguinea Latreille, 1798, Essai Fourmis France, pp. 37-38; worker (widely distributed in temperate Eurasia).

We have had the opportunity to examine large numbers of series of this species from over most of its range. We have found it to differ with reasonable consistency from the cognate Nearctic species *subnuda* in the following worker characters:

(1) The clypeal notch is much deeper in *sanguinea.* The section of the clypeal margin enclosing the notch appears moderately concave when the head is viewed in perfect full face (at maximum length); in *subnuda* it usually appears flat or feebly convex.

(2) The body hairs are longer and more abundant in *sanguinea.* At least four or five standing hairs project

beyond the dorsal margin of the pronotum seen from the side; in *subnuda* at most three or four are visible in this view, and usually less.

(3) The head of *sanguinea* is always infuscated, and on the average more deeply than in *subnuda,* although there is some amount of overlap in the total variation of the two species.

Despite the completely allopatric distribution of *sanguinea* and its obvious cognate relationship to *subnuda,* we are treating the two forms as distinct species. The reason is that they differ by at least two discontinuous characters, while the total morphological difference is apparently greater than that separating some of the sympatric Nearctic species. Thus, in the absence of direct evidence concerning their status, reliance is placed on an arbitrary, morphological "species-standard" method in order to insure uniformity of treatment throughout the species group.

The intermediate position of *sanguinea* between *subnuda* and *subintegra* with respect to the pilosity and clypeal notch characters described above may represent another case of the phenomenon of "character displacement" as recently described in the genus *Lasius* by Wilson (1955). Our interpretation would be that *subnuda* remains well segregated morphologically from *subintegra* because it is partly sympatric with it, and as a result the two species tend to occupy ecologically different "niches." As a distinct species and the Palaearctic equivalent of *subnuda, sanguinea* has no such competitor, and therefore presumably converges morphologically toward *subintegra* in filling the adaptive vacuum which a companion species might otherwise occupy.

We have made no attempt to treat the Palaearctic "varieties" of *sanguinea* in the present study. Most of these are based on color differences and do not seem on cursory examination to be strong candidates for species rank. We have included in our diagnosis of *sanguinea* varietal material from the following several localities: Guadarrama, Spain (C. Schramm leg.; var. *flavorubra*

Forel, det. W. M. Wheeler); Lake Sevan, Armenian S. S. R. (F. Arnoldi leg.; var. *clarior* Ruzsky, det. Arnoldi and B. Finzi); neighborhood of Kiev (W. Karawajew leg.; "var. *clara*" Karawajew, ms?); "Ussurigebiet", Soviet Maritime Territory (var. *orientalis* Ruzsky, det. Karawajew); Kedzovajapadj, near Vladivostok (N. Kusnezov leg.; var. *clarior* Ruzsky, det. Kusnezov).

Formica subnuda Emery (figs. 3, 5, 8)

Formica sanguinea rubicunda var. *subnuda* Emery, 1895, Zool. Jahrb. Syst., 8: 335; worker. Type locality: Yale, British Columbia.

Formica sanguinea subnuda, Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 409. Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104: 469.

Formica emeryi Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 419; worker, queen. Type locality: Broadmoor, Colorado Springs, Colo. NEW SYNONYMY.

This is the most boreal and widespread of the North American members of the *sanguinea* group. Its affinity to the Palaearctic *sanguinea* is evidenced by the form of the petiolar scale, pilosity, body coloration, and degree of intranidal size variation, as well as its similar ethological characteristics. The characters which separate the two species have already been presented in the section on *sanguinea,* above. *F. subnuda,* like *F. sanguinea,* is only facultatively a slave-maker. Even when taken, the slaves frequently form only a small percentage of the nest population, (Wheeler, "Ants," p. 454; Creighton, 1950, p. 469).

A single worker and three queens from the *emeryi* type series that we have examined conform to *subnuda* in critical pilosity characters. Other differences advanced by past authors as diagnostic for *emeryi* have proven to be worthless. To avoid future confusion these are discussed in some detail below.

(1) *Emeryi* has been distinguished from *subnuda* (by Creighton) on the contention that in the largest workers the eyes extend to the margin of the head seen in full

face. As previously noted, this is a character subject to strong allometric variation. The *subnuda* types we have examined in the same size class as the *emeryi* syntypes (head widths 1.41 — 1.64 mm) exhibit the same head shape and eye placement, and this also holds for other *subnuda* series.

(2) Wheeler and Creighton both have distinguished *emeryi* from *subintegra* (= *pergandei*) by the presence in *emeryi* of a shallow transverse groove on the dorsal propodeal face of the worker. In this case the wrong pair of species was being compared, but the character must also be considered with reference to *subnuda.* Of the four *subnuda* syntypes we have examined, three possess the character and one lacks it. Other *subnuda* and *subintegra* series show the same strong intrandidal variation, and we are of the opinion that the propodeal impression is either an ecophenotypic character or else an artifact produced by warping when the specimens were first dried out. In any case, it is not diagnostic.

(3) The genal borders of the *emeryi* syntype are nearly straight, and where they meet the curved occipital border near the lower margin of the eye a weak concavity is produced. This is not so common a feature of *subnuda,* but is nevertheless within the normal range of variation for the species. One specimen of a series from Magnolia, Mass., shows the "*emeryi*" contour on one side and the typical *subnuda* contour on the other.

(4) The *emeryi* worker and queen syntypes actually differ the most from average *subnuda* in a character not mentioned by previous authors. The petiolar scale in side view is unusually thick for *subnuda,* approaching the usual *subintegra* condition, but even this is still within the range of continuous variation of *subnuda* as we conceive of that species.

F. subnuda definitely has a more boreal distribution than does *F. subintegra,* though the ranges of the two species come into close contact and even overlap in regions such as eastern Massachusetts, part of Michigan, and in widespread areas in the Rocky Mountains. The northern distribution brings *subnuda* into broad contact with *Formica neorufibarbis,* which frequently is pressed into slavery.

Formica subintegra Emery (figs. 1, 7)

Formica sanguinea var. *subintegra* Emery, 1893, Zool. Jahrb. Syst., 7: 648; worker. Type locality: District of Columbia.

Formica subintegra Creighton, 1950, *op. cit.,* p. 470.

Formica pergandei Emery, 1893, *op. cit.,* pp. 646-647; worker. Type locality: District of Columbia. NEW SYNONYMY.

Formica sanguinea rubicunda Emery, 1893, *op. cit.,* pp. 647-648; worker, queen. Type locality: Pennsylvania. NEW SYNONYMY.

Formica rubicunda, Creighton, 1950, *op. cit.,* p. 468.

Formica sanguinea puberula Emery, 1893, *op. cit.,* p. 648; worker. Type locality: Hill City, South Dakota. NEW SYNONYMY.

Formica puberula, Creighton, 1950, *op. cit.,* p. 468.

Formica sanguinea rubicunda var. *sublucida* Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 408; worker. Type locality: Stony Brook Reservation, near Boston, Mass. NEW SYNONYMY.

Formica sublucida, Creighton, 1950, *op. cit.,* p. 471.

Formica sanguinea subintegra var. *gilvescens* Wheeler, 1913, *op. cit.,* pp. 412-413; worker. Type locality: Tuckahoe, New York.

The involved synonymy under *subintegra* has been the principal source of difficulty in the taxonomy of the *sanguinea* group. Myrmecologists in recent years have wasted untold amounts of time trying to distinguish species, the types of which represent nothing more than trivial infraspecific variants. The characters on which these species were based have been greatly exaggerated by both the original describers and subsequent reviewers.

Rubicunda is probably the most often used of the names considered herein as junior synonyms. Several characters have been advanced at different times and by different authors in an attempt to separate this form. The merits of each are discussed below.

(1) *Rubicunda* is said to have a darker body color; the gaster is piceous and the rest of the body "blood red", while in *subintegra* (the type series included) the gaster is medium brown and the remainder of the body yellowish red. Even in his original description, Emery made note of a series intermediate in color to *subintegra*. Fresh series in the Museum of Comparative Zoology grade through in this character; also, it has been our impression in the field that color is not reliable.

(2) The head has been considered more trapezoidal in *rubicunda*. We find that head shape shows great variation both intranidally, through allometry, and internidally, through different grades of allometry. We have been unable to separate two forms in any given size class on the basis of this character.

(3) *Rubicunda* has been considered to be distinguished by an emarginate dorsal petiolar border, opposed to an non-emarginate condition in *subintegra*. A glance at a small number of series is sufficient to show that this character grades through completely.

A syntype of *pergandei* in the Museum of Comparative Zoology appears in every aspect to be only a small but otherwise normal worker of *subintegra*. In full face view, a small space is left between the eye and the margin of the head, contrary to the key character presented by Creighton. But even if the eye extended to or beyond the margin, this would still not exceed the range of variation of *subintegra*, which is highly variable in head shape (see under *curiosa*).

Puberula, according to the diagnoses of both Wheeler and Creighton, is marked by the presence of raised pubescence on the scape, especially (according to Creighton) on the inner surface near the tip. The most extreme series we have examined, from Pullman, Wash. (W. M. Mann), has no more than four or five hairs raised at all strikingly from the surface along any single edge of the scape, and none of these makes an angle of more than 45°. Other western series show every gradation from this extreme to the typical, completely "smooth" *subintegra* condition. An intermediate pilosity has been encountered also in a series from Rogers City, Presque Isle Co., Mich. (P. B. Kannowski), but otherwise the *puberula* variant is mostly limited to the western United States.

Sublucida was erected by Wheeler for a single series, which he considered to have a distinctively smooth and shining body surface. Examination has shown that this series is really well within the normal range of variation of *subintegra*, and in fact is not far from average for that species. Wheeler's inability to recognize his own variety was revealed when he later inadvertently added a large part of the unlabelled *sublucida* type series to the *subintegra* section of his collection.

Perhaps the most extensive variation shown by *subintegra* is in quantity and length of body pilosity. At one extreme, exemplified by the type series, numerous hairs are present on the pronotum and mesonotum, at the junction of the basal and declivitous faces of the propodeum, and along the dorsal crest of the petiole. The pronotal hairs are especially abundant, fairly long and sinuous, and form a characteristic pattern, the anterior ones bending posteriorly and the posterior ones bending anteriorly, so that those at the very center often seem in side view to touch or cross at the tips. At the other extreme, recognized by Wheeler in his variety *gilvescens*, only a few scattered stubby hairs are present on the pronotum, and the mesonotum, propodeum, and petiolar crest are completely bare. The "typical" *subintegra* tends to have longer hairs throughout, e. g. the longest on the first gastric tergite (exclusive of the extreme posterior strip) may be 0.20 mm or more, while in the "*gilvescens*" extreme of equivalent size the longest may not exceed 0.06 mm.

Mr. P. B. Kannowski has recently expressed the opinion to us (*in litt.*) that what we call "the *gilvescens* form" perhaps represents a distinct species distinguished by the following characters supplemental to pilosity: occiput more rounded, petiole blunter and usually with an emarginate dorsal border, gaster usually lighter in color. We have examined in detail 54 nest series from all over the eastern United States (excluding available western samples, which may be complicated by the presence of possible sibling species such as *curiosa* and *wheeleri*). We have noted a weak tendency, with many exceptions, toward correlation in Kannowski's characters, but we have not been able to detect significant bimodality in any character or character combination.

F. subintegra appears to be an obligatory slave-maker, and the proportion of slaves to *subintegra* workers is normally higher than the corresponding ratio in *subnuda* nests. *Subintegra* occurs largely within the United States, usually at lower latitudes and altitudes than *subnuda*. It takes a great variety of slaves, including members of the *fusca, pallidefulva* and *neogagates* groups, and it can occupy a wide range of habitats from mesic even to somewhat xeric.

Formica curiosa Creighton (fig. 2)

Formica curiosa Creighton, 1935, Amer. Mus. Novitates, no. 773, pp. 5-8; worker, queen. Type locality: Lake McGregor, near Kalispell, Montana.

This species is presumed distinguishable by the queen, which is concolorous yellowish red. A careful examination of part of the type series has failed to reveal any characters which will surely separate the worker caste of *curiosa* from the worker caste of *subintegra* as we broadly conceive of it here. We have noted several character trends, however, which may prove significant as more collections are made in the future.

(1) The placement of the eye as described by Creighton may have some merit as a character, and we have attempted to refine it as follows: in the six *curiosa* syntypes

we have examined (head width 1.08-1.32 mm) the eyes extend prominently beyond the margins of the head seen in full face. In the majority of *subintegra* cabinet series, few or none of the workers range below 1.32 mm in head width. In those that do, the shape of the head and placement of the eyes are highly variable. Some approach the *curiosa* condition; e. g. Broadmoor, Colo. (W. M. Wheeler); Alamogordo, N. Mex. (G. v. Krockow); Bronxville, N. Y. (Wheeler). In others, the eyes do not approach the lateral margins; e. g. Pullman, Wash. (W. M. Mann); Breckenridge, Colo. (P. J. Schmitt); Tesuque Canyon, Hyde Park, N. Mex. (A. C. Cole); Manzanares, N. Mex. (M. Cooper). At least one series is intermediate: Manitou, Colo. (Wheeler); associated queens here are typical *subintegra* and do not approach the *curiosa* color character. In general, variation is primarily internidal, with allometric trends within single nest series remaining constant. The "*curiosa*" head shape may be more common in western series of *subintegra* — at least the tendency for the production of smaller workers of the *curiosa* size class seems to be stronger.

(2) Worker series from Culbertson, Mont. (E. O. Wilson) and Twin Falls, Ida. (Cole), unaccompanied by queens and therefore not definitely determinable, are so similar in pilosity and minor-worker head shape to the *curiosa* types that they have been tentatively associated with this species. If correctly determined, then they may provide the additional diagnostic character: larger workers (head width 1.45-1.65 mm) are present and differ from *subintegra* workers of equivalent size by having heads proportionately more massive and with a slightly more quadrate frontal outline (figs. 1,2).

(3) The body pilosity of the *curiosa* types and Culbertson and Twin Falls series is very long and abundant, with numerous hairs on the mesonotum, but still within the extreme range of variation of verified *subintegra*.

(4) The first gastric tergite, exclusive of the extreme posterior strip, is yellowish brown in color and contrasts with the remainder of the gaster in the larger *curiosa*

types and Culbertson workers, but resembles the *subintegra* condition in the Twin Falls series.

(5) All three series have relatively short antennal scapes consistent with the western *subintegra* population.

Formica parcipappa Cole

Formica parcipappa Cole, 1946, Ann. Ent. Soc. Amer., 39: 616; worker. Type locality: Nampa, Idaho.

The diagnostic character lies with the reddish yellow gaster of the worker, little or no darker than the alitrunk. We can find no structural characters that will separate the meager known sample of *parcipappa* from *subintegra,* and the light color will have to be the basis upon which this species uneasily rests. The *"gilvescens"* form of *subintegra* is frequently nearly as light and as close to concolorous as the *parcipappa* types, but the extent to which such coloration is due to tenerality or cabinet fading remains unknown. Dr. Cole (*in litt.*) assures us that the *parcipappa* types were noted as near their present striking hue when collected alive.

The variable lightening of the anterior gastric segments in some western series of *curiosa* (see above) suggests a condition intergradient between the gastric pigmentations of bicolorous *subintegra* and concolorous *parcipappa.* This species will remain doubtful at least until additional material is studied.

Formica wheeleri Creighton

Formica wheeleri Creighton, 1935, Amer. Mus. Novitates, no. 773, pp. 1-5; worker, queen. Type locality: Warner Ranger Station, La Sal Mountains, Utah, 9500 feet.

This species is supposed to be separable by the dark brownish tone of the head and alitrunk of the queen, and by the generally reduced size of this caste; the head is only slightly larger than that of the largest workers. No characters have been discovered that will surely separate the worker caste of *wheeleri* from that of *subintegra.* Workers in the type series possess very deep clypeal notches and show light cephalic infuscation, but both features are within the extremes of the range of variation of verified *subintegra*. We have tentatively associated with *wheeleri* a series from Madison Junction, Yellowstone Park, Wyoming, 6800 feet (E. O. Wilson). The queens are smaller than eastern *subintegra* at our disposal and appear darker despite their teneral condition. The workers differ from the *wheeleri* types by the possession of a shallower clypeal notch and "*puberula*" pilosity type (see under *subintegra*). A queen collected with workers by A. C. Cole at Dailey Canyon, Beulah, New Mexico, 8000 feet, is intermediate between the Yellowstone series and eastern *subintegra* in size and color. We have not been able to see a syntype queen of *wheeleri*, but judging from Creighton's description alone, the gap between *wheeleri* and *subintegra* appears to be filled by the Yellowstone and Dailey Canyon series. Future collecting in the Rockies and Great Basin may reveal that *wheeleri* is nothing more than one of the western variants of *subintegra*.

THE OBTUSOPILOSA COMPLEX OF THE NEOGAGATES GROUP

In the light of their new association with *F. neogagates* and relatives, the *obtusopilosa* group species must now all be re-evaluated. It is possible that some additional synonymy previously obscured by the false *Raptiformica-Proformica* dichotomy will be established when the *neogagates* group meets its first comprehensive revision. Such revision is not attempted here.

Formica bradleyi Wheeler

Formica bradleyi Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 423-425; worker, male. Type locality: Georgetown, Colorado.

Formica (*Proformica*) *neogagates* var. *morbida* Wheeler, 1913, *ibid.*, pp. 538-539; worker, queen. Type locality: Lenox, Iowa. Synonymized under *F. neogagates* Emery by Creighton, 1950, p. 459. NEW SYNONYMY.

Syntypes of *bradleyi* and *morbida* in the Museum of Comparative Zoology have been compared, and are closely similar, corroborating Dr. Buren's findings. *F. bradleyi* differs from *neogagates* in its much lighter color and denser and longer body pilosity.

Formica manni Wheeler

Formica manni Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 420-421; worker, queen. Type locality: Kiona, Washington.

Formica oregonensis Cole, 1938, Amer. Midl. Nat., 20: 368-369; worker. Type locality: Pendleton, Oregon. NEW SYNONYMY.

Four paratypes of *oregonensis* in the Museum of Comparitive Zoology are identical to the type series of *manni* in nearly all characters studied. Only the two characters treated below seem worthy of further discussion.

(1) Creighton (1950) states that the largest workers of *oregonensis* exceed the largest of *manni* in size. However, the M. C. Z. *oregonensis* paratypes show a head width range of 1.05-1.27 mm, while the M. C. Z. *manni* type series ranges 0.97-1.29 mm. There is no indication of a significant mean difference between these two samples.

(2) The alitrunk and head of the *oregonensis* types are dark brown, while those of the *manni* types are clear yellowish red. This difference apparently reflects geographic variation, i. e., a tendency to darken southward. Series from Wenatchee and Wapato, Wash. (Mann) are similar to the *manni* types in coloration. Series from Ellensburg, Wash. (Mann), Twin Falls, Ida. (Cole), and Hammett, Ida. (E. O. Wilson) exhibit varying degrees of intermediate infuscation. A single queen from Owens Lake, Calif. (H. F. Wickham) has a slightly darker altitrunk than the *manni* gynetype, but an even lighter head.

The extreme coloration of the *oregonensis* types may be a consequence, either genetic or ecophenotypic, of the unusual environment in which they were collected. Cole found them on an herb in an alpine meadow above timberline. The Washington *manni* (Wheeler, 1913) and the series from Hammett were taken under radically different conditions at low elevations in desert habitats.

Manni may be following Gloger's rule, tending to darken in a cooler, moister climate.

Formica obtusopilosa Emery

Formica obtusopilosa Emery, 1893, Zool. Jahrb. Syst., 7: 648-649; worker. Type locality: New Mexico.

Formica munda var. *alticola* Wheeler, 1917, Proc. Amer. Acad. Arts Sci. Boston, 52: 534; worker. Type locality: Jefferson Co., Colo., 9500 feet. NEW SYNONYMY.

Formica obtusopilosa alticola Creighton, 1950, Bull. Mus. Comp. Zool. Harv., 104: 466.

Wheeler's variety *alticola* was based on workers differing from typical *obtusopilosa* (= *munda*) only by a darker body color, a character of demonstrably little taxonomic value in other "*sanguinea* group" members. Creighton retained *alticola* because of the possibility that it might represent a geographic altitudinal variant. We are inclined to discount even this possibility now, in view of the fact that a collection of workers as dark as the *alticola* types has recently been made in scrub desert at 6000 feet near Junction, Piute Co., Utah (E. O. Wilson). The position of *obtusopilosa* as to species group is at present very uncertain, and may not be settled until males are studied.

Formica perpilosa Wheeler (figs. 4, 6)

Formica fusca subpolita var. *perpilosa* Wheeler, 1907, Mem. Revist. Soc. Ant. Alzate, 17: 141; worker. Type locality: Canyon City, Colo.

Formica perpilosa Wheeler, 1913, Bull. Mus. Comp. Zool. Harv., 53: 421.

Acknowledgements

After the first draft of this paper had been prepared, we were privileged to examine a near-finished manuscript by Dr. W. F. Buren dealing broadly with the subject of group classification within the genus *Formica*. The correspondence between Buren's and our ideas on this subject are frequently close and detailed (within the scope of

our own present paper), and most of the morphological observations bearing on species-group affinities are identical, even though independently accomplished. Dr. Buren has graciously deferred to us in the mention of a few points discovered by himself where these are necessary to a clear understanding of the group affinities of the species treated below, and for this we are most grateful. It is inconvenient for us to indicate in the text all points that should be credited in whole or part to Buren's original work, but it can be emphasized that his contribution was indeed an important one. Treatment of species within the *sanguinea* group, however, is entirely original with us.

We have also consulted for purposes of this study Dr. A. C. Cole, Mr. P. B. Kannowski, and Dr. Mary Talbot (all of whom also furnished important series), Dr. W. S. Creighton, Dr. R. E. Gregg and Dr. M. R. Smith. We thank these workers for their criticisms and information.

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DIVISION OF LABOR IN A NEST OF THE SLAVE-MAKING ANT *FORMICA WHEELERI* CREIGHTON

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It is a well known fact that most of the dulotic *Formica* are not "host-specific." They normally employ several species as slaves and are apparently governed in their choice at least in part by the species that happen fortuitously to be accessible to the colony. *F. subintegra* Emery, for instance, most commonly enslaves *F. fusca* Linn., but I have seen it associated in cabinet series with *F. lasioides* Emery, *F. neogagates* Emery, and *F. schaufussi* Mayr, while Creighton (1950) records it in addition with *F. montana* Emery and *F. pallidefulva* Mayr. According to Forel (1928, p. 12), the slave workers may retain some of the behavioral traits peculiar to their species. He notes that in Europe *Formica pratensis* Retzius workers reared from pupae by *F. sanguinea* Latreille tend to construct the form of nest characteristic of their own species. Talbot and Kennedy (1940) have made observations suggestive of the same behavior in *F. fusca* enslaved by *F. subintegra*. When *sanguinea* workers kept in observation nests were induced by Forel (*op. cit.*, p. 126) to rear pupae of *Polyergus rufescens* (Latreille) and several common *Formica* so that all these species coexisted in the same nest, differences in behavior were noted: "the *F. exsecta* and *fusca* were distinguished by their activity in working, the *Polyergus* by their complete idleness, the *sanguinea* by their skill, and the *pratensis* by their clumsiness."

During a recent field trip through the western United States, I was able to study in some detail a remarkable compound colony of the slave-maker *F. wheeleri* Creighton[1] and two slave species (*F. neorufibarbis* and *F. fusca*) in which behavioral differences were so strong as to produce

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[1] A tentative determination, since the status of this species relative to *F. subintegra* is still uncertain; see the preceding article by Wilson and Brown.

a clearcut interspecific division of labor. The complex organization of this colony was so interesting in every detail that I have considered it worthwhile to record below all of my observations, despite the fact that they pertain to a single and possibly aberrant case.

The mixed colony was first encountered at 2:30 on a warm, sunny afternoon, July 20, 1952, in a meadow near Madison Junction, Yellowstone Park, Wyoming (elevation 6800 feet). The *wheeleri* workers, accompanied by large numbers of *neorufibarbis* and a very few *fusca*, were in the process of raiding two nests simultaneously, one of *fusca* about eighteen feet from the home nest, and another of *lasioides* about seven feet beyond in a straight line. The exteriors of both raided nests were inconspicuous, each consisting of nothing more than several entrance holes in the open ground. The *wheeleri-neorufibarbis* raiding file contained workers spaced at intervals averaging about six to eight feet. Most were halting at the *fusca* nest, but some were bypassing it and proceeding on to the smaller *lasioides* nest. The scene around the raided nests was one of outstanding confusion. Frenzied *fusca* and *lasioides*, some carrying brood, were mingled with the *wheeleri* and *neorufibarbis* slaves. Running over the same spot were *fusca* and *neorufibarbis* from alien nests, possibly drawn to the scene by the general excitement. Needless to say it was difficult at any given time to pick out the slaves, the ants being raided, and the extraneous marauders.

Many of the homeward bound *wheeleri* were transporting pupae, *neorufibarbis* slaves, and other *wheeleri*. The *neorufibarbis* were never laden and seemed to be running back and forth without contributing any service to the raid. On a single occasion a *fusca* slave was observed carrying one of its *wheeleri* mistresses. The method of adult transport was the same as that already described in the literature for other *Formica*: the ant to be carried was approached face-to-face, seized by the mandibles, and lifted aloft; it submissively curled its body under the head of its transporter, folded in its legs, and became completely still.

After observing the raid for about an hour, I excavated the *fusca* nest in part. My efforts were clumsy, and I succeeded only in turning up a few workers and blocking the main entrance galleries. But at this point the role of the *neorufibarbis* was revealed, for as soon as I buried the access to the nest, they joined in with the *wheeleri* workers to dig it out again. There was no hesitation in this act, despite the fact that they did not follow through to join in the actual pillaging.

The raid continued through the remainder of the afternoon, the intensity of activity fluctuating as from time to time the number of workers issuing from the home nest rose and then fell again. After 4:00 the raid against the *lasioides* began to slacken, and by 5:15 it had ceased altogether. By 5:30 activity around the *fusca* nest was also noticeably less.

When the raid had fallen into an obvious decline, around 5:30, I proceeded to excavate the *wheeleri* home nest. The exterior consisted of a low, oblong earthern mound about two-and-a-half feet in maximum length and three inches high. Sparse tufts of grass emerged through the periphery, at one end sheltering three inconspicuous entrance holes. By digging a pit four feet deep in from the side, I uncovered the deepest galleries of the nest at about three-and-a-half feet. Inside the nest the *wheeleri* were outnumbered by their slaves by at least three to two, while the *neorufibarbis* and *fusca* occurred in approximately equal numbers. No *lasioides* were encountered, despite the fact that the *wheeleri* had been engaged in a raid against a nest of this species earlier in the day. The upper galleries and chambers of the nest contained large numbers of *wheeleri* and *neorufibarbis* and a few small individuals of *fusca*. The former two species sallied out aggressively to defend the nest. The deeper galleries, those at a depth of about two feet or more, were larger in size and packed with large *fusca* workers, *wheeleri* brood, callow *wheeleri* queens (a single fully colored male was also found), and a small number of *wheeleri* and *neorufibarbis* workers. The *fusca* workers were relatively docile, and nearly all were in a semi-replete condition. Their preponderance over other adults in this part of the nest and their close association with the brood gave the strong impression that they were serving as nurses.

At noon on the next day the wrecked nest was visited again. The colony was busily engaged in migrating to the undamaged part of the *fusca* nest which had been raided the day before. The *fusca* workers were no longer in evidence and presumably had been forced out. The *wheeleri* were doing all the work in this operation; most of the workers in the migrating file were carrying something in their mandibles, either brood, or slaves, or other *wheeleri*. In contrast, many of the slaves were running back and forth with the slave-makers but none were burdened.

In summary, an interspecific division of labor was pronounced in this particular case. The slave-maker species *wheeleri* functioned in raiding, nest defense, and transport during colony migration. Workers of the slave species *neorufibarbis* accompanied the *wheeleri* on their raid and helped them excavate one of the besieged nests when the entrance holes were blocked; they were also active in nest defense. The *fusca* workers were very passive, did not contribute materially to the slave-raid, and gave every sign of serving primarily as nurses and food receptacles. A deeper significance of the dulotic habit is underscored here. It is apparent that the slave-maker colony not only adds to its labor force quantitatively by taking slaves but may also incorporate specialists that increase the efficiency of the colony in a fashion analogous to that seen in normal worker polymorphism.

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NOTE ON *TARSOPHLEBIOPSIS MAYI* TILLYARD (ODONATA: TARSOPHLEBIIDAE)

BY LT. COL. F. C. FRASER, I.M.S., RETD.
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I wish to correct a serious error made by the late Dr. R. J. Tillyard when describing his *Tarsophlebiopsis mayi* Tillyard[1]. I am indebted to the Curator of the Sedgwick Museum, Cambridge University, for the opportunity of re-examining this very interesting fossil wing, an examination which convinces me that we are not dealing with a fore wing and a hind wing as Tillyard supposed, but with the right and left fore wings. Tillyard was no doubt swayed by the fact that the impression of the supposed hind wing is pigmented whilst that of the fore wing is not so; he also based his opinion on what he thought to be a greater divergence of the origins of Rii (Mi--ii) and IRiii (Ms), a divergence which seems to me to be identical in the two impressions. His greatest error, however, is his statement that the fossil shows *unspecialized antenodals*, which in so archaic a wing is *absolutely impossible.* It was to prove this latter point that I requested a loan of the specimen and found after my re-examination that the two primary antenodals were indeed present. By making careful sketches of the portions of the wing to the same scale and then making a combined tracing of the two, I found that the various longitudinal veins ran in smooth continuation of one another and that they were obviously both portions of a forewing, the left and right of the insect under examination. Some differences were also found in the anal area of the wing, where only two cross veins can be seen running between CuA and CuP and only four in the cubital space. The slight reticulation in the distal part of this space shown by Tillyard appears to me to be due to foreign matter or artefacts. The primary antenodals are the 3rd and 5th from the base of the wing. The reticulation posterior to the anal vein is of three rows of cells, not a network as shown

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[1] 1923, Geol. Mag., **60**: 146-52, 1 pl., 3 figs.

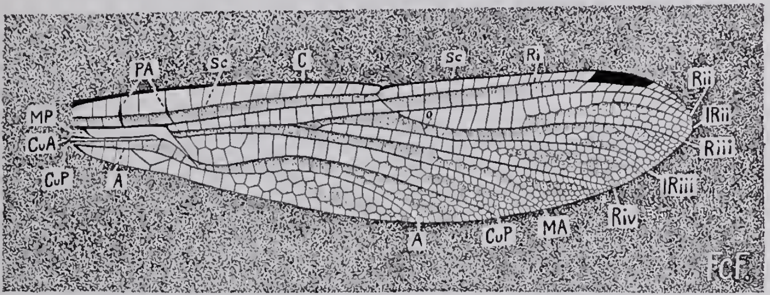

Fig. 1. Reconstruction of fore wing of *Tarsophlebiopsis mayi* Till. (Tillyardian notation employed).

by Tillyard. The supposed fragment of "the basal posterior margin of a hindwing" fits into the area posterior to the anal vein in the right fore wing. After making these corrections, I have been able to reconstruct a complete fore wing.

Nylanderia myops (Mann), New Combination (Hymenoptera: Formicidae). — The small-eyed Cuban *Prenolepis* of Mann is placed in *Nylanderia* to follow the modern classification of these groups. Weber has described a species *troglodytes,* also from Cuba, supposing it to differ from *myops* "in distinctly larger size and in the shape of the petiole." Direct comparison of three syntypes of each of these forms now in the Museum of Comparative Zoology shows a slight average size difference, but an absolute overlap exists even in this minute sample. Mann's cited measurements are too low, and could not have been made from a stretched-out specimen. Head and petiole shapes in these delicate specimens vary widely, due to warping and buckling upon drying out of the alcohol. Weber apparently refers to such differences, although these are not clearly seen in the types before me. Formal synonymy follows. *Prenolepis myops* Mann, 1920, Bull. Amer. Mus. Nat. Hist., 42: 432, worker, female, male. Type loc.: Mina Carlota, Sierra Trinidad.

Paratrechina (*Nylanderia*) *troglodytes* Weber, 1934, Rev. Ent., Rio de Janeiro, 4: 58, fig. 7a, b, worker. Type loc.: near Casa Harvard, Soledad, Cienfuegos, Cuba. **New synonymy.**

In addition to specimens collected at or near the two type localities by P. J. Darlington and E. O. Wilson, Darlington took a series at the Sierra de Cobre, from 3000-3800 feet altitude, Oriente Prov., Cuba, showing that the species is both widespread and ecologically adaptable within the limits Cuba offers. — By WILLIAM L. BROWN, JR., Museum of Comparative Zoology.

THE STATUS OF THE ANT GENUS MICROBOLBOS DONISTHORPE. — During a recent visit to the British Museum (Natural History) I was able to examine the holotype of the enigmatic species *Microbolbos testaceus* Donisthorpe, described from the Gold Coast (1948, *Entomologist*, 81: 170-171)). *Microbolbos* was found to be a junior synonym of *Leptogenys* Roger 1861 (*s. l.*) (**new synonymy**). Donisthorpe's *testaceus* may stand as a valid species, however, distinguished from other *Leptogenys* by the following combination of characters: (1) hind claws with small, well separated teeth instead of combs, (2) mandibles with 3 distinct teeth including the apical, (3) body size extremely small, only about that of a large *Ponera*, (4) body surface heavily shagreened, completely opaque, (5) color dark yellowish brown, (6) body covered with abundant, short, erect hairs. The absence of combs on the tarsal claws, or at least their reduction to separated teeth, forms an exception to what is the principal diagnostic character of the Leptogenyini, but actually the African species *Leptogenys arnoldi* Forel and *L. castanea* Mayr show the same condition, and the character grades through between the two extremes in the genus. Possession of mandibular teeth additional to the apical tooth is also unusual, but is shared with *L. myops* Emery and members of the *L. processionalis* group. — E. O. WILSON, Biological Laboratories, Harvard University.

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CAMBRIDGE ENTOMOLOGICAL CLUB
1874

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PSYCHE

Vol. 62 December, 1955 No. 4

A TERRESTRIAL DAMSELFLY NYMPH (MEGAPODAGRIONIDAE) FROM NEW CALEDONIA[1]

By Ruth Lippitt Willey

Biological Laboratories, Harvard University

Recently, a damselfly nymph of the family Megapodagrionidae was found in the berlese funnel material of soil and leaf litter sent to the Museum of Comparative Zoology from Ciu, New Caledonia, by Dr. E. O. Wilson. It is a rather young stage and cannot be placed definitely to genus. However, on the basis of the labium and the horizontal type of caudal gill, it seems reasonable to classify the nymph as one of the four known species of Megapodagrionidae from New Caledonia: *Argiolestes uniseries* Ris, *A. sarasini* Ris, *A. ochraceous* Montrouzier, or *Trineuragrion percostale* Ris. Both Dr. Fraser and Dr. Lieftinck have kindly confirmed this supposition. Lieftinck writes that his extensive, unpublished notes and sketches of Megapodagrionid nymphs from Malaysia and New Guinea show a very close relationship with this New Caledonian form.

The habitat in which the nymph was found is extremely unusual for an Odonate nymph, and is a strong factor in favor of treating this form as normally terrestrial. Dr. Wilson writes that "all soil and leaf litter samples were collected in dry to moderately moist (but never wet) spots on the forest floor, never less than 200 feet from the

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[1] Published with the aid of a grant from the Museum of Comparative Zoology at Harvard College. This study was supported by the Alice Freeman Palmer Fellowship, Wellesley College, 1954-55.

river and 75-100 feet above it on a fairly steep slope. There were no lesser streams or other standing bodies of water in the part of the forest I worked. Most of the samples were taken in a level area with numerous small rocks and moist leaf litter several inches deep". The nymph is too young to have been wandering away from the river in search of a place to transform to the adult. The morphology would suggest either a burrowing or terrestrial habitat. However, in consequence of the locality in which it was collected, it seems reasonable to consider it terrestrial, in this being similar to the specialized Hawaiian species of *Megalagrion* McLachlan.

The nymph had been preserved in alcohol, and as a result, the tissues were very poorly fixed. It was post-fixed in Carnoy's fixative in an attempt to preserve some of the few remaining internal structures.

Total length 11.2 mm., body length (minus caudal gills) 8.7 mm., abdomen length 4.5 mm. Head broad, median length 1.6 mm., maximum width 2.6 mm., well covered with heavy setae (Pl. 13, fig. 3). Antennae 6-segmented. Scape and pedicel longest antennal segments; thickly covered with long setae. Relative lengths of antennal segments 12:12:5:5:4:6. Mentum of labium broad, almost square in outline (Pl. 13, fig. 1). Mental setae absent. Distal margin of the mentum minutely crenelate with short, thick setae between each projection. Small median cleft present. Just proximal to distal margin and located on each side of the cleft is a minute tooth similar to that found in Cora and Thaumatoneura. At each corner on the distal margin, near the base of the lateral lobes, is a tuft of 8 setae. Lateral lobe slender, with a long movable hook (Pl. 13, fig. 2). Of the 3 teeth, the center one is longest and sharpest. End tooth of left maxilla with 3 basal teeth (Pl. 13, fig. 4).

Incisor region of the mandibles with 5 teeth. Molar region separated by a membranous area from the rest of

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Explanation of Plate 12

Megapodagrionid nymph, Ciu, New Caledonia. Fig. 1, dorsal view. Fig. 2, ventral view. Magnification, (×9).

1

2

WILLEY — MEGAPODAGRIONID NYMPH

the mandible. In the left mandible, the molars form a cutting edge parallel to that of the incisors, with a sharp tooth at each end and 5 small intermediate teeth (Pl. 13, fig. 6). In the right mandible, the molar region is reduced to a single,independent, sharp tooth; the first incisor has a small basal tooth (Pl. 13, fig. 5). A muscle can be seen attached to the molar region of the left mandible, indicating that the molars are probably capable of independent movement; exact information must await study of properly fixed material.

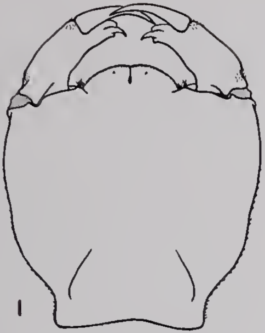
Mesothoracic wingpads extend to the posterior margin of 2nd abdominal segment, 1.8 mm. long. The nymph is too young and the fixation too poor to identify it by wing venation. It is interesting to note that the thoracic spiracles are not open or functional. Peritreme and trachea present, but lips sealed together, as found normally in aquatic forms. Legs short, densely covered with long, simple setae (Pl. 14, fig. 3). Femora compressed, incrassate; length of left prothoracic femur 1.1 mm., mesothoracic femur 1.9 mm., metothoracic femur 2.8 mm. Both femora and tibia are heavily ridged, and are, as a consequence, almost rectangular in cross-section. Tarsi slender, very short, each with a well developed pair of claws. Abdomen short and thick, round in cross-section, maximum width of 3rd segment 2.1 mm., covered with heavy setae. Proventriculus primitive, generalized, with 16 well-defined folds, 8 major (7-9 teeth) and 8 minor (5-6 teeth), plus 16 anterior, half-length folds (2-4 teeth) which alternate between the regular folds (Pl. 13, fig. 7).

Caudal gills one-jointed, of the saccular triquetroquadrate type (Pl. 14, figs. 1, 4). Median gill quadrangular, but somewhat flattened in the horizontal plane, 2.3 mm.

EXPLANATION OF PLATE 13

Megapodagrionid nymph, Ciu, New Caledonia. Fig. 1, dorsal view of labium. Fig. 2, detail of right lateral lobe of labium. Fig. 3, dorsal aspect of nymphal head. Fig. 4, right maxilla. Fig. 5, left mandible. Fig. 6, right mandible. Fig. 7, diagram of several dental folds of proventriculus to show generalized pattern.

Magnification. Figs. 1, 3 (×20). Figs. 2, 4-7 (×40).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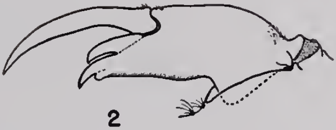
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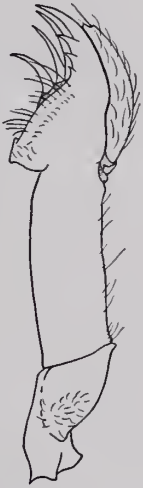
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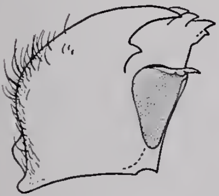
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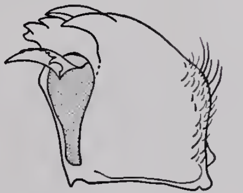
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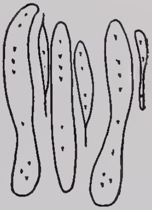
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Willey — Megapodagrionid Nymph

long, maximum width 1.0 mm. Lateral gills similarly flattened, triquetral; left lateral gill 2.1 mm. long. Tillyard[2], when speculating upon the evolution of the horizontal lamellar type of gill in his Australian *Argiolestes,* postulated just such an intermediate form as this between the primitive saccoid gills and the specialized lamellar types. It seems reasonable to assume that this nymph represents one of the intergrade types leading to the specialized situation in the Australian species. The gills are attached to the abdomen by a remarkably narrow constriction, a very efficient breaking point. In cross-section can be seen the vertical internal laminae which are characteristic of the horizontal gill type (Pl. 14, fig. 2). The hypodermis and tracheae are heavily pigmented. The tracheae enter the gill as a single trunk, divide immediately into the two main trunks which then divide repeatedly throughout the length of the gill. Long slender setae densely cover the gill. They are held in unusually deep, cup-like sockets which keep the processes in an erect position.

It would be interesting to study the life-history of this species in view of the apparent shift in habit, and to compare it with closely related aquatic forms. When the nymph was received, it was heavily coated with debris caught among the long hairs. In this immature form, respiration must take place through the cuticle. The increased number of setae serves to maintain a cover of damp debris which keeps the cuticle moist, a necessity for gas exchange. Such a cover is also of advantage as protective coloration. Lieftinck (*in litt.*) feels that the hairiness of this nymph may be, however, a common

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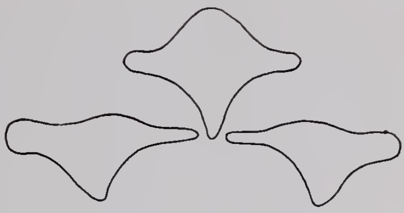
[2] 1917. On the morphology of the caudal gills of the larva of Zygopterid dragonflies. Proc. Linn. Soc. N. S. W., 42: 31-112, 606-632.

EXPLANATION OF PLATE 14

Megapodagrionid nymph, Ciu, New Caledonia. Fig. 1, outline diagram of cross-section through caudal gills to show relative shapes and positions. Fig. 2, reconstruction of cross-section through middle of left lateral gill. Fig. 3, right mesothoracic leg. Fig. 4, ventral view of left lateral gill. dbc, dorsal blood channel; dn, dorsal longitudinal nerve; il, vertical internal lamina; tr, tracheal trunk.

Magnification. Fig. 3 (×10). Figs. 1, 4 (×20). Fig. 2 (×67).



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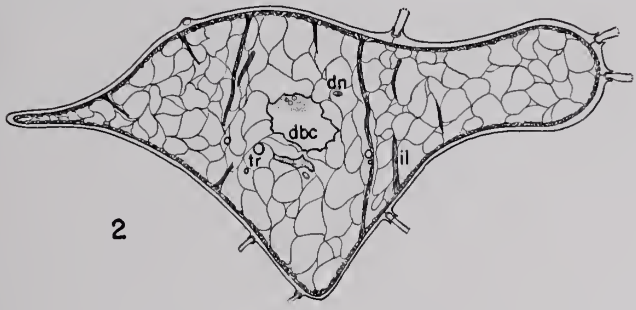

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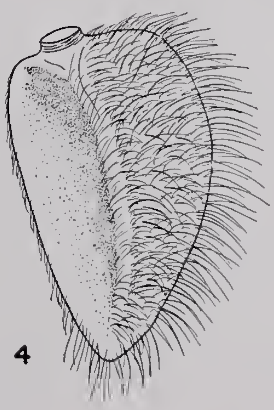

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Willey — Megapodagrionid Nymph

characteristic within the genus, at least with his Malaysian and New Guinea specimens, and not necessarily an adaptation to a terrestrial environment. The short, strong legs, with well-developed tarsal claws, which are similar to a burrowing condition, would be useful for locomotion in the absence of the usual support of the aquatic medium. Fraser also has suggested (*in litt.*) that the ocelli are unusually large for such a young form; this also may be due to its unusual environment. Comparative study of the nymphs and adults of the New Caledonian *Argiolestes* will be necessary before the evolution of terrestrial modifications of this nymph can be understood.

I am indebted to Dr. F. C. Fraser and Dr. M. A. Lieftinck for their letters with suggestions on the taxonomic position and habit of this unusual nymph. I also wish to thank Dr. E. O. Wilson for his notes on its habitat.

INCISALIA SCUDDER[1], A HOLARCTIC GENUS (LEPIDOPTERA: LYCAENIDAE)[2]

By Nicholas W. Gillham

Harvard University

Recently I have compared specimens of *Ahlbergia frivaldszkyi* (Lederer), the generitype of *Ahlbergia,* and *Incisalia niphon* (Hübner), the generitype of *Incisalia.* The genitalia and external facies of these species indicate that they are congeneric, and examination of other species of *Incisalia* further supports this conclusion. I therefore propose the following synonymy for the genus *Incisalia*:

Incisalia Scudder

Incisalia Scudder, 1872, 4th Ann. Rept. Peabody Acad. Sci., 1871:31. Generitype: *Lycus niphon* Hübner, by original designation.

Thecla, div. auct., nec Fabricius, 1840, *in* Illiger, Magazin für Insektenkunde, 6:286 (generitype *Papilio betulae* Linnaeus, designation by Swainson, 1821, Zoological Illustrations, (1) 2, pl. 69), *part.*

Lycus Hübner, [1819], Verzeichniss bekannter Schmettlinge [!] (generitype *Papilio rubi* Linnaeus, designation by Scudder, 1875, Proc. Amer. Acad. Sci., Boston, 10:210), *part.*

Licus Hübner, [1819], Zuträge zur Sammlung exotischer Schmetterlinge, 2:7, no. 102 (generitype *Papilio rubi* Linnaeus, designation by Scudder, 1872, 4th Ann. Rept. Peabody Acad. Sci., 1871:52), *part.*

Satsuma Murray, *nec* Adams, 1874, Ent. Mon. Mag., 11:168. Generitype: *Lycaena ferrea* Butler (=*Thecla frivaldszkyi* Lederer), monobasic. **New Synonymy.**

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[1] Scudder is the author of this genus, not Minot; see dos Passos (1943).

[2] Published with a grant from the Museum of Comparative Zoology at Harvard College.

Ahlbergia Bryk, 1946, Ark. för Zool., 38A(3):50. Generitype: *Thecla frivaldszkyi* Lederer, by original designation. **New Synonymy.**

Generic Description Based on the Adults

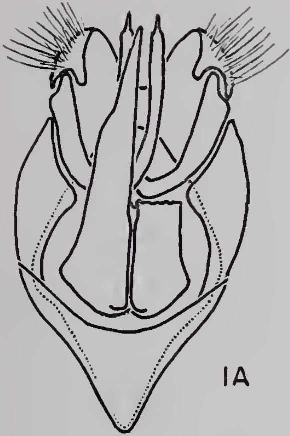
External facies. The ground color above is gray to orange brown in most of the Nearctic species. In the Palearctic species it is blue to iron gray with the exception of *chalybea pluto* Leech and *circe* Leech. In *chalybea pluto* the ground color is a deep black and in *circe* the distal area is dark while the basal area is dusted with bright metallic blue. The hindwings lack the "tails" characteristic of many genera and species of Theclinae, and usually have somewhat scalloped outer margins. The inner margins are often concave above the anal angles, and these are prolonged and bent downward at right angles. The ground color of the underside is a shade of brown, sometimes suffused with gray on the outer half of the hindwing. The eyes are hairy and large.

Male genitalia (figs. 1 and 2). Labides (paired, rounded, hairy, dorsal projections) projecting shortly, but deep dorsoventrally. Falces (heavily chitinized, paired, sharp, subdorsal structures which, with the paired labides, characterize the Lycaenidae) of fairly even width subterminally; tapering to a point terminally. Saccus short, thick, and without any pronounced angling. Aedeagus very long and slender.

Female genitalia (figs. 3 and 4). Ostium flaring into a

Explanation of Plate 15

Fig. 1. Male genitalia of *Incisalia niphon* (Hübner) from Waltham, Mass. (30×). A. Ventral view with aedeagus removed and hairs of harpes not shown. B. Inset of a harpe showing hairs. C. Lateral view of aedeagus. Fig. 2. Male genitalia of *Incisalia frivaldszkyi* (Lederer) from South Korea (30×). A. Ventral view with aedeagus removed and hairs of harpes not shown. B. Lateral view of aedeagus. Fig. 3. Female genitalia of *I. niphon* (Hübner) from Tyngsboro, Mass., ventral view (9.9×). Fig. 4. Female genitalia of *I. frivaldszkyi* (Lederer) from Okeanskaja, Ussuri, ventral view (9.9×). All specimens in the collection of the Musuem of Comparative Zoology, Cambridge.



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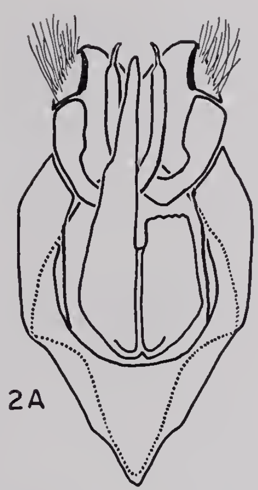

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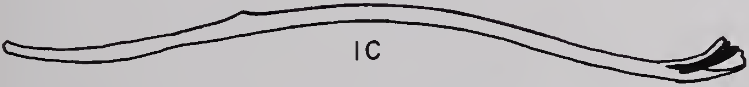

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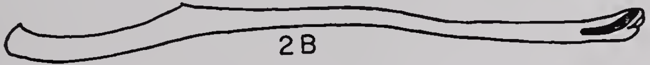

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GILLHAM — INCISALIA

wide, lipped, transverse band caudally. The ventral lip partially covers the more dorsal band which is sometimes strongly folded along its caudal edge. Ductus bursae rather long, narrow, and even in width. It is sclerotized throughout most of its length. Bursa copulatrix elongate, and bearing two signa. Ovipositor lobes narrow and somewhat pointed terminally.

Life History

The life histories of most of the North American species are known, but I can find none recorded for the Palearctic species. Because of this I defer inclusion of life history notes in my generic description until this information becomes available. Descriptions of the early stages of the eastern North American species are available in Klots (1951), and further references may be found in Hy. Edwards (1889), Davenport and Dethier (1938), and Dethier (1946). The foodplants of the larvae are varied, including conifers (*Picea*, *Juniperus* etc.) and flowering plants (*Kalmia*, *Arctostaphylos*, *Vaccinium*, *Prunus* etc.).

Distribution

In North America this genus ranges from east to west coasts. It is found well north into Canada, whence it ranges south to Florida, Texas, and southern California. In Asia it is found from Siberia, the Amur basin, and Japan south through China to the Khasia Hills of Assam. It ranges westward to the Altai Mountains, and its Asiatic metropolis is central and western China, where the greatest number of species occur.

Synonymy

Prior to the beginning of this century, a large majority of the "hairstreaks" were assigned by most authors to the catchall genus *Thecla*, even though a number of other generic names were available. In many places, such as South America, this is still the case, and it is only in the last fifty years that some attempt has been made to break the hairstreaks up into more natural groupings. Hübner included *Incisalia niphon* (Hübner) in his genera *Lycus* and *Licus* with one or two unrelated species. Later authors either missed or disregarded this reference, and generally assigned the species of *Incisalia* to *Thecla*. In 1872 Scudder erected the genus *Incisalia* for *niphon* and its allies, while in 1874 Murray created the genus *Satsuma* for *Lycaena ferrea* Butler[3]. Leech was aware of Murray's genus, and towards the end of the 19th Century described several new species as belonging to it. In 1946 Bryk pointed out that *Satsuma* Murray, 1874, was a homonym of *Satsuma* Adams (Mollusca), 1868. He therefore proposed the name *Ahlbergia* to replace *Satsuma* Murray. My own studies show that *frivaldskyi* is congeneric with *niphon*. For this reason I am placing *Satsuma* and *Ahlbergia* in the synonymy of *Incisalia*, the senior name.

Synopsis of Species

The following synopsis is based on current American references for Nearctic species and on Seitz (1910) for Palearctic species. No attempt has been made to determine whether or not any of these should be synonymized.

Incisalia niphon (Hübner), [1819], Verzeichniss bekannter Schmettlinge [!], (5) :74. Type locality and sex not stated.

Incisalia irus (Godart), 1823, *in* Latreille, Encyclopedie Methodique, Histoire Naturelle Entomologie, etc., 9:674. Type locality: America (?), male.

Incisalia augustinus (Westwood), 1852, *in* Doubleday and Westwood, The Genera of Diurnal Lepidoptera, 2:486. Type locality: northern parts of North America.

Incisalia iroides (Boisduval), 1852, Ann. Soc. Ent. France, Series 2, 10:289. Type locality: California, sex not stated.

Incisalia eryphon (Boisduval), 1852, *ibid.*, p. 290. Type locality: California, sex not stated.

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[3] There is some disagreement on the specific distinctness of *ferrea* from *Incisalia frivaldszkyi* (Lederer). I have examined the genitalia of Japanese specimens referable to *ferrea* and Asiatic specimens referable to *frivaldszkyi* and can find no differences that would warrent keeping them separate as species. Therefore, I regard these names as concerning the same species.

Incisalia frivaldszkyi (Lederer), 1855, Ver. zool.-bot. Ver. Wien, 5:100. Type locality: Ust-Buchtarminsk, Altai Mtns., male.

Incisalia henrici (Grote & Robinson), 1867, Trans. Amer. Ent. Soc., 1:174. Type locality: Maine to Philadelphia, Pa., male and female.

Incisalia fotis (Strecker), 1877, Lepidoptera, Rhopaloceres & Heteroceres, indigenous & exotic, No. 14:129. Type locality: Arizona, sex not stated.

Incisalia mossii (Hy. Edwards), 1881, Papilio, 1:54. Type locality: Esquimalt, Vancouver Is., British Columbia, male.

Incisalia chalybea (Leech), 1890, Entomologist, 23:43. Type locality: Chang-Yang, Central China, male.

Incisalia pratti (Leech), 1890, *ibid.*, p. 44. Type locality: Ichang, China, male.

Incisalia leechii (de Nicéville), 1892, Bombay Nat. Hist. Soc., 7:335. Type locality: Khasia Hills, Assam, female.

Incisalia circe (Leech), 1893-94, Butterflies from China, Japan & Corea, 2:354. Type locality: Ta-chien-lu, China, male and female.

Incisalia nicévillei (Leech), 1893-94, *ibid.*, p. 355. Type locality: Chang-Yang, Central China, male and female.

Incisalia polios Cook & Watson, 1907, Can. Ent., 39:202. Type locality: Lakewood, New Jersey, males and females.

Incisalia hadros Cook & Watson, 1909, *ibid.*, 41:181. Type locality: unknown, perhaps Houston, Texas, male and female.

Incisalia lanoraieensis Sheppard, 1934, *ibid.*, 66:141. Type locality: Lanoraie, Quebec, male and females.

Incisalia doudoroffi dos Passos, 1940, *ibid.*, 72:168. Type locality: Big Sur, Monterey Co., California, males and females.

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ON SOME COCCINELLIDAE (COLEOPTERA) FROM NEWFOUNDLAND AND NOVA SCOTIA.

By Edward A. Chapin

Museum of Comparative Zoology, Harvard University

In 1949 and 1951, Dr. Carl H. Lindroth, of the University of Lund, Sweden, and party made extensive collections of insects in Newfoundland, with some attention paid to Nova Scotia and Miquelon. The writer has been privileged to examine the lady-beetles collected by the members of the two expeditions, which were made possible by grants from the Arctic Institute of North America and the University of Helsinki, Finland. A total of 348 specimens, representing 19 species, one of which appears to be new to science, was taken. The first set of specimens is deposited in the Helsinki University museum, the second (including the unique type of the new species) in the Canadian National Collection. Other specimens are in the collections of the United States National Museum, the Museum of Comparative Zoology and the writer. A list of the species taken, with localities, dates, collector's initials and station numbers, is given at the end of this paper. The collectors were C. H. Lindroth and E. Palmen. The following species seem worthy of special comment.

Coccinella undecimpunctata L. Known from various stations along the Atlantic coast from Massachusetts northward. At this time it seems best to correct the record of this species from Alaska. Dobzhansky, in his revision of North American Coccinella[1] reported two specimens from Alaska as belonging doubtfully to this species. Dissection of one of them, a male, showed them to be *C. difficilis* Crotch. Therefore, at present, the known distribution of *C. undecimpunctata* L. in North America is along the Atlantic coast from Massachusetts to Newfoundland and the distribution of *C. difficilis* Cr. is from Colorado, Utah and Nevada north to a point 60-75 miles north of Rampart House, Alaska.

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[1] U.S. Nat. Mus., Proc., Vol. 80, Art. 4, p. 28, 1931.

Microweisea misella (Leconte). A single specimen, which I refer to this species, differs from the type in that the punctation of the elytra seems to be slightly coarser. This apparent difference could be due to the difference in age of the specimens, the Newfoundland specimen being fresher and cleaner than the Leconte type. Otherwise, no differences could be noted.

Hyperaspis novascotiae n. sp.

A single specimen from Nova Scotia appears to be undescribed and is characterized as follows. —

Female: form very broadly oval, similar to that of *H. lugubris* (Rand.), piceous black, with head, lateral margins of pronotum narrowly, and four spots on each elytron, yellowish brown. Head and pronotum finely and moderately densely punctured, very finely alutaceous between punctures, pronotum finely margined across base. Scutellum extremely finely and sparsely punctured. Elytra much more coarsely punctured than pronotum except on extreme flanks where the punctures are fine and sparse. Each elytron decorated with four spots — a triangular spot on the humerus which fails narrowly to reach the base but which reaches the marginal bead; a lateral spot, almost semicircular, at the beginning of the posterior half of the length of the elytron, its outer margin following the marginal bead; an apical spot, slightly larger than the lateral spot and evenly elliptical, failing to reach the apical angle by a little less than its long diameter but following the marginal bead; a discal spot, similar in size to the lateral spot and located slightly apicad of the lateral spot, so that the lateral and discal spots together form a row across the elytra which is slightly curved with the convexity toward the apices. Under parts dark except epipleura of thorax and elytra; anterior and middle legs, posterior coxae, tips of femora, tibiae and tarsi pale. Metacoxal arcs on first visible sternite semicircular, nearly touching posterior margin of sternite. Metasternum and abdominal sternites coarsely punctured laterally, finely and sparsely punctured along median line. *Dimensions*: length 2.3 mm., width 1.8 mm.

Male: unknown.

Type locality and known distribution: Nova Scotia, Bridgewater, Crescent Beach. Type and only specimen collected May 19, 1951 by C. H. Lindroth (CHL 179). Deposited in the Canadian National Collection.

At first glance this species appears to be *H. undulata* (Say) with the discal spots displaced apicad on the elytra. However, its form and other characteristics seem to ally it with *H. lugubris* (Rand.).

List of species, with localities.

Hippodamia tredecimpunctata tibialis (Say). 119 specimens.

Newfoundland: *Northeast.* Springdale, 20-21.VI.51 (CHL 254); Twillinggate, 5 and 8.VII.51 (CHL 276,280). *East.* Gambo, 25-26.VIII.49 (CHL 160,161,163); Terra Nova, 28.VII.51 (CHL 328). *South.* Rencontre West, 17-20.VI.49 (CHL 36); Terrenceville, 13-14.VIII.51 (CHL 357). *West.* Deer Lake, 18.VIII.49 (CHL 148); Deer Lake, 1-2.VI.51 (CHL 212,213,215); South Branch, 4.VII.49 (EP 109); Cooks Bk., Curling, 15.VIII.49 (EP 242). *Northwest.* St. Pauls, 10.VIII.49 (CHL 134); Cow Head, 7.VIII.49 (CHL 130); Cow Head, 9.VIII.49 (EP 216); Daniels Harbour, 23.VII.49 (EP 169). *Central.* Gander, 2.VI.49 (EP 3); Buchans Junction, 15.VI.51 (CHL 240); Badger, 22-25.VI.51 (CHL 256,257,258,259); Grand Falls, 26.VII.51 (CHL 324).

Nova Scotia: Baddeck, 24.V.51 (CHL 190); North Sydney, 27.V.51 (CHL 200).

Anisosticta bitriangularis (Say). 21 specimens.

Nova Scotia: Halifax, 18.V.51 (CHL 177); Halifax, Waverley, 21.V.51 (CHL 184); Baddeck, 24.V.51 (CHL 189,190); Cheticamp, 25.V.51 (CHL 191); North Sydney, 27.V.51 (CHL 200,201).

Coccinella transversoguttata Fald. 82 specimens.

Newfoundland: *Northeast.* Hampden, 12.VII.49, 24.VII.51 (CHL 87,316,317); Springdale, 20-21.VI.51 (CHL 254); Fogo, Tilting, 30.VI.51 (CHL 268). *East.* Terra Nova, 26-28.VII.51 (CHL 327,328); Port Rexton, 30-31.VII.51 (CHL 332,333). *Southeast.* Holyrood, 10.VI.49 (CHL 23). *South.* Rencontre West, 15-20.VI.49 (CHL 32,36,40); St. Albans, 26.VI.49 (CHL 51); Garnish, 6.VIII.51 (CHL

349); Terrenceville, 13-14.VIII.51 (CHL 356). *West.* Deer Lake, 2.VI.51, 25.VII.51 (CHL 215,320,321); Lomond, Bonne Bay, 14.VII.49 (EP 149). *Northwest.* St. John I., St. John Bay, 3.VIII.49 (EP 195). *Central.* Millertown Junction, 22.VIII.49 (CHL 152); Glenwood, 23.VIII.49 (CHL 158); Gander, 1.IX.49 (CHL 173, EP 307); Lake St. John, 27.VII.51 (CHL 325).

Nova Scotia: Halifax, 21.V.51 (CHL 183); Cape North, 26.V.51 (CHL 198); North Sydney, 27.V.51 (CHL 199).

Miquelon. 8-10.VIII.51 (CHL 351).

Coccinella trifasciata L. 29 specimens.

Newfoundland: *Northeast.* Springdale, 20-21.VI.51 (CHL 252,253,254); Fogo, Tilting, 30.VI.51 (CHL 268); Norris Arm, 23.VIII.49 (EP 278). *South.* Rencontre West, 17-20.VI.49 (CHL 36). *West.* Stephenville Cross, 5-8.VII.49 (CHL 69); Deer Lake, South Brook, 3.VI.51 (CHL 219). *Central.* Millertown Junction, 22.VIII.49 (CHL 152); Victoria Lake, 11-12.VI.51 (CHL 237); Buchan Junction, 15.VI.51 (CHL 240).

Nova Scotia: Halifax, 21.V.51 (CHL 183); Orangedale, 28.V.51 (CHL 202).

Coccinella undecimpunctata L. 39 specimens.

Newfoundland: *Northeast.* Fogo, Tilting, 30.VI.51 (CHL 269); Twillinggate, 5.VII.51 (CHL 276). *South.* Grand Bank, 3.VIII.51 (CHL 345). *West.* Piccadilly, Port au Port Peninsula, 7.VII.49 (EP 117). *Northwest.* Cow Head, 7-13.VIII.49 (CHL 128,135); St. Pauls, 10.VIII.49 (CHL 134).

Nova Scotia: Halifax, 18.V.51 (CHL 178).

Miquelon. 8.VIII.51 (CHL 352).

Anisocalvia quattuordecimguttata (L.) 3 specimens.

Newfoundland: *West.* Deer Lake, 25.VII.51 (CHL 321); Deer Lake, South Brook, 3.VI.51 (CHL 217). *Central.* Glenwood, 23.VIII.49 (CHL 155).

Anisocalvia quattuordecimguttata duodecimmaculata (Gebl.) 4 specimens.

Newfoundland: *Northeast.* Fogo, Tilting, 30.VI.51 (CHL 268). *West.* Deer Lake, 30.V.51 (CHL 205); Deer Lake, 25.VII.51 (CHL 321).

Anatis ocellata (L.) 2 specimens.

Newfoundland: *South.* Port aux Basques, 1.VII.49 (CHL 61).

Nova Scotia: Bridgewater, Crescent Beach, 19.V.51 (CHL 179).

Adalia bipunctata (L.) 11 specimens.

Newfoundland: *West.* Cooks Bk., Curling, 15.VIII.49 (EP 242); Corner Brook, 15.VIII.49 (EP 247).

Nova Scotia: Halifax, 21.V.51 (CHL 183).

Adalia frigida (Schneider) 7 specimens.

Newfoundland: *Northeast.* Fogo, Tilting, 30.VI.51 (CHL 268). *West.* Stephensville Crossing, Harry's River, 5-6.VII.49 (CHL 70, EP 112); Steady Brook, Humber, 10.VII.49 (EP 136); Spruce Brook, 8-9.VII.49 (EP 125); Deer Lake, 31.V.51 (CHL 211).

Mulsantina hudsonica (Casey) 9 specimens.

Nova Scotia: Bridgewater, Crescent Beach, 19.V.51 (CHL 179).

Psyllobora vigintimaculata (Say) 10 specimens.

Newfoundland: *West.* Spruce Brook, 8-9.VII.49 (EP 125); Glenburnie, Bonne Bay, 19.VII.49 (EP 165).

Microweisea misella (Lec.) 1 specimen.

Newfoundland: *West.* Deer Lake, 31.V.51 (CHL 210).

Hyperaspis undulata (Say) 1 specimen.

Nova Scotia: Orangedale, 28.V.51 (CHL 202).

Hyperaspis novascotiae n.sp. 1 specimen.

Nova Scotia: Bridgewater, Crescent Beach, 19.V.51 (CHL 179).

Hyperaspis moerens (Lec.) 1 specimen.

Newfoundland: *Northwest.* Cooks Harbour, 16.VII.49 (CHL 97).

Scymnus (*Pullus*) *haemorrhous* Lec. 2 specimens.

Newfoundland: *Northeast.* Twillinggate, 4-8.VII.51 (CHL 277).

Nova Scotia: Halifax, Sackville, 20.V.51 (CHL 181).

Scymnus (*Nephus*) *ornatus* Lec. 5 specimens.

Newfoundland: *Northwest.* Cooks Harbour, 16.VII.49 (CHL 96,97); St. Pauls, 10.VIII.49 (CHL 134).

Scymnus (*Nephus*) *flavifrons* (Melsh.) 1 specimen.

Newfoundland: *Central.* Gaff Topsail, 19-20.VIII.49 (CHL 149).

MAGICICADA SEPTEMDECIM LINN., BROOD XI, IN CONNECTICUT (HEMIPTERA: CICADIDAE)

By J. A. Manter

Storrs, Connecticut

Brood XI of the periodical cicada made its scheduled appearance above ground during June 1954 in Connecticut. Only broods II and XI of this cicada occur in Connecticut. Brood XI in the past has been reported from scattered areas of Connecticut, Massachusetts, and Rhode Island but with only scanty records in recent years. Mr. George Dimmock observed the species in Suffield, Connecticut, in 1869 but could not find any 51 years later while visiting the same locality. The Hartford Courant, June 6, 1903, printed a letter from a correspondent describing the reappearance of "locusts" in a forest where "vast numbers" were seen in 1886 near the town of Willington. He wrote "The forest seems alive with this wonderful insect." A few local residents of the region recall hearing the cicadas in 1920, but entomologists apparently did not know of this colony and had no records of the Suffield colony since 1869.

In Massachusetts and Rhode Island Brood XI has apparently disappeared forever. Dr. Dow writes in the Bulletin of the New England Museum of Natural History, April, 1937, "though Dr. C. W. Johnson (1920) visited the locality in Rhode Island from which it was reported by Prof. A. S. Packard in 1903, he failed to discover any evidence that the cicadas had emerged." In the July number of the Bulletin, Dr. Dow reported, "The three localities in Rhode Island which had been recorded by Professor Packard in 1903 were visited by Dr. C. H. Blake and the writer on June 12, 1937. We failed to hear any cicadas or find any trace of them, and were likewise disappointed on the following day, in Suffield, Connecticut, though a map drawn by Mr. Dimmock guided us to the exact site of the former colony." From these unsuccessful attempts to locate colonies it seemed probable that brood XI had become extinct.

On June 16, 1937, Dr. W. E. Britton informed Dr. Dow that the writer had reported the emergence of the periodical cicada in East Willington, Connecticut. Dr. Dow visited the colony with the writer on June 20, and reported his observations in the Bulletin, July, 1937. The writer prepared a short article for the 37th Report of the Connecticut State Entomologist, Bul. 408, May, 1938.

From the records available it seemed probable that the East Willington colony was the last in existence of brood XI. So it was with great interest that I made several visits in 1954 to the site of the 1937 colony on the farm of Mrs. Mary Blahusiak. The area has remained in pasture and there appears to have been no great change in conditions, although it has been kept partially free of brush by the feeding of the pastured animals.

The first cicadas were found on June 10, 1954, in the same pasture area as observed in 1937. Several later visits were made until the cicadas disappeared. At no time did their numbers approach those of 1937. From casual observations it seems that the colony has been greatly reduced in individuals, although it extended over about the same area as in 1937.

During a visit later in the summer no evidence of egg laying or of subsequent wilting of twigs was found. This was quite surprising since the injured twigs caused by egg punctures were so very conspicuous in 1937. These observations lead to the conclusion that brood XI is approaching extinction and one wonders how many more times this remarkable species will make its reappearance in East Willington, Connecticut.

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