JOURNAL

OF THE

NEW YORK

ENTOMOLOGICAL SOCIETY

Devoted to Entomology in General

VOLUME LVI, 1948

PUBLISHED QUARTERLY BY THE SOCIETY
NORTH QUEEN ST. AND MCGOVERN AVE. LANCASTER, PA.
NEW YORK, N. Y.

BUSINESS PRESS, INC.
LANCASTER, PA.

CONTENTS OF VOLUME LVI

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Vol. LVI No. 1

MARCH, 1948

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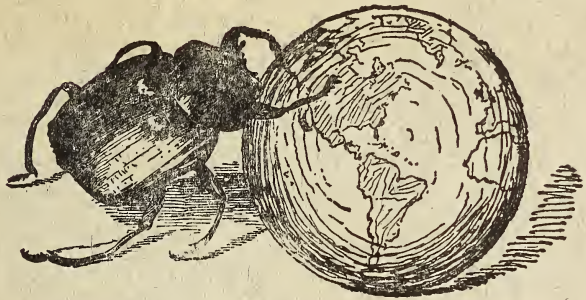

Edited by HARRY B. WEISS

Subscription $4.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1948

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NOTICE: Volume LV, Number 4, of the Journal of The New York Entomological Society was published on December 16, 1947.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

VOL. LVI MARCH, 1948 No. 1

A SECOND REVIEW OF MELINÆA AND MECHANITIS (LEPIDOPTERA, ITHOMIINÆ)

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Some years ago I published summary revisions of these two genera.[1] Since then considerable more material has been seen, and there has been a good deal of activity in the Ithomiinæ, which cannot be completely reviewed here; but the following notes appear of value to the writer. There has still been no line-breeding in either of the two genera, and we have no more knowledge than before as to the species or varietal status of many of the names: on the contrary some of the specimens showing intermediate patterns throw doubt on the analysis presented before without any indication of a better solution.

Indebtedness has as usual been too wide to acknowledge in full detail. It includes the plate of British Museum types, and further data on the types from N. D. Riley of the B.M., loans from Pittsburgh, the American Museum, the National Museum, Cambridge and Philadelphia, and from Dr. Pablo Anduze of material destined for the Museum of Natural History at Caracas; also courtesies at visits to most of the museums of the east, and to the British Museum, Tring and Oxford in England.

Melinæa

Within this period the following names have been added to our list.

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[1] Jour. N. Y. Ent. Soc., 32: 145–157, 1924; 35: 23–36, 1927.

agricola Hall, Ent., 68: 227, Pl. 6, fig. 6, 1935; from Ega. I have discussed this as a very striking race of *mneme* (*crameri*) (Bull. Ent. Ven., 1: 28, 1942).

aurantia Forbes, Bull. Ent. Ven., 1: 27, 1942. Venezuela, possibly Colombia. Also considered a striking race of *mneme* (Fig. 3).

borealis Hall, Ent., 68: 226. Venezuela. As described, a race of *mæonis* with areas across cell of fore wing and through cell of hind wing yellowish. From the locality this should be the same as the form considered *zamora* in my revision, but Hall does not mention the linear border of hind wing. Our specimen is from Mucuchachi, and may be considered a topotype.

eratosthenes Hall, Ent., 68: 227, pl. 6, fig. 5. French Guiana. I have discussed this very distinct species, which also occurs in Venezuelan Guiana, in Bull. Ent. Ven., 1: 26, 1942.

erica Bargmann, Ent. Anz., 9: 141, 1929. Rio Dagua, West Colombia. See below.

ezra Fox, Ent. News, 50: 72, 1939. See below.

incisa Kaye, Proc. Ent. Soc. London, 1925, xxiii. A variant of *mneme* (*crameri*) with the black of hind wing divided into two patches.

juruaënsis D'Almeida, Papeis Avulsos Dep. Zool. (S. Paulo, Brazil), 3: 165, 1943 (fig.). See below.

lateapicalis Hall, Ent., 68: 227, 1935. Mérida, Venezuela. See below.

limitata Hall, *l.c.* Synonym of *mneme sola* Kaye, which is a race of *lilis,* not *mneme.* See below.

lutzi Fox, Am. Mus. Novit., 1194: 1, fig. 2, 1942. A race of *lucifer* Bates, *nec auct.* (*l.c.,* fig. 1) from the Upper Marañon. See below.

purusana Riley, Ent., 52: 181, 1919 (*purusana* Aurivillius, Ent. Tid., 50: 155, 1929, *romani* Bryk) Rio Purus, Amazons. A race of *madeira,* with base of cell and cell Cu_1 solidly black, followed by deep red-brown, with little or no yellow scaling in cell Cu_1; but hind wing with black markings reduced. The Carnegie Museum series of this form is from Nova Olindia, Rio Purús.

rileyi Fox, Am. Mus. Novit., 1194: 3, 1942. Upper Amazon Basin. The form of *marsæus* commonly called *lucifer* on the basis of Staudinger's misdetermination.

romani Bryk, Lep. Cat., 80: 641, 1937. See *purusana.*

sola Kaye, Trans. Ent. Soc. London, 1924, 413; Mem. Dept. Agr. Trinidad and Tobago, 2: 16, pl. 1, fig. 5, as *tachypetis* in error. This has none of the special features of *mneme,* as described; I am treating it as a race of *lilis.* See below. *Limitata* Hall is the same form, described from Venezuela.

M. eratosthenes and the true *M. lucifer* show a feature that is otherwise unknown in the genus, namely a series of unpaired submarginal spots, which lie a little further basally than the usual paired ones, and in *eratosthenes* take the place of the usual subapical patch or bar. So they should be inserted in the key just after *egina,* in some such way as follows:

A$_2$. Fore wing with unpaired white or yellow submarginal spots.
  B. A complete series of five or six spots on fore wing, replacing the subapical bar, spots also present on hind wing ...... *eratosthenes.*
  BB. Two or three spots on fore wing only near middle of outer margin, and a large separate subapical patch .... *lucifer.*
    C. Light areas in end of discal cell, cell Cu$_1$ and submarginal spots largely yellow (Upper Marañon in Peru) .... *l. lutzi.*
    CC. These areas largely or wholly tawny (Upper Amazons in Brazil). *l. lucifer.*
AA$_2$. No unpaired submarginal spots.

Considering the wide variation in the genus it is really not impossible that lucifer and eratosthenes are subspecies of the same species, from the Amazon Basin and Guiana, respectively.

The name *purusana* was used twice in the genus, by Riley and Aurivillius; fortunately according to Fox (Ann. Carn. Mus., 29: 397, Pl. 1, fig. 1) they are the same form. The general effect is closely that of the Venezuela specimens I take to be *zamora* (presumably also *borealis* Hall), but the ground is much darker, the median band on hind wing is partly broken into spots, and the border a little broader.

On *macaria* and *egesta* G. & S., I have nothing to add to Fox (Am. Mus. Novit., 1941: 1) nor anything to say about *brunnea* and *strigilis,* omitted before from complete lack of data.

M. lilis. Additional material has given quite a different appearance to this species and a new key to races and forms is in order. Four of the names represent single small lots taken each on a single occasion: *erica, dodona, lateapicalis* and *ezra.* Of these, *ezra* is not from the Magdalena basin, as one might assume from the published locality, but the northwest corner of the Sierra Marta; *erica* takes an intermediate position between two main series of races, and as it should be, was taken in western Colombia. *Lateapicalis* may well represent a mere field-form, but the residue are well defined races, though the blend-zones are sometimes broad (as with *flavicans* and typical *imitata*).

A. Apical half of fore wing black, with the pm. and st. bands represented by series of white spots; tawny basal area extending broadly to inner margin.

  B. Hind wing with a longitudinal black median band .... *parallelis.*

  BB. Hind wing with only outer half of band visible .... *messatis.*

AA. Light portions of apical half of fore wing yellow; basal half with inner margin black, or at least a black band along anal vein.

  B. Outer margin of fore wing with conspicuous double white marginal dots.

    C. Outer part of wing with a continuous postmedial yellow band, at least down to vein M_2; inner margin of fore wing tawny at base (Rio Dagua, Col.) .... *erica.*

    CC. Postmedial fascia represented by four separate spots, as in *l. messatis;* inner margin broadly black (not seen) .... *dodona.*

  BB. Outer margin of fore wing above without marginal white dots, or at most with a few scattered ones (*lilis*); postmedial fascia continuous down to M_2 and almost always much farther; base of inner margin broadly and solidly blackish.

    C. Fore wing with yellow postmedial band broad and continuous, more than half as wide as distance from it to apex, broadly connected to the tawny base, the black at end of cell only extending a little below lower angle of cell (Venezuela and Trinidad). *sola* (*limitata, tachypetis*).

    CC. Fore wing with the black band across end of cell extending far out in cell M_3, cutting the postmedial fascia almost or quite completely off from the tawny basal area; pm. fascia narrow and often broken.

      D. Subapically with the pm. and st. spots of each cell fused into a long streak, except for a small black spot in cell R_5 (Mérida, Venezuela) .... *lateapicalis.*

      DD. Pm. fascia narrow and zigzag or interrupted, separated from the st. spots by an area which is black on costal half of wing, black or tawny on inner half.

        E. Fore wing with a continuous black stripe from base of costa, out through cell, and along upper side of Cu_1 half way or more to margin; apical markings of fore wing pure yellow.

F. Hind wing with a yellow median stripe, as in *M. ethra.* *flavicans.*
FF. Hind wing with ground concolorous tawny .... *imitata.*
EE. Fore wing with this stripe interrupted at lower angle of cell; yellow markings in apical area normally more or less edged or shaded with tawny.
F. Black bands across end of cell and between the postmedial and subterminal yellow spots, both interrupted with tawny submarginally, leaving only black marginal triangles (Santa Marta) .... *ezra.*
FF. Black bar across end of cell shortly interrupted in cell M_3 (type) or complete, the one between the pm. and st. yellow spots complete .... *lilis.*

Kaye's figure of *sola,* cited above, was published under the name of *tachypetis* in error, and I have seen material determined with that name. I can see no significant difference between it and a specimen from El Chorro, Sucre, Venezuela, which may be considered typical of *limitata.*

Bryk, in the Lep. Cat., missed the original description of *M. l. flavicans* Hoffmann. It was Rev. Mex. Biol., 4: 70, 1924. As Hoffmann reported it, it is definitely racial in the northern part of its range (which includes Nayarit), but appears further south as a casual variant. *M. l. erica* Bargmann is also imperfectly racial according to its describer. The single specimen I have seen is in the Rothschild collection, standing as *dodona,* which is really very close.

Under *Melinœa egina,* Tessman has described *manuelito,* as probably a race. I have seen it in the Rothschild collection, from the Rio Palcazú, and a transitional specimen in the Reading Museum from the R. Huallaga; and agree with Tessman, so in place of *paraiya* in my key there should stand:

C. Fore wing with a broad median yellow fascia across end of cell; only two postmedial yellow spots, the middle one being missing (S. Brazil) .... *e. paraiya.*
CC. Fore wing tawny medially with only a slight paler shade at the outer end; three pm. spots, as in typical *egina;* last two spots on hind wing placed transversely (Peru) .... *e. manuelito.*

The Reading Museum specimen of *manuelito* has the proper black pattern, but the yellow postmedial fascia of the fore wing is preserved.

Melinæa mænius. While in its normal condition this appears to be a quite distinct species from *menophilus,* being somewhat larger as well as having a different comma-mark, the Reading Museum has every possible intergrade in a series of specimens with the typical *menophilus* coloring, finally with the exact pattern of *mænius chincha,* but the yellow pm. band of *menophilus.* One specimen at Cornell is exactly of this type, and was taken at Chuchurras, not far from Pozuzo, Peru, the type locality of *chincha.* The question what constitutes a species becomes more difficult than ever.

M. menophilus. In the key, instead of *zaneka* should be substituted:

B. . . . , or with limited and diffuse median spots.
  C. Fore wing with yellow pm. fascia.
    D. Black of inner margin of fore wing a narrow streak a little back from margin; hind wing without median spots .... *zaneka.*
    DD. A very heavy black fascia along inner margin of fore wing, hind wing with four diffuse black spots .... *juruaënsis.*
  CC. Fore wing without yellow markings; with heavy fascia like *juruaënsis;* hind wing without spots .... *clara.*

Melinæa **isocomma,** new species (Fig. 2; holotype)

Closely related to *M. comma* Fbs., but with the size and coloring of *M. menophilus messenina.* Male fore tibio-tarsus slightly more than half as long as femur plus trochanter (equal to the longest condition in *M. comma,* much longer than in *egina*). Friction area on fore wing above A with narrow hair-scales, like *messenina,* etc., unlike *comma.* Male genitalia normal.

Head and body pattern normal, the present specimen with tawny only on collar, sides of tegulæ and a slight shade on posterior face of thorax, but probably variable, as in other species of Melinæa. Yellow middorsal line and line across back of mesothorax stronger than in *messenina* specimens with an equal amount of black on wings.

Fore wing above black at base to a third way out near costa, a little beyond fork of Cu along lower side of cell and to two-thirds on inner margin; vein R tawny and with long pointed extensions of the tawny extending nearly to base along costa and Cu. Median area light tawny (the same color as *menophilus,* etc.), out as far as the cell spots, vein Cu_1 and the comma-mark; marked by a black spot over fork of R_1 which is narrowly outlined with tawny, a spot over the lower discocellular vein, filling lower angle of cell, and a rather rounded spot in the fork of Cu, not filling the angle. Comma-mark with its upper end tangent to Cu_1, definitely diverging from it to outer margin, and leaving a full quarter of that cell yellow at outer margin (unlike all other Melinæas at hand), the inner and marginal portions connected at their upper edges by a fine and faint black line. Marginal patch smallish, subtriangular, *separated from margin* except at its upper end by a tawny stripe, not nearly reaching up to Cu_1, nor quite down to Cu_2. Tawny area reaching outer margin, except for the black terminal line down to the fold, and black fringe; even the latter being interrupted with tawny at anal angle (unlike *M. comma,* where it is continuous). Yellow postmedial fascia wide, more than half as wide as the following apical black area, and hardly narrowing to the outer margin, its inner boundary normal, but its outer boundary toothed out on R_1 and Rs, squarely lobed on M_1, with a rounded extension on M_2, and with a long tooth reaching far toward margin on M_3 (the last unlike all other Melinæas, but perhaps not a trustworthy character). Terminal end of fascia separated from margin only by a narrow black terminal line, for some distance both above and below Cu_1, therefore ending squarely, unlike all other Melinæas at hand. Apex solid black. Hind wing brown-black; costal area dirty gray-brown, costal pencils cream; a small tawny apical patch with irregular but generally erect inner boundary from costal area to tip of Cu_1, continued as a fine terminal line halfway to Cu_2, and interrupted by a small black spot in tip of cell M_1. Fringe all black.

Under side approximately as above, fore wing with the comma-mark with even less black; inner margin below Cu and Cu_2 light tawny, but with a blackish streak along base of Cu. Hind wing with apical patch continued narrowly along costa toward base, then widened and overlaid with yellow on basal quarter, the small black apical spot covering cell R as well as M_1. Expanse 87 mm.

Upper Rio Negro in Colombia (Fassl); 1 male holotype in collection of Cornell University. The specimen is labelled 800 M., but the greatest height shown in that part of Colombia on the

''Millionth'' map is 700 M., and the highest near the Rio Negro 300 M., or less. I think I have seen other specimens with nearer the *chincha* coloring, but have no notes.

In my key the species will run to *comma* on the shape of the comma-mark, length of fore tibia and marginal tawny in cell Cu_1 of fore wing; but the pattern is entirely different from our series. The specimen figured by Poulton from the Oxford collection, Trans. Ent. Soc. London, 1908, Pl. 33, fig. 1, should be examined. It is of the purely black and red *mothone* coloring. This form may possibly be a hybrid of *comma* and *messenina*. *M. isocomma* and *comma* may be separated in the key as follows:

C. Smaller (expanse 3 in.); yellow or possibly tawny area preceding the black apex toothed out slightly on M_3, ending roundly along Cu_1; tawny area at tip of cell Cu_1 below enclosed in black; anal fringe black (Fig. 1) .... *comma.*

CC. Larger ($3\frac{1}{4}$ in.); yellow preceding the black apex toothed out almost to margin along M_3, ending squarely and separated from margin by only a black line both sides of vein Cu_1; tawny area at tip of cell Cu_1 broadly connected below with the tawny ground; fringe cut with tawny at anal angle (Fig. 2) .... *isocomma.*

The preceding notes by no means exhaust the possibilities of variation in the genus, and the following further oddities may be cited from the Cornell collection.

In the *M. mneme* complex, Fleming of the Tropical Research Station has taken several more specimens of *aurantia* at Caripito, Venezuela, and finds an occasional specimen transitional to typical *mneme.* The most striking, now in our collection, has gone about half way to *mneme,* having the apical border of fore wing solid black, the postmedial area black with only subordinate brown scaling, and the black of hind wing extended to cover about half the area, including broad stripes in the costal part of the discal cell and cell M_1. Another interesting intermediate comes from the Fassl collection; it was taken on the Rio Songo, Bolivia, along with normal *satevis,* but is much paler though without any more yellowish tint, and the yellow pm. band obliterated by the light reddish ground; the black pattern is quite normal for *satevis.*

A specimen—also from the Fassl collection—was taken at Villavicenzio, E. Colombia. It agrees with the telegraphic description of *macaria* G. & S., described from the same region, but shows the hook in cell Cu_1 of fore wing crossing the vein, and so should fall to *marsœus* rather than *menophilus.* We obviously need a redescription or figure of the type. If this is really *marsœus,* the key to the forms of the latter species should be modified as follows; in place of the misdetermined *"lucifer":*

C. Postmedial area tawny; subapical patch large and contrasting (yellow), of four fused spots .... *m. rileyi* Fox (*lucifer*‡).
CC. A contrasting yellow postmedial fascia; the subapical spots only three, and the two lower small, the last in our specimen visible only below .... *m. macaria* (supposition).

Another specimen from the Rio Madre de Dios in southern Peru shows the fore wing pattern of *marsœus,* but wholly lacks yellow, the basal two-thirds of the fore wing being black on an even tawny ground, and the apical third solid black; while the hind wing is wholly tawny except the usual blackish shading below the costa and a fine black fringe.

It has not been noted, I think, that the sex-tuftings on the costal area of the hind wing above show some variation in this genus. In the normal group they are so variable individually as to give little help in identifying species, but *eratosthenes* and *comma* stand out in the very small first pencil, with the second starting much nearer the base than usual in *eratosthenes,* actually before the point of origin of Cu_2. In the other species, even *egina,* tendencies are shown at most. Our specimen of *borealis* shows much more space between the two pencils than the other *maëlus* specimens, which rather consistently have a moderate first pencil, with only a short gap beyond it; the *lilis* complex also fall rather definitely into two groups, the first pencil being much more massive and second further out in *messatis* and *parallelis* than the more northern types, while *scylax* stands between them. The most variable species, to judge by present specimens is *menophilus,* the most constant (of which more than two specimens were examined), *maëlus.*

The development of the male fore leg is equally variable, and further shows frequent asymmetry. Here it is *egina* which shows the most constant difference, the fore tibio-tarsus being only about one-fourth as long as the femur with trochanter; *comma* comes next, with the tibio-tarsus from half to two-thirds as long, while it is longer in the residue; but occasional specimens show very short tibiæ on one or both sides, and one *idæ* actually matches the shortest *comma.* The single specimens of *eratosthenes* and *isocomma* agree with the longest *comma,* but are matched by one *menophilus* as well as the *idæ* just mentioned, and approached by several more. The most striking case of asymmetry was a *mœnius chincha,* with the femur twice as long on one side as the other, but somewhat less difference in the tibio-tarsi. The character may be of some use in separating *mœnius* and *menophilus,* which generally have fore femora-trochanters shorter and longer than 0.046 length of fore wing, respectively.

The third neglected character is the scaling of the friction area on the under side of the fore wing above A. In most of the species this area is clothed with slender deciduous hair-scales, which are lost, exposing the glossy membrane, in somewhat rubbed specimens; but in *comma* and *eratosthenes* the scales are broader, more firmly attached, and match the yellow or tawny general wing surface in color. *M. egina* has dense scaling like the rest of the wing, with both under- and overscaling; but *menophilus* and *isocomma* have the fine-spaced deciduous hair-scales.

Mechanitis

In this genus most of the new data are on local variation in the *polymnia* complex. Longer series have given a better idea of the racial pattern, but some intermediates have appeared that can hardly be placed in any workable key. The following names come under consideration, partly recent, and partly which I was unable to place when the first paper was written:

angustifascia Talbot, Trans. Ent. Soc. London, 76: 411, etc., Pl. 14, figs. 7, 16; 16, figs. 4, 7, 1928. An isolated colony nearest *p. polymnia,* with the black costal stripe on hind wing below much narrower. Rio Serragem, Matto Grosso.

argentea Prüffer, Tow. nauk. Warsz., Arch. nauk. biol., 1(2): 5, pl. 2, fig. 3 (not no. 1 as stated in Bryk, but no. 2). Peru. A variant of *eurydice,* lacking yellow on the hind wing like most specimens of *eurydice* from the limits of its distribution (Coroico, Bolivia, and La Chorrera, Rio Putumayo), but with distinct white marginal spots, as freqently in the Chanchamayo. Type locality the Marañon above Iquitos. The relationships between these northern *eurydice* forms and the *doryssides* of the vicinity of Iquitos are worth study.

blissi Fox, Sci. Publ. Reading Mus., 4: 26, 1942. A Central American race of *macrinus,* almost completely lacking the yellow postmedial fascia.

californica Reakirt. I cannot see any validity to this name, which is based on typical *isthmia.*

connectens Talbot, Trans, Ent. Soc. London, 76: 412, etc., Pl. 14, fig. 8; 16, figs. 2, 8. Rio Serragem, Matto Grosso, with *angustifascia.* A form of *elisa* with the yellow spot in Cu_1 large, crossing vein Cu_2 and resting solidly on the discal cell like *ocona,* but without the oblique pm. streak which is always present in male *ocona.*

contracta Riley, Entomologist, 52: 182, 1919 (figs. 14, 15, types). Rio Purus. Close to *egaënsis* Bates, but differing in the subapical band being clear yellow without reddish, and narrow border of hind wing. Rio Purús.

egaënsis Bates, Trans. (not Proc.) Linn. Soc. London, 23: 531, pl. 56, fig. 7a. This name was based on an array of specimens from Ega (approximately modern Teffé). His typical lot were very dark, wine-colored, and not very distinct from what Butler afterward described as *obscura* (figs. 16, 17, types). His var. no. 1 was described as paler and yellower, with markings more like *polymnia,* and therefore quite unlike the specimens which Butler considered to be number 1 and named *obscura.* His number 2, of course belongs to *olivencia.*

elevata Riley, Entomologist, 52: 182, 1919 (figs. 12, 13, types). This was taken with *contracta* and raises a problem, since it would generally be considered a separate race of *mazæus,* and in fact similar specimens occur rather widely outside the area of wine-colored and red-brown forms. We have it from Teffé, where again it occurs with the wine-colored *egaënsis.*

escalantei Hoffman, Anales Inst. biol. Mexico (Univ. nacional), 11: 636 (with figure). An aberration of *doryssus saturata* with the apical half of wing almost solid black, containing two postmedial and the subapical yellow spots. (Guerrero, Mexico.)

extrema Hoffman, *l.c.* (with figure). An aberration of *doryssus* with the comma-mark and spot in base of cell Cu_1 absent, leaving the whole area between the cell and the black marginal markings tawny. (Southern Chiapas.)

forbesi Bryk, Lep. Cat., 80: 491, 641 (not in index). A pure synonym of *limnœa* Fbs.

limnœa Forbes, Jour. N. Y. Ent. Soc., 38: 317. See below.

obscura Butler, Cist. Ent., 2: 149. (Figs. 16, 17, types.) Stated to be a new name for *egaënsis* var. 1 Bates, Tr. Linn. Soc. 23: 531, but as shown by the types much more nearly representing dark specimens of the typical race.

ovata Distant, Pr. Ent. Soc. London, 1876: 11. Kept as a Costa Rica race by Bryk, but there is every reason to consider it a mere synonym of *lycidice,* following Godman and Salvin.

peruana Hopffer, Stett. Ent. Zeit., 40: 419. Tawny area in disc of hind wing narrow and yellow edged with tawny, instead of broad and tawny. A mere variant of *menapis,* which we have from Colombia with both the *franis* and *menapis* type of border.

plagigera Butler, Cist. Ent., 2: 150. One of the chestnut Amazon forms, the description totally inadequate to place it in *polymnia* or *mazœus.*

septentrionalis Apolinar. Placed with *egaënsis.* Fox informs me this is an earlier name for *caucaënsis.*

sylvanoides Godman and Salvin, Trans. Ent. Soc., 1898: 110. Listed by Bryk as distinct, but clearly a pure synonym of *equicola* as noted by d'Almeida in Lambill. 39: 81. Both are from Guiana, not Ega as stated by Bryk.

visenda Butler, Cist. Ent., 2: 150 (fig. 11, type). See below.

werneri Hering, Iris, 39: 188. The West Colombian representative of the normal group, discussed under *mazœus.*

williamsi Fox, Sci. Pub. Reading Public Mus., 2: 6, 194. A *mazœus* race from northeastern Peru. See below.

I now have the female of *equicola,* and have examined that of *proceris* in the British Museum; both have the long-stalked R and M_1 in the hind wing, like the species I called *truncata* (which I should have called *olivencia,* since Bates's second form of "*polymnia*" definitely belongs to this species). Alternative 5 of my key should be recast, since the distinctive Upper Amazon ground color is the best character to use. Read in place of the second alternative 5:

5. Postmedial area of fore wing wholly brown or tawny or with a little yellow toward costa .... 5½.
5½. Ground color deep red-brown .... *o. olivencia.*
5½. Ground color bright tawny .... *o. huallaga.*

Our normally colored *o. huallaga* is from southern Peru; a specimen from the Ucuyali (received as *fallax*) is a general intermediate, with the ground tawny like *huallaga* and *truncata,* but appearing extensively in the apical area, like *olivencia,* the postmedial area rather heavily shaded with yellow (without a clearly defined yellow area) and the median band of hind wing broad and even, instead of narrow and waved or absent.

M. proceris. The male genitalia are like those of *olivencia;* also barely distinct from the normal group.

M. polymnia. Additional material of this species and the *mazœus* complex, among them a block of *caucaënsis* from the Fassl collection, make the definition of this species more difficult than ever, yet there are enough places where members of both these complexes are found side by side (see maps), to indicate pretty strongly that there are really two species. The localities from which I have examined pairs of populations that appear to belong to these two species are Venezuelan Guiana, the Tumatumari in British Guiana, Paramaribo in Dutch Guiana, and the lower Maroni in French Guiana, also several points on the middle and lower Amazon. In northern Venezuela a block of specimens from the State of Sucre (Fig. 5) plainly belong to a distinct race of *polymnia,* while a colony from Caripito in the plains a short distance south, as obviously belong to *mazœus* (Fig. 6; near *m. elevata*), and the two colonies may very probably overlap. The dominant Mechanitis in northern Venezuela is of course a race of *doryssus,* which also reaches Trinidad. From the eastern slopes of the Andes I have only seen *mazœus* types, usually coëxisting in any given place with a colony of *doryssus* or *doryssides;* but the three forms seen from the western Andes are unique: *chimborazona,* from western Ecuador has the pattern of *polymnia,* while *werneri* from western Colombia comes closer to *mazœus;* both have lost the median band of the hind wing on the under side and upper side of the female, like *macrinus* from the same area, and many specimens of *lycidice* (and *isthmia*) from a little further north. It looks as if there must have been some interbreeding and transfer of genes, if not an actual break-down of the species character. The Cauca Valley race (*septentrionalis, i.e., caucaënsis*) goes in another direction. By the black pattern it also suggests *mazæus* more than *polymnia,* but has almost the deep coloring of a middle Amazon race.

To fill out the picture of *polymnia,* alternatives 10 and 11 of the key should be replaced by the following:

10. Hind wing on both sides in female and under side in male with the postmedial band reduced to a fragment, or lost, but broad on upper side in male .... 10a.

10. Hind wing with black medial band as strong below as above and alike in both sexes; yellow pm. band of fore wing about as broad at margin as at end of cell .... 11.

10a. Two small well separated black spots at end of cells; pm. band much narrowed toward inner margin (Western Ecuador). *p. chimborazona.*

10a. A heavy black bar at end of cell; pm. band not narrowed at inner margin (western Colombia) .... *m. werneri.*

11.[2] Yellow postmedial fascia of fore wing very broad, extending ⅖ way to apex and filling the whole width of cell M_3 toward outer margin; subterminal band strong, partly tawny (NE. Venezuela) (Fig. 5). new race *solaria.*

11. Yellow pm. fascia of fore wing extending only ⅓ way to apex, rounded off below and not nearly filling width of cell M_3, subterminal fascia weaker or obsolete .... 11a.

11a. Median black band of hind wing narrower and waved, fore wing with cell Cu_1 practically solid tawny and black; costal stripe of hind wing below narrow .... *p. angustifascia.*

11a. Median band of hind wing more weakly scalloped across the two uppermost cells only, stripe of hind wing typically broad .... 11b.

11b. Outer third of discal cell largely tawny, cell Cu_1 normally wholly tawny, ground color somewhat deeper tawny (Middle Amazons) (Fig. 4). *p. mauensis.*

11b. Outer third of discal cell almost wholly yellow, cell Cu_1 heavily shaded with yellow, the tawny ground paler .... 12.

Another character of considerable racial significance is the black at end of cell; typically there are two separate spots—one out of fourteen from British and French Guiana with the bar, two out of ten from southeastern Venezeuela, three out of ten

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[2] *M. m. septentrionalis* may run here; the ground is red-brown, unlike any of the forms of polymnia.

mauensis (all male), one male out of eleven from the Lower Amazon, but half the females—while all the specimens from southern Brazil, also the three specimens figured by Talbot of *p. angustifascia* and most of the types of *solaria* have the complete bar. The only specimen here of *chimborazona* has well separated spots. The single specimen at hand labelled Trinidad (Busck) has a bar, though it is otherwise normal *p. polymnia;* one would have rather expected *solaria* in Trinidad, since its special model, *sola,* occurs there.

Mechanitis polymnia **solaria**, new race (Fig. 5)

Similar to *M. p. polymnia;* postmedial yellow fascia much broader, mimicking *Melinœa sola;* no yellow in cell or only a little scaling, the median yellow showing mainly as a bar on costa; median black spot in cell large and triangular, unlike most specimens of other races; bar at end of cell complete or very shortly interrupted; subterminal yellow band strong, almost as wide as the following black marginal area, often continuous from just below costa to M_2, but then curving around parallel to the margin below, even on under side, not approximate to margin as usually in *M. m. beebei,* yellow, only narrowly edged with tawny. Expanse ♂ 66, ♀ 76 mm.

El Chorro, Sucre, Venezuela (Anduze) ♂ holotype June 27, ♀ allotype June 23, 1937, in coll. Cornell University; Cumanacoa and Elvecia, near Mt. Turumquire, Sucre (G. Netting), female paratypes in Carnegie Museum.

M. polymnia **mauensis**, new race (Fig. 4)

Similar to typical *polymnia,* but apparently slightly broader-winged; the tawny ground a shade brighter, and the yellow limited to a postmedian band, there being only a moderate amount in end of cell and none in cell Cu_1. Two separate spots at end of cell except in three males (including the paratype figured).

I have suspected this was the *egaënsis* var. 1 of Bates (not Butler) and from the very brief description had imagined it might also be the *visenda* of Butler, but the type of the latter (Fig. 11) is a much paler *mazœus* form.

Santarem, Amazons, Brazil, Jan., Feb., 1938, male type and five male and one female paratypes; Maués, June, 1937, one female; Centenario, near Maués, August, 1937, one male; all collected by Wucherpfennig, also one from Staudinger and Bang-

Haas, received without locality, but most probably from Santarem; Teffé, Dec. 18, 1919, one female (Carnegie Museum).

Mechanitis mazæus

Variation in this species is becoming clearer with additional material, and shows the complexity so frequent in South American butterflies belonging to mimetic associations; while variation is chiefly racial, there is always among specimens with the normal coloring of any race, a proportion far from their proper area, especially in the case of the more striking types, so that the distinction of race and dimorphic form becomes nearly meaningless. For instance the *messenoides* coloring (black base and apex of fore wing and hind wing, with half tawny and half yellow median area) is before me from eastern Colombia close to the Cordillera, from far away on the Upper Rio Negro, and also Bolivia, in several specimens each, besides a single specimen from French Guiana; while other color forms occur in each of these localities. The chestnut coloring makes a pretty clear patch on the middle Amazon, but Wucherpfennig also took examples of the bright tawny coloring at Teffé, in the heart of the chestnut area, and Riley's *elevata* and *contracta* occur together on the Rio Purús.

The following revised key (beginning at no. 13 of the old key) includes all the forms credited to *mazæus* by Bryk, except *nesæa*, which is really a race of *lysimnia*.

13. Fore wing with ground tawny or red-brown to base, at least in cell ...... 14.
13. Fore wing with base solid black, or at most with slight reddish streaks, hind wing all black except apex ...... 18l.
14. Fore wing with ground of medial and postmedial areas all or nearly all tawny or brown, the subterminal band sometimes yellow.
14. Fore wing with a yellow postmedial band or a larger yellow area ...... 18a.
15. Apical part of fore wing solid black; the bands of hind wing either separate or fused ...... *m. nigroapicalis.*
15. A distinct yellow or tawny subapical band ...... 16.
16. Subapical marking a large patch, much wider than the preceding and following black ...... 17.
16. Subapical marking a narrow band, much narrower than the preceding and following black areas ...... 18.
17. Subterminal band dominantly yellow, the pm. area with considerable yellow scaling though no complete yellow band ...... *m. lucifera.*
17. Subterminal and postmedial areas both wholly tawny ...... *m. phasianita.*

18. Subapical band connected or nearly connected with postmedial by tawny suffusion along the outer margin, at least beneath; hind wing in male with black border fading out to apex, in female with long black streaks only in cells Cu_1 and Cu .... *m. jurimaguensis.*

18. Subapical band ending abruptly both above and beneath, usually at vein M_3 or higher; border of hind wing in male continuous to apex, and enclosing white spots there, in female with a long streak in cell M_3 as well as below Cu_1 .... *m. mazæus.*

18a. Hind wing below in male and on both sides in female lacking the median black stripe, with only a short fragment outward .... *m. werneri.*

18a. Median stripe of hind wing strong in both sexes above and below .... 18b.

18b. Yellow area of fore wing large, covering outer third of discal cell and heavily shading area Cu_1 before the comma, strongly contrasting with the deep brown or mahogany general ground .... 18c.

18b. Yellow in the form of a postmedial band, with only slight shading in outer part of cell, and not dominant in cell Cu_1; more extended in some light tawny specimens, but not contrasting .... 18d.

18c. Ground rather lighter; black mark at end of cell in the form of two separate spots .... *m. septentrionalis* (*caucaënsis*).

18c. Ground very deep mahogany brown; bar at end of cell complete; or the lower spot very large, 5 mm. long (Fig. 9) .... *Madeira race.*

18d. Ground chestnut or mahogany brown .... 18e.

18d. Ground tawny .... 18f.

18e. Subapical bar wholly yellow, contrasting (Figs. 14, 15, types). *contracta.*

18e. Subapical bar shaded with red-brown (Figs. 16, 17, types of *obscura*). *m. egaënsis* (*obscura*).

18f. Black spot at lower angle of cell and spot in cell, both small, at most 2 mm. in diameter, the spot at upper angle of cell small or obsolete; postmedial band very broad, extending $\frac{2}{5}$ way to apex but without an extension in cell M_3 .... 18g.

18f. Spots in cell much larger, and almost always black at upper angle of cell also, yellow band narrower, or less often much extended in cell M_1 .... 18h.

18g. Five small black spots in disc, representing the one in cell, costal spot and spot at lower angle of cell, and apex of "comma-mark" (Fig. 11, type) .... *m. visenda.*

——. Only two small black spots on disc, the ones in and at lower angle of cell—the costal one at end of cell being vestigial or absent, and the comma mark fully developed (Fig. 7) .... *m. bipuncta.*

18h. Subterminal bar solid tawny, contrasting with the yellow postmedial band .... *m. williamsi.*

18h. Subterminal band wholly or largely yellow .... 18i.

18i. Hind wing with marginal series of black patches when conspicuous strong toward inner margin above, sometimes fused with median series, but leaving distal part of wing clear tawny, with only a black terminal line (beneath much less developed and separate, when present at all) ..... *m. fallax*

18i. Hind wing marginal markings in male short, and almost always present at apex, where they often enclose white spots, in female elongate, but not invariably joining the median series unless the black at apex is heavy; about as well developed below as above ..... 18j.

18j. Subapical bar wholly yellow (a single exception at hand), rarely extending below M$_2$; hind wing with black very heavy, the median and marginal bands usually fused, and the median when free extending heavily to inner margin (Fig. 10, type) ..... *m. pannifera.*

18j. Subapical bar partly tawny at least below; hind wing with marginal and median black well separated, the median when broadened sharply narrowing or obsolete to inner margin ..... 18k.

18k. Median band of hind wing rather even in width, reaching practically to inner margin, and not much narrowed below Cu$_2$; subapical bar on under side so far as examined suffusing out to outer margin below, enclosing the white marginal spots, and leaving only fine black terminal line and outlines (Figs. 12, 13, types) ..... *m. elevata.*

18k. Median band on hind wing patch-like, especially in female, where it ends abruptly or is very weak below 2d A (Fig. 6) ..... *m. beebei.*

18l. Fore wing with a yellow postmedial fascia ..... *m. messenoides.*

18l. Fore wing all black and reddish ..... *m. deceptus.*

The pattern formed by these (and more) races and forms is a curious double one. In the case of the types with normal *Mechanitis* coloring the variation seems local, but so subdivided that the majority of types are represented by single spots; only *pannifera* and *fallax* have wide distributions. On the other side the forms that are dominantly red (with little or no yellow) or black (with or without yellow) form a belt along the eastern foothills of the Andes from Colombia to Bolivia, extending out on the Amazonian plain as far as it remains hilly and well-drained (to La Chorrera in the Putumayo Valley, and to the extreme southeast corner of Colombia on the Rio Negro). I have a single specimen also of normal *mazæus* from Caripito, Venezuela, taken with the block of *beebei,* and a totally normal *messenoides* labelled French Guiana. Where these specimens come from the same localities as tricolored forms they may show a slight flavor of the special local pattern (*e.g.,* the Caripito specimen) or not. From the Chanchamayo south I have seen only these bicolored types.

Mechanitis mazæus **beebei**, new race (Fig. 6, paratype)

Ground pale tawny, about like *fallax,* paler than most races of *mazæus.* Postmedial band yellow, tending to shade into the tawny base, with a little yellow scaling in outer part of cell, but usually none in the middle part of cell Cu_1; subterminal fascia yellow, shaded with orange in varying proportion. Black pattern on fore wing somewhat reduced; the spot in cell small and round, two well separated spots at end of cell, spot in base of cell Cu_1 small, though triangular. Subapical band rather large, slightly diffuse, about as wide as the following but much narrower than the preceding black bands, generally extending below vein M_2, often to vein M_3, but tapering off and curving around, not very close to the margin. Black streak along base of A strong, usually more than twice as wide as the tawny stripe on inner margin. Hind wing tawny, without yellow in cell; the median black stripe very thick, much wider than the following tawny band, widest from M_2 to Cu_2, in the male gradually tapering from Cu_2 to inner margin, which it almost reaches, in the female much reduced beyond Cu_2 or even absent, most often represented by two or three small shade-spots. Border narrow, roughly a third as wide as median stripe in male; in female wider, though hardly as wide as the preceding tawny band, and deeply toothed between veins, but with no tendency to fuse with the median stripe. Under side similar, the subapical stripe of fore wing larger, often indented by the black areas around the marginal white dots, but usually leaving a distinct black terminal line about 1 mm. wide; hind wing with marginal black nearly divided into triangles in both sexes, enclosing conspicuous white dots, not nearly meeting the median band, which is also more dentate than above.

The short oval median stripe of hind wing above will distinguish this race from all others, and with the general light color makes it a mimic of the local *Melinœa m. aurantia,* though not as a rule so extreme. Closest to it is a population from the vicinity of the Huallaga basin in Peru (south of *williamsi* but overlapping with it) in which the banding of the hind wing is more normal and the tawny apical stripe below is wider, normally resting on the margin, leaving only a black fringe.

Caripito, Monagas, Venezuela, holotype March 15, 1942 (Beebe and Fleming), 12 paratypes May, 1937 (Anduze), and March to May, 1942 (Beebe and Fleming), also in the Museum of Natural History, Caracas.

M. mazœus **bipuncta,** new race (Fig. 7, holotype)

Fore wing with base and inner margin light tawny out to end of cell and up to the comma mark; pm. area clear yellow, unusually broad, extending two-fifths way from end of cell to apex, its outer end nearly confined to cell M_3, but extending somewhat across vein Cu_1 to the comma mark; black spot in outer part of cell small and rounded, at end of cell small, at lower angle; the usual spot at upper angle represented by a shade of deeper tawny which may contain a small black spot wholly above the cell; no spot in base of cell Cu_1; comma mark moderately heavy, a good-sized round spot, connected by a black band above its middle to the black border, as most usual in mazæus forms. Apex black with well marked, almost wholly yellow subapical stripe. Stripe on inner margin moderate, even to two-thirds wing, leaving a narrower tawny inner margin. Hind wing tawny, the usual median stripe and border about equally wide, and separated by a waved tawny stripe about half as wide. Under side similar with large white marginal spots on both wings; fore wing with subapical stripe stronger and more tawny, spot in cell larger, and more or less traces of the spot in base of cell Cu_1; hind wing with a strong black costal stripe. 65 mm.

Surukum Basin, Upper Caroni River, Venezuelan Guiana, December, 1941 (Pablo Anduze), five females in Cornell University collection. The small size and peculiar pattern indicates that the local model is probably the local *Ceratinia mutilla* strain, which was much commoner than either the local *M. polymnia* or itself. A single specimen of *M. m. pannifera* was also taken, but perhaps not at the identical spot. This race is nearest *visenda,* from south of the Amazon, but easily distinguished by the lack of the costal spot and spot in cell Cu_1, and much larger comma-mark.

M. limnæa Forbes (Fig. 8, holotype)

This tiny species really is very close to *polymnia* in most ways, though it has a distinctive look. The best distinguishing character is probably the combination of a very heavy bar or spots at end of cell with the extreme reduction or absence of the spot in the cell. *M. mazæus bipuncta* looks at first glance the same, but in it the black at end of cell is also reduced, and the border of hind wing shows the extensions between the veins distinctive of *mazæus,* while it is narrow on both sides in *limnæa.* It should be taken out in the key at alternative 7 by these characters. *M. forbesi* Bryk is a plain synonym of *limnæa,* since the specimen discussed in my first paper under *mantineus* was made one of the types of *limnæa.* The holotype, by the way, was male.

M. m. elevatus Riley (Figs. 12, 13, types). We have a fairly typical pair from Teffé, and specimens transitional to *williamsi* Fox from Oxapampa and Chuchurras, eastern Peru.

A Colombian specimen in the National Museum, without exact locality, suggests hybridism, perhaps of *polymnia* with *lycidice.* It would key to *veritabilis,* having the tawny anal area connected to the basal tawny, but the bar at end of cell joined to the comma mark into a solid black fascia, and the antennæ largely black.

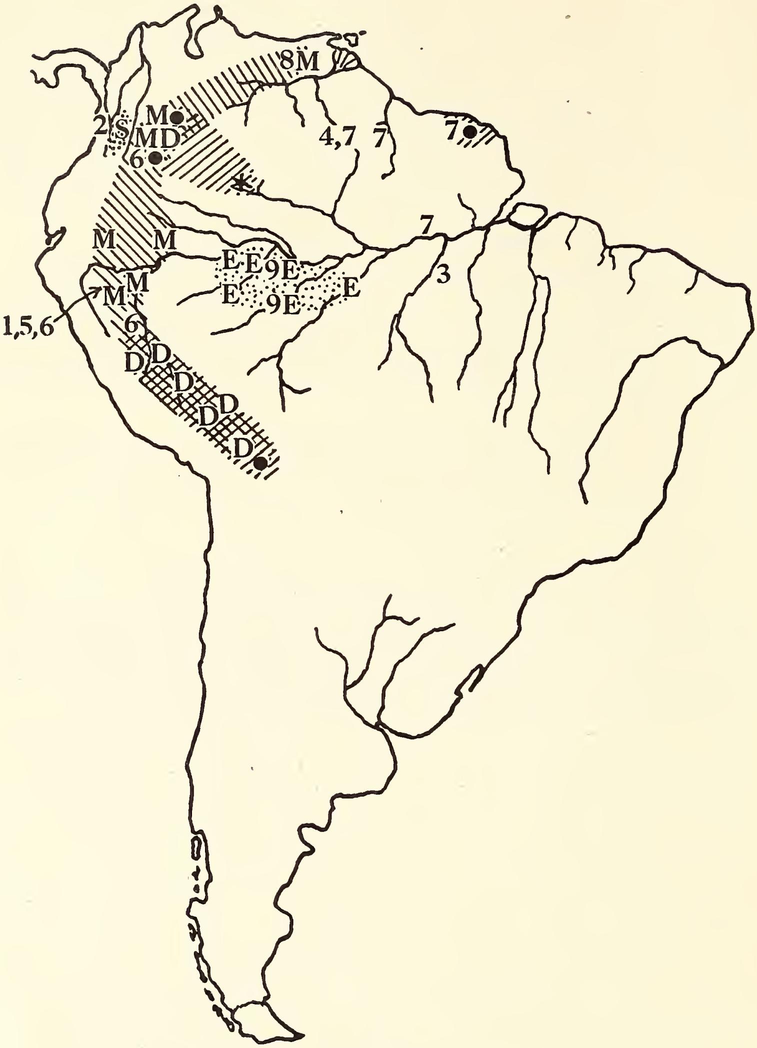
But the postmedial band is much wider toward outer margin than in any form except *solaria,* covering half of cell M_2 as well as the whole of cell M_3. In contrast the costal half of the band is not widened. The black median band on hind wing is widened, above, like *mazœus* and *lycidice* forms, but much reduced below (like *lycidice,* but not *mazœus* or *polymnia,* etc.) and there is no apical tawny below. The habitus is most suggestive of *lycidice,* but I have never seen a specimen with so little black.

We may also note the following corrections in Bryk's catalogue:

Under *Melinœa brunnea, purusana, Mechanitis elevata, contracta, Hypothyris wickhami, clara, medea* and *virgilini* and *Hyaliris flavigera,* the volume number in the Riley reference should be 52, not 32.

P. 488, under *isthmia,* reduce *californica* to a pure synonym. The specimens were doubtless collected in Panama by some traveller in the days when that was the comfortable way to go to California.

P. 494. *M. p. nesœa* Hübner. Transfer to *lycidice* on p. 490, where the name will combine with *nessœa* Haensch. I find this method of listing minor misprints and emendations of names as separate entries extremely confusing; and in this particular case it was evidently too confusing for Bryk himself.



MAP 1. Distribution of *M. mazœus* forms

Shading slanting down: bicolored races: D, *deceptus* and *nigroapicalis;* M, *mazœus* and *jurimaguensis.*

Shading slanting up: races with solid black apical area: D, *deceptus* and *nigroapiculis;* ●, ∗ *messenoides.*

Stippling: races with darkened ground: S, *septentrionalis;* E, *egaënsis, obscura, contracta,* Madeira race.

Numbers: normally colored races: 1, *lucifera;* 2, *werneri;* 3, *visenda;* 4, *bipuncta;* 5, *williamsi;* 6, *fallax;* 7, *pannifera;* 8, *beebei;* 9, *elevata.*

MAP 2. Distribution of *M. polymnia* forms. A, *angustifascia;* C, *casabranca;* Ch, *chimborazona;* M, *mauensis;* P, *polymnia;* Pl, *plagigera;* S, *solaria.*

PLATE I

Types of Forbes Species

Figure 1. *Melinœa comma,* holotype. Chanchamayo, Peru.

Figure 2. *Melinœa isocomma,* holotype. Upper Rio Negro, East Colombia, 800 M., Fassl.

Figure 3. *Melinœa mneme aurantia,* holotype. Caripito, Monagas, Venezuela, July 19, 1937, Pablo Anduze.

Figure 4. *Mechanitis polymnia mauensis,* paratype. Centenario, near Maués, Amazons, Brazil, August, 1937, F. Wucherpfennig.

Figure 5. *Mechanitis polymnia solaria,* holotype. El Chorro, Sucre, Venezuela, 800 M., June 27, 1937, Pablo Anduze.

Figure 6. *Mechanitis mazœus beebei,* paratype. Caripito, Monagas, Venezuela, April 24, 1942, Beebe and Fleming.

Figure 7. *Mechanitis mazœus bipuncta,* holotype. Surukum Basin, Upper Caroni Valley, Venezuela, December, 1941, Pablo Anduze.

Figure 8. *Mechanitis limnœa,* holotype. St. Laurent, Maroni River, French Guiana.

Figure 9. *Mechanitis mazœus,* race. Manicore, Rio Madeira, Brazil, December, 1937, F. Wucherpfennig.

PLATE II

Types of species in British Museum

Figure 10. *Mechanitis mazœus pannifera* Butler, holotype. Obidos forest, Amazons, Brazil, February 13, 1874, Traill.[2]

Figure 11. *Mechanitis mazœus visenda* Butler, holotype. Trovador, R. Tapajos, Brazil, Lat. 4°15′ S., March 13, 1874, Trail.[2]

Figure 12. *Mechanitis mazœus elevata* Riley, type male. Allianca, Canutama, Rio Purús, Brazil, September, 1913, E. H. W. Wickham.

Figure 13. Same, female type, with same data.

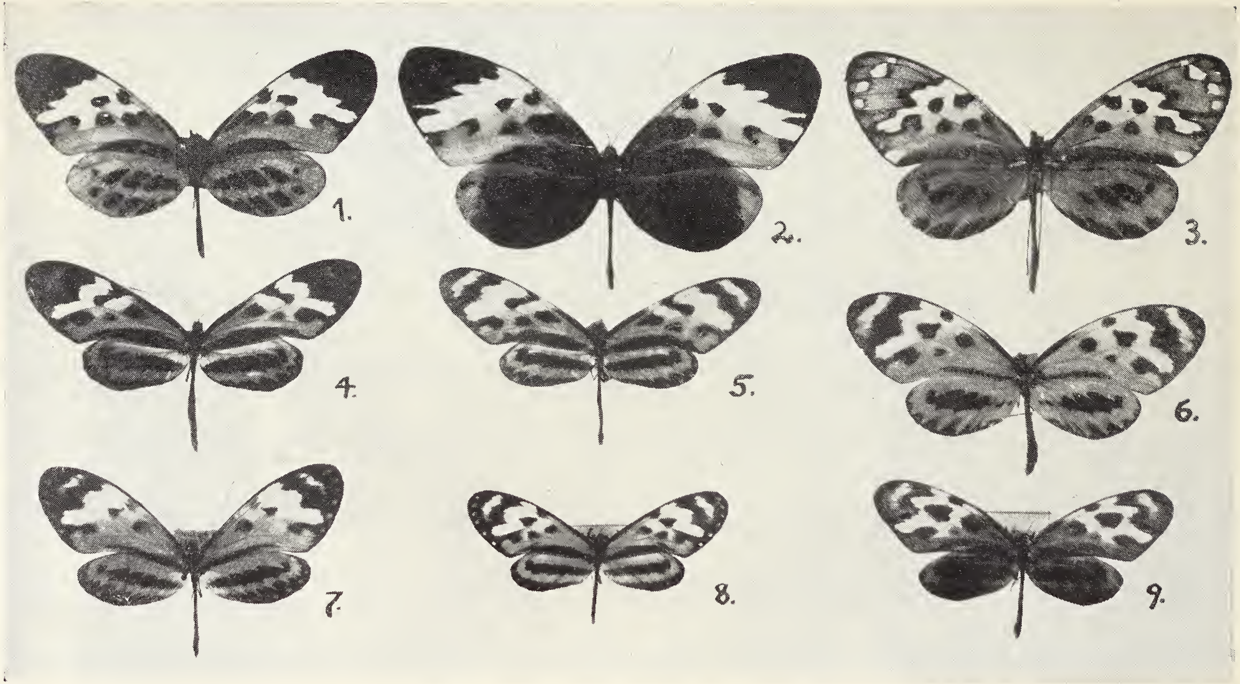
Figure 14. *Mechanitis mazœus contracta* Riley, type male. Same data.

Figure 15. Same, female type, with same data.

Figure 16. *Mechanitis mazœus obscura* Butler, type male. Ega, Amazons, Bates.

Figure 17. Same, female type, with same data.

[2] As spelled on original labels of the types.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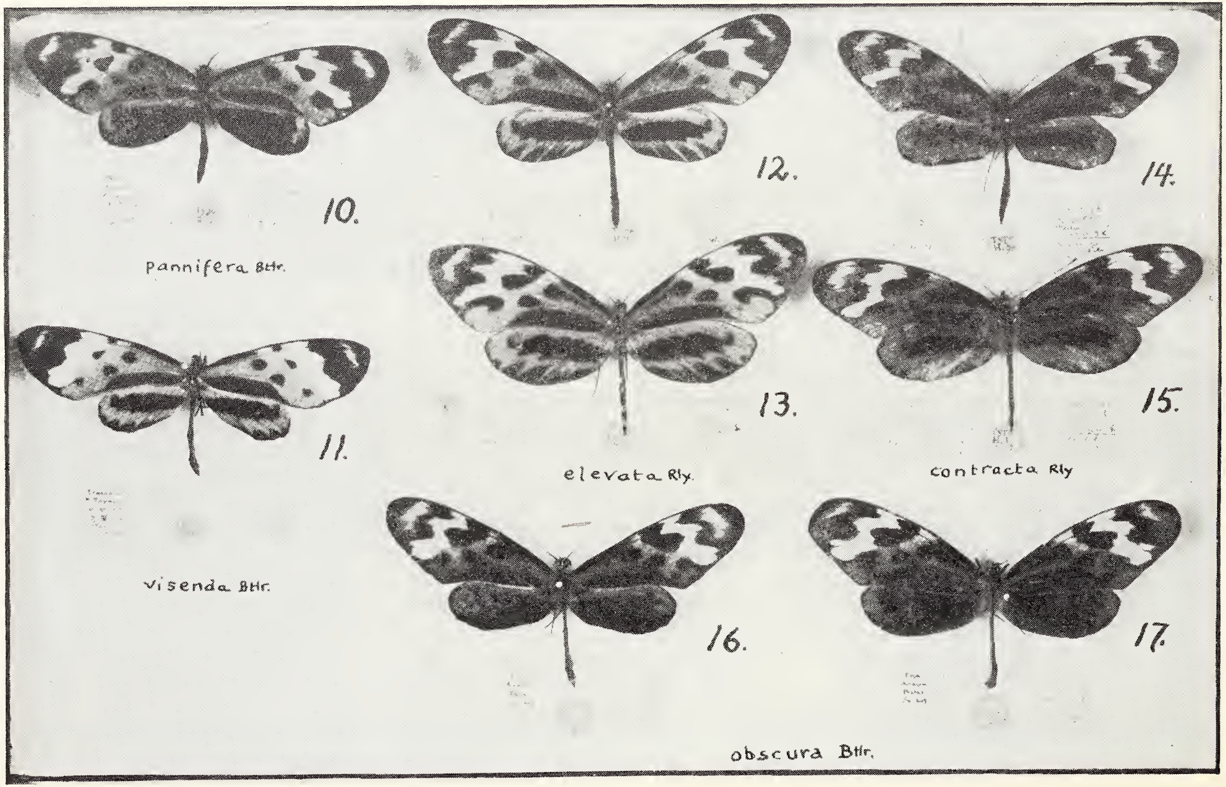
10.
pannifera Btlr.
11.
visenda Btlr.
12.
13.
elevata Rly.
16.
14.
15.
contracta Rly
17.
obscura Btlr.

THE MALE GENITALIA OF EPHEMERIDA (MAYFLIES)

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The male reproductive systems of seven species of mayflies were studied in order to form a basis of comparison between their morphology and that of those European species studied by Quadri (1940), as well as that of several species of *Stenonema* used by Needham *et al.* (1935).

Pickles (1931) devoted a portion of his paper to the rôle played by the mayfly alimentary canal in the later development of the male reproductive system, and discussed the theories of Palmen (1884) and Fritze (1888).

Spieth (1933) described both the development of and the adult form of the male genitalia of Ephemerida, and used the genitalia as one of the factors in a study of the phylogeny of some mayfly genera.

Needham *et al.* (1935) presented a brief description of the morphology of the male genitalia and the internal anatomy of the male reproductive system of mayflies, including the histology, based on studies of nymphs and adults of *Stenonema vicarum,* with four other species of this genus used for comparison.

Snodgrass (1936) described the morphology of the male genitalia of mayflies and gave considerable material on the embryology of these parts and their homologies in other insect groups. He included diagrams of the male genitalia of *Ephemera simulans* and *Blasturus cupidus* and went into detail concerning the muscles of the accessory genitalia.

Quadri (1940) used data obtained from five species of mayflies, *Chleon dipterum, Ephemera vulgata, Heptagenia* sp., *Rhithrogena* sp., and *Bœtis* sp. Under the heading of "Adult Organs," he described the organs of the reproductive system, discussed their histology, and gave a description of the penes and accessory genitalia. Under "Development," he considered the embryology and development of both internal and external genitalia.

In the present investigation, mature nymphs, subimagoes, and imagoes of the following species were used:[1]

Hexagenia limbata occulta Walker
Siphlonurus quebecensis Provancher
Ephemera guttulata Pictet
Heptagenia hebe McDunnough
Blasturus cupidus Say
Stenonema rubromaculatum McDunnough
Isonychia bicolor Walker

The insects were studied by means of reconstructions from serial sections, whole mounts, and microdissections. All specimens had been fixed and preserved in 70–95 per cent ethyl alcohol, and it was found that four hours of post-fixation in Zenker's Fluid resulted in somewhat better preparations. Both nymphs and adults were treated in the same way.

The abdomens were removed just posterior to the fifth segment and then post-fixed. It was occasionally found necessary to squeeze air out of the abdomens to prevent them from floating on the surface of the various fluids used during imbedding. Dioxane was used for dehydration and the regular procedure for paraffin imbedding was followed. A 58–60° C. paraffin was found to give the best results. The blocks were then sectioned at 10–12 microns and the ribbons were fixed to the slides with the aid of albumin. After drying, the preparations were stained with a dioxane technique, Levy (1943).

EXTERNAL GENITALIA

The following is a general description of the morphology and histology of the male genitalia of *H. limbata occulta* imagoes. The general histological picture is the same in the other species except where differences are specifically mentioned, although the shape, size, and appearance of these structures may differ in each species.

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[1] All the specimens used were from the collection of Dr. Herman T. Spieth, who identified all the material, and to whom I am indebted for invaluable suggestions and criticism during the progress of the work and the preparation of the manuscript. I would also like to thank Dr. James I. Kendall and Dr. Charles D. Michener for their and and criticism.

The penes of *H. limbata occulta* originate from the membrane between the dorsal part of the styliger plate and the paraprocts of the tenth sternum and appear as beak-like structures with their posterior ends curving medially. They are covered by a thick layer of cuticula which is heaviest at the basal region and on the dorsal side. The hypodermis of the penis is well developed in the imago.

The cuticula of the penes is apparently made up of a thick layer of exocuticle and a well developed epicuticle, although the tips of the penes seem to lack the latter. The endocuticle is either poorly developed or absent.

The styli or forceps of *occulta* originate from the ventrolateral parts of the styliger plate and are composed of a basal segment (which has the only muscles found in these structures), a long, slender subsegment, and two short terminal subsegments. Snodgrass (1936) called these "subsegments," claiming that they are not true segments since they lack muscles. The long first subsegment of *occulta* is laterally constricted along most of its length, so that it appears dumb-bell-shaped in cross-section. This condition is not found in any other species studied.

The medial surfaces of the styli are covered by many small mating glands, derived from the hypodermis, which project through the cuticula. These glands appear to have a thin layer of endocuticle and are easily ruptured. Spieth (1933) noted that the styli of *Blasturus* lack these glands, and this was found to be the case in *B. cupidus*.

INTERNAL GENITALIA

In *H. limbata occulta,* the muscles of the styli, as stated by Snodgrass (1936), attach at the ventrolateral wall of the anterior portion of the styliger plate and insert near the stricture between the basal segment and the first subsegment. The rest of the stylus, as stated by Needham *et al.* (1935), is filled with fluid containing blood corpuscles. There are also a number of small tracheoles.

The above description applies also to those structures in *Siphlonurus quebecensis, Isonychia bicolor, Stenonema rubromaculatum, Heptagenia hebe,* and *Ephemera guttulata. Blasturus cupidus* shows some differences.

Spieth (1933) pointed out that the styli of *Blasturus* originate from the dorsal surface of the styliger plate, while this is not the case in most genera. He also noted that the styli of this genus lack the basal articulation found in the Heptageniidæ and *Siphlonurus,* and that the styli of *Blasturus* are only three-jointed.

The anterior attachments of the muscles of the styli in *B. cupidus* are on the ventrolateral wall of the styliger plate, as in other species studied. However, these muscles attach posteriorly on the dorsolateral wall of the posterior portion of the styliger plate, this in view of the fact that the basal segment is lacking in the styli of this species.

In *H. limbata occulta,* the dorsal portion of the basal two-thirds of each penis is almost completely filled by a heavy mass of muscle fibers, the ventral portion being occupied by the ejaculatory duct which extends to the tip. These muscles run obliquely in the penes so that their anterior attachments are on the lateral walls of the basal portions of the penes, and their posterior attachments are on the medial walls of the distal portions, although there are no attachments in or near the tips. Their probable action is to bend the penes medially, and to aid in the ejaculation of spermatozoa. The rest of the penis is filled with fluid containing spindle-like blood corpuscles.

These muscles first appear in the mature nymph, and may develop from undifferentiated cells seen in the developing penes of immature nymphs. It should be emphasized that these muscles are attached only within the penes, and have neither origins nor insertions on any other structure or part of the insect. No evidence was found to indicate whether or not they may have migrated to the penes from any other area.

These same muscles have also been found in mature nymphs, subimagoes, and imagoes of *Isonychia bicolor,* and the above description fits this species as well.

As shown in figures 5, 6, the penes of *Heptagenia hebe* and *Stenonema rubromaculatum* are quite different in appearance from those of *H. limbata acculta,* although the same penial muscles are found in both of these species. Some of the medial or posterior attachments of these muscles are located more distally than in *H. limbata occulta* and are found on the extreme posteromedial walls. Since relatively more of the basal portions of the penes in these two species are joined together than is true in *occulta,* the muscles in the extreme basal regions are attached on the ventro-lateral walls, while the posterior attachments are on the medial portions of the dorsal walls. This condition exists only in the basal portions. The penial muscles do not have any attachments in the distal lateral processes of the penes of either of the two species.

The internal morphology of the penes of *Siphlonurus quebecensis* is quite different from that of any other species studied. The presence of muscles in the penes of mature nymphs, subimagoes, and imagoes has been noted, but these muscles have different positions and may have different origins than those of the species previously discussed.

In mature nymphs of *S. quebecensis,* the penial muscles originate on the ventrolateral walls of the ninth sternum, posterior to the origins of the muscles of the styliger plate, and are attached on the dorsolateral walls of the developing penes. The developing styliger plate is found posterior to the origins of these muscles. These muscles are better developed in the subimago and in the imago. They originate on the ninth sternum walls just posterior to the most anterior part of the styliger plate and are attached to the dorsolateral walls in the middle portions of the penes. They have no attachments in either the basal or distal portions.

No undifferentiated cells, such as those seen in the penes of *H. limbata occulta* nymphs, were seen in the penes of near-mature, *S. quebecensis* nymphs. Unfortunately, there is insufficient evidence to indicate the embryological origin of these muscles in *quebecensis.*

The absence of muscles in the penes of mature nymphs, subimagoes, and imagoes of both *Ephemera guttulata* and *Blasturus cupidus* has been noted. No evidence was found in *E. guttulata* of the existence of the basal arms or lateral prolongations of the penes, nor of the muscles described and figured as activating these structures in *E. simulans* by Snodgrass (1936).

In *H. limbata occulta,* the vasa deferentia appear to originate in the testes as a result of the coalescence of a number of small testicular tubules. They proceed posteriorly between the dorsolateral muscles of the abdomen and enlarge in the posterior portion of the eighth abdominal segment to form the seminal vesicles. These, distended with spermatozoa, fill almost all of the ninth segment and the anterior part of the tenth.

The seminal vesicles are joined together to form a single tube at the point where they empty into the ejaculatory ducts, in a manner shown in figure 1, which are at this point also joined together to form a single duct. This duct soon bifurcates, and the ejaculatory ducts terminate at the gonopores at the tips of the penes.

The ejaculatory ducts of *occulta* are enclosed by a thick layer of circular muscles and are lined by a flattened epithelial layer. The muscles are heaviest at the level of the basal portions of the penes, gradually decreasing and disappearing as the ducts near the gonopores.

The seminal vesicles of *occulta* are lined by a thin epithelial layer with invisible cell boundaries and elongate, granular nuclei. Enclosing this layer is an equally thin layer of circular muscles of the same type found in the ejaculatory ducts.

The structure of the seminal vesicles in *occulta* shows some variation, not only between individuals, but between the two vesicles of the same individual as well. Among the approximately thirty specimens of this species examined, however, all showed the same general characteristics.

Other workers have shown that there is a close relationship between the changes in the gut in the mature nymph and subimago and the changes in the reproductive system at this time. Palmen (1884) suggested that air is taken into the gut of the subimago, causing it to inflate, and that this pressure is responsible for histological changes in gut tissue.

Fritze (1888) claimed that the flattening of the epithelium and the dilation of the mesenteron is due to intake of water by the nymph shortly before the emergence of the subimago, the water then being replaced by air.

Pickles (1931) described the reduction of the epithelium of the alimentary canal and stated that the gut contents are expelled before the transformation of the alimentary canal commences. In his summary, he stated that extensive changes take place in the structure of the gut in which both epithelium and musculature become reduced, forming a thin membrane in the imago. He claimed that no pressure exists in the gut until the tissue transformation has taken place.

In all species used in this study, the mature nymphs' guts did not contain any food material, indicating that they had ceased to feed at some previous time, nor was any distortion of the gut noted at this time. The movements of the gut at the time of the emergence of the subimago are apparently of great importance in the conformation of the parts of the reproductive system.

In the mature nymph, the genital tube is a straight, undifferentiated structure with neither folds nor pouches. When the mature nymph emerges to become the subimago, it takes in large gulps of air, which inflate the gut like a balloon as far posteriorly as the ilio-colic constriction, which acts like a valve. This violent expansion of the gut, in addition to the action of the abdominal muscles, serves to push the whole genital apparatus posteriorly. The testes are moved back to the seventh and eighth segments, and at the same time, are emptied of their spermatozoa, which pass through the vasa deferentia into the seminal vesicles. These, enormously distended, are forced posteriorly to occupy only the ninth segment and the anterior part of the tenth.

Such movement causes a number of changes in the relative position of the seminal vesicles, both in the horizontal and vertical planes. In the vertical plane, they are folded to form Z-shaped loops. Since the ninth segment is smaller and narrower than are the preceding segments, in almost all mayflies, this same pressure causes that region of the genital tube which includes the posterior parts of the seminal vesicles and the extreme anterior parts of the ejaculatory ducts to loop medially and anteriorly in the horizontal plane. The medial walls of each loop are brought together and break through, so that at this point there is a common ejaculatory duct receiving the contents of a common seminal vesicle. This series of changes is apparently completed in the subimago, and no further change has been noted in the imago.

The morphology of the genital tube in imagoes of *Isonychia bicolor* is different from that seen in *H. limbata occulta.* In *I. bicolor,* the seminal vesicles are separate and distinct structures and there is no connection between them at any point. Similarly, there is no fusion of the anterior parts of the ejaculatory ducts, and the contents of each seminal vesicle pass into the ejaculatory duct on that same side.

Each seminal vesicle, as it enters the ninth segment, enlarges until it occupies about one-quarter of the abdominal cavity. At about the middle of the ninth segment, these vesicles curve ventrally to enter the penes. Some specimens show the Z-shaped loops seen in *H. limbata occulta* to a moderate degree, but most do not. The seminal vesicles are divided into compartments, at right angles along almost their entire length, by a series of septa, each of which is attached to the wall of the seminal vesicle by trabeculæ. Each septum is apparently made up of a core of connective tissue with a thin epithelial covering. These septa can be seen developing in mature nymphs. They are moderately well developed in the subimago and very well developed in the imago. The function and action of these septa are not known.

The ejaculatory ducts of *I. bicolor* have a less well developed coat of circular muscles than do those of *H. limbata occulta*, and have a better developed epithelium with numerous small folds.

The seminal vesicles of *Siphlonurus quebecensis* resemble those of *H. limbata occulta*, but there is no fusion of the anterior parts of the ejaculatory ducts, nor is there any connection between the seminal vesicles. The form taken by these structures is much the same as in *H. limbata occulta*. The vesicles fill more than half the abdominal cavity and are filled with spermatozoa.

The ejaculatory ducts of *S. quebecensis* narrow abruptly in the basal part of the penes and the circular muscles disappear at this point, so that the posterior portions of these ducts consist of epithelial tissue only.

The same form of the seminal vesicles occurs in *Ephemera guttulata* as in *H. limbata occulta*, except that the Z-shaped loops are not so well developed, nor is there any connection between any of the parts of the two genital tubes. Testicular and Malpighian tubules are frequently found in the lumena of the adult penes of this species. The histology of the seminal vesicles and ejaculatory ducts of *guttulata* is the same as that of *H. limbata occulta*, except that the epithelial layer of the seminal vesicles is better developed in *guttulata* and has folds that project into the lumen.

The looped form of the seminal vesicles is not so pronounced in *Stenonema rubromaculatum* as it is in *H. limbata occulta,* nor is there any connection between the two genital tubes. In occasional specimens, the form taken by the seminal vesicles of *rubromaculatum* resembles that of *I. bicolor* very closely.

The distal portions of the seminal vesicles of *S. rubromaculatum,* near where the ejaculatory ducts begin, are divided at right angles to their length by septa similar in appearance to those seen in *I. bicolor.* However, these septa are not so numerous in *rubromaculatum* and are restricted to the distal portions of the seminal vesicles. The histology of these septa is the same as that of *I. bicolor.*

The ejaculatory ducts of *S. rubromaculatum* have a well developed epithelial lining and a poorly developed musculature. These ducts have been pushed into the seminal vesicles for a short distance somewhat like a piston into a cylinder. The ducts narrow abruptly in the posterior parts of the penes and lose their musculature, as in *Siphlonurus quebecensis.*

The morphology and histology of the seminal vesicles and ejaculatory ducts of *Heptagenia hebe* is the same as that of *S. rubromaculatum.* There is no connection between any of the parts of the two genital tubes. However, the septa in the seminal vesicles of *H. hebe* are not so numerous as those of *S. rubromaculatum.*

In *Blasturus cupidus,* the seminal vesicles, unlike the other species studied, are found in the middle of the eighth abdominal segment and are about four times the diameter of the vasa deferentia. In the middle of the ninth segment, they are collapsed and empty, of about the same diameter as the vasa deferentia. These slender tubes then proceed posteriorly and enter the basal portions of the penes to become the ejaculatory ducts. This condition has been found in six imagoes and two subimagoes and does not appear to result from fixation effects. There is no connection between the two genital tubes. It is to be noted that the seminal vesicles are not looped, nor do they have any pouches in *cupidus,* but are straight, unfolded tubes. Unlike the other species studied, they fill less than one-eighth of the abdominal cavity in the ninth segment, while the posterior collapsed portions occupy much less space.

The expanded parts of the seminal vesicles of *B. cupidus* consist of an extremely thin circular muscle sheath with a much flattened epithelium lining the tube. In the collapsed parts of the vesicles, the epithelium is thicker and appears to be better developed. The ejaculatory ducts have a well-developed epithelium with a fairly heavy layer of circular muscles in the basal portions of the penes, which gradually disappears as the ducts near the gonopores.

DISCUSSION

Considering the limited number of genera used in this study, it is inadvisable to conduct more than a brief discussion of its implications. Admittedly, the relationships of wings, gills, external genitalia, and mouthparts are more valuable than are the internal organs of the reproductive system in studies of mayfly phylogeny.

It is interesting to note that only in *Hexagenia* is there any connection between the paired genital tubes, and that this occurs in such a way that both the seminal vesicles and the ejaculatory ducts are involved. The similarity in the septa seen in the seminal vesicles of *Isonychia, Heptagenia,* and *Stenonema* indicates a close relationship between these three genera as mentioned by Spieth (1933). The morphology of the seminal vesicles of *Blasturus* would seem to indicate that there is comparatively little posterior movement of the reproductive organs with the emergence of the subimago in this genus.

Although Spieth (1933) mentioned the close relationship between *Hexagenia* and *Ephemera,* it is noteworthy that *Hexagenia* has penial muscles and *Ephemera* does not.

The genera used in this study may be divided into three groups:

1. Those that have penial muscles having an attachment outside the penis: *Siphlonurus.*
2. Those that have intrinsic penial muscles, *i.e.,* muscles that have all their attachments within the penes: *Hexagenia, Isonychia, Heptagenia,* and *Stenonema.*
3. Those that do not have penial muscles: *Ephemera* and *Blasturus.*

The existence of muscles in the penes of *Siphlonurus* which have one of their attachments on the ventrolateral wall of the ninth segment introduces a question as to the embryological origin of these muscles which is beyond the scope of this paper.

Spieth (1933) concluded that *Siphlonurus* is the most primitive genus of the 25 genera that he studied, which includes all of the genera used here. It is possible that the type of penial muscles found in *Siphlonurus* represents the primitive condition, that those found in *Hexagenia* represent more specialized and advanced conditions, and that the lack of penial muscles, such as seen in *Ephemera,* indicate a different evolutionary branch.

The peculiarity of the posterior attachments of the styliger plate muscles in *Blasturus* indicates that one of two things has happened to the basal segment of the stylus. Either they have disappeared entirely, or they have fused with the styliger plate. From the unusual position of the styli in the genus, the latter would seem to be the case, although there does not appear to be any other evidence to support this.

No positive evidence has been presented here as to the embryological origin of either of the two types of penial muscles. It has been suggested that apparently undifferentiated cells seen in the developing penes of immature nymphs of those species having intrinsic penial muscles may give rise to these muscles. It would probably be necessary to rear large numbers of eggs of one or more of these species in the laboratory, fixing and preserving several individuals at regular intervals from the time that the penes first begin to develop until the last nymphal instar. These would have to be sectioned and carefully studied to establish the embryology of the penial muscles. The same procedure could be followed in studying the penial muscles of *Siphlonurus.*

Needham *et al.* (1935) stated that the ejaculatory ducts have a layer of circular muscles enclosing a more or less glandular epithelium. Quadri (1940) claimed that the ejaculatory ducts do not have any circular muscles. Based on the seven species studied, it has been found that the ejaculatory ducts do have a circular muscle coat, but that it is restricted to the basal or anterior half of the ducts in almost all cases. Such muscles are extremely well developed in *H. limbata occulta* and moderately developed in the other species.

The designation of the parts of the genital tube used here is that of Needham *et al.* (1935), except that the whole length of the genital tube that is swollen with spermatozoa is recognized as the seminal vesicle, and not divided, as indicated by Needham, into seminal vesicle and ''coiled part of the ejaculatory duct.'' In all species studied, the terminus of the seminal vesicle and the beginning of the ejaculatory duct was fairly well indicated by an increase in the amount of circular muscle tissue.

SUMMARY

The male reproductive systems of seven species of mayflies were studied by means of reconstructions from serial sections, whole mounts, and microdissections.

Muscles have been found in the penes of mature male nymphs and adults of *Hexagenia limbata occulta, Isonychia bicolor, Heptagenia hebe,* and *Stenonema rubromaculatum* which are attached only within the penes, having no attachment at the ninth sternite nor at any other part of the insect.

Muscles have been found in the penes of mature male nymphs and adults of *Siphlonurus quebecensis* which originate on the ventrolateral walls of the ninth sternite and attach to the dorsolateral walls of the penes.

The absence of muscles in the penes of mature male nymphs and adults of *Ephemera guttulata* and *Blasturus cupidus* has been noted.

The later development, morphology, and relative disposition of the various parts of the male reproductive systems of some mayflies have been described.

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PLATE III

Figures 1–7. Dorsal aspects of dissections of the posterior portions of the abdomens of male Ephemerid imagoes. On each specimen, the styliger plate and the tenth abdominal segment have been removed. Muscles are shown on the left, the genital tube on the right.

Figure 1. *Hexagenia limbata occulta*
Figure 2. *Isonychia bicolor*
Figure 3. *Siphlonurus quebecensis*
Figure 4. *Stenonema rubromaculatum*

Key:

ej.d.,—ejaculatory duct.
p.,—penis.
s.v.,—seminal vesicle.
st.,—stylus.
st. msc.,—stylus muscles.
p. msc.,—penial muscle.
epi.,—epicuticle.
exo.,—exocuticle.
hyp.,—hypodermis.
sp.,—spermatozoa.

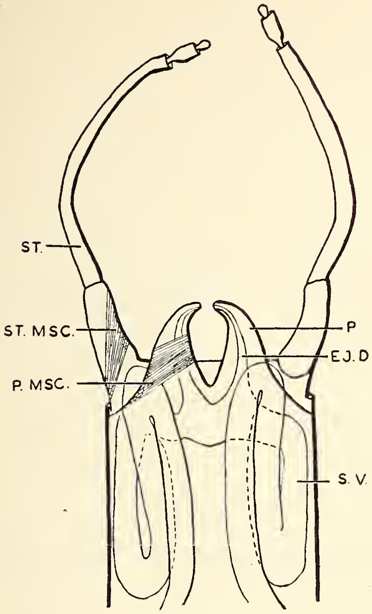

FIG. 1

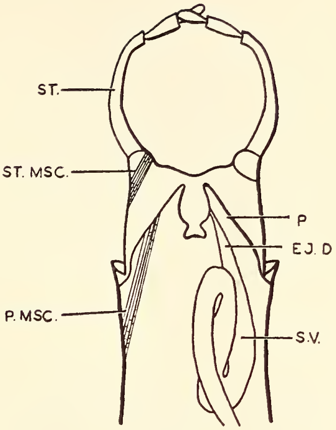

FIG. 3

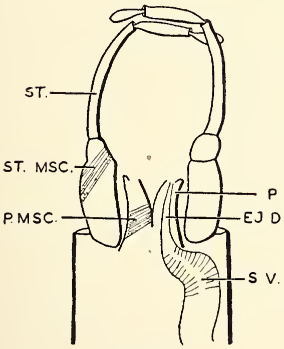

FIG. 2

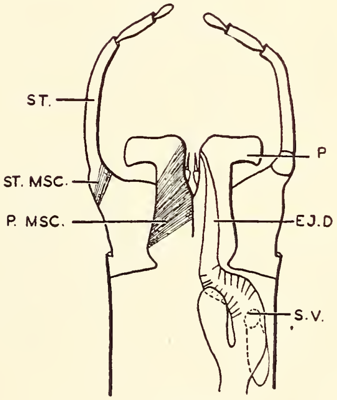

FIG. 4

PLATE IV

Figure 5. *Heptagenia hebe*
Figure 6. *Ephemera guttulata*
Figure 7. *Blasturus cupidus*
Figure 8. Transverse section through the basal portion of a penis of an *H. limbata occulta* imago.

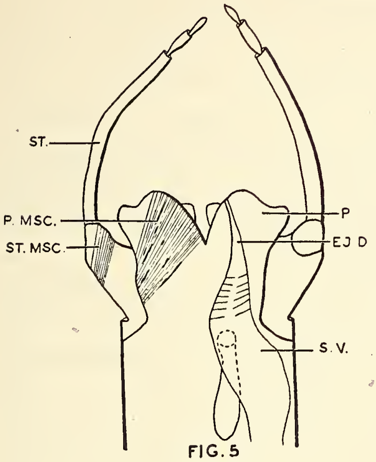

FIG. 5

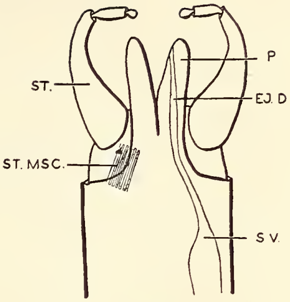

FIG. 7

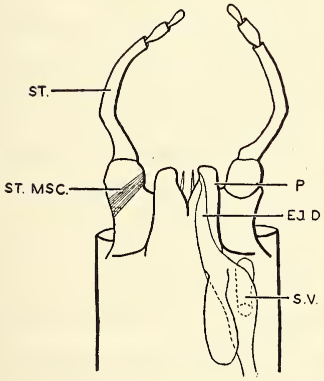

FIG. 6

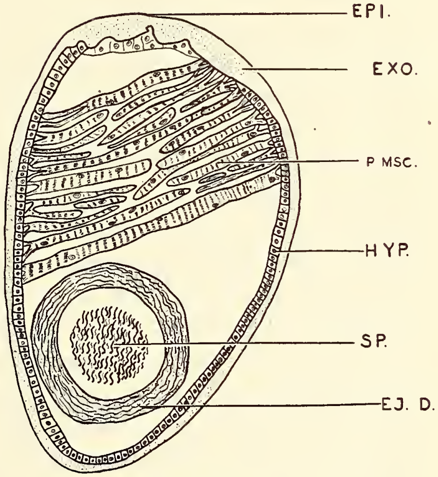

FIG. 8

BOOK NOTICE

Stingless Bees (Meliponidæ) of the Western Hemisphere. Lestrimelitta and the Following Subgenera of Trigona: Paratrigona, Schwarziana, Parapartamona, Cephalotrigona, Oxytrigona, Scaura, and Mourella. By Herbert F. Schwarz. *With a Bibliography* by Herbert F. Schwarz and Annette L. Bacon. Bulletin of the American Museum of Natural History. $10\frac{1}{2} \times 7\frac{1}{2}$ inches, Volume 90, pages i–xviii, 1–546. 87 text figures. 8 plates. 5 tables. $7.00.

This impressive, well-printed volume, which is an outstanding and important contribution to entomology, is deserving of the highest praise. The Introduction of 166 pages is an authoritative and highly interesting account of stingless bees, their structural characters, phylogeny, distribution, nesting habits, activities in the colony, castes, nocturnal activites, foraging, flight equipment, honey, wax, etc., etc. Every one who reads Mr. Schwarz's account of these moist tropic insects will appreciate the ability, care and judgment which the author has lavished upon his work. There is no longer any excuse for entomologists in general to be totally ignorant about meliponids. Although Mr. Schwarz refers to the Introduction as a ''suggestion of the picture as a whole,'' it is a very capable, stimulating and informative ''suggestion'' and the gaps in our knowledge are not the fault of the author.

The systematic account, which occupies the remainder of the volume, is devoted to descriptions, keys, distribution, etc., of species and varieties, including descriptions of some new species and varieties. Although I am without the competence necessary to evaluate this portion, I am aware of Mr. Schwarz's ability and of his meticulous study of the Meliponidæ for many years, in view of which I am sure that the systematic portion is as precise as it was possible to make it. Although insect descriptions are not required reading for non-specialists, one should not pass over lightly the author's ''discussion'' of each form. These are well worth reading. An extensive bibliography rounds out this well-written, valuable, encyclopedic monograph.—H. B. WEISS.

A BUCCULATRICID GALL MAKER AND ITS HYPERMETAMORPHOSIS

BY JAMES G. NEEDHAM

I have a pocket-knife that whittles, and once when I was out in a South Florida wilderness in December, I came upon a patch of wild sunflowers with knot-like swellings in their stems. I set my knife to whittling, and soon found that the swellings had very hard walls and were hollow inside. They were galls; and lying inside each gall was a very curious larva. It was evidently a moth larva of some sort, but it had a very small head, a nearly moniliform body (by reason of deep and wide constrictions between the body segments), no hair or spines or setæ on its dry, tough skin, and no prolegs. It did not creep, but lay on its side with the front end thrown back in a J-shaped hook, the head at the tip of the hook. It spun no silk, not even enough to hold back the pellets of frass. It lay among these dry pellets and tumbled around with them when the gall was shaken. When the gall was opened and inverted, the pellets fell out in a shower, like that from an up-tipped pepper box.

Specimens of the larva were sent to Dr. W. T. M. Forbes and Mr. H. W. Capps, and neither would venture a determination nor even a reference to any Lepidopterous family. They both suggested that I rear the larvæ and send in some adult moths. So that is what I did; and on the doing of it (and certain related other things) I now herewith make report.

The plant is a native annual sunflower, *Helianthus agrestis* Pollard (*H. curtissii* Fernald). On the rich soil in which I found it, it grows head-high, on wand-like stems. Crowded together in close ranks, the stems rise unbranched to shoulder height; where not crowded they branch extensively at lower levels. I found them in nearly pure stands in long patches of an acre or less, these patches in the edge of low places in the flatwoods, in spots too wet for saw palmetto and for most grasses, and too dry for saw-grass and for marsh fleabane (*P. luchea*), but with the two latter generally near at hand. All that I saw were within a mile or two of salt water, between Sarasota and Englewood.

The gall is a thickening of the walls of the stem, about an inch long and four-fifths as wide, and with a large oval cavity inside. It varies in form from oblong to almost round. It tapers a little more abruptly to the stem at the upper end. Its surface is generally bare and somewhat uneven. The outer layer of its walls is filled with rosin, and is very hard, especially on the upper side. Its cavity is normally centrally located in the axis of the stem, but sometimes it is on one side, where it causes a jog in the stem. In such a case the rosin is deposited only on the bulging side, the opposite side remaining soft as elsewhere on the normal stem.

The walls of the gall vary in thickness and consistency. Generally when old and dry there is an inner brittle layer formed by the drying up of the pabulum tissue that earlier feeds the larva; and between this and the very hard resin-filled outer defense layer there remains some softer parenchyma. Certain inquilines (to be noted later) burrow in this softer tissue. Elsewhere in the plant the stem is filled with pith.

Galls occur singly on the stems; very rarely two, and when two, one or both are imperfectly formed. They are generally located somewhat below mid-height of the plant. Often growth continues above the gall, not in a single normal stem, but in several weaker branches that may, however, bear perfectly normal heads of flowers, at the general level above. A few belated flowers on over-shaded and dwarfed stems were still present in December. The blossoming heads are very pretty, with their bright yellow rays, and disc flowers of deep violet.

The gall-making larvæ in the winter season are full-grown and full fed, awaiting the warmer weather of early spring for transformation. Placed on a flat surface they are quite incapable of locomotion, and lie always in a lateral position. Touched at any point on the body, they respond with a sudden lashing motion that may be repeated several times before coming to rest again. The J-shaped hook at the front may be a position assumed in preparation for attack by an enemy, for dead specimens lie straight and fully extended.

The length of grown larvæ varies from 10 to 12 mm. Dorsal and ventral surfaces are similar in appearance, both being a little flattened and narrowed toward each end.

Although the larva, if undisturbed, lies inactive within the gall all winter long, important changes are going on inside it. It is about to resume a more normal lepidopterous larval form, preparatory to transformation to the pupal stage. What was my surprise, on opening a gall in early March of 1946, to find a cast-off larval skin of the form above described, and a living larva of quite a different form beside it. The new larva was cylindric in body. It crept about on regular caterpillar prolegs. Its body bristled with setæ. Its head was of the proper size for a normal lepidopteran, and it could spin silk!

Here was a non-feeding instar, interpolated between larval and pupal stages: a clear case of hypermetamorphosis.

The larva in this non-feeding stage has strong mandibles, and it gnaws a hole through the wall of the gall to the outside. Then it returns and casts off a very thin transparent skin; thin, except on the brown head, where the strong jaw muscles require solid support for their gnawing. Behind the head the skin is soft and papery. It gets compacted into a little bunch in which black dots mark the bases of the body setæ. The duration of this stage is very short, probably less than a week.

The pupa is of ordinary lepidopterous form. The adult is a little bucculatricid, whitish moth[1] (length about 6 mm.) without any brilliance of coloration; creamy white with just enough touches of tan and brown to make its rough surface and frayed-out wing margins look as lifeless as a bit of bark torn from a broken sunflower stem by the wind.

I had my troubles rearing this larva. I collected galls by the score, repeatedly, through two winter seasons at Sarasota, Florida. I opened galls by the dozen looking for signs of development, and finding none. I kept them under varied conditions of temperature, moisture, and exposure to sun, rain, and wind, opening some of them weekly or oftener only to find in the end that none of these measures was of any effect. My troubles were all due to enemies: to mordellid beetle larvæ: mites, and ants.

The final rearing of the moths came by partial successes. On

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[1] Now in the hands of Dr. Annette Braun for description.

the first of February, 1945, I found a gall that had a very active larva inside it. I put back the chip removed in opening the gall, fastened it securely, put it in a tray, covered the tray with a close-fitting glass plate, set it in a South window where it was exposed to sunshine in a warm room. Next day there appeared a white cocoon on the smooth inner edge of the rim of the tray. It had been spun during the night; a beautiful cocoon, close-woven to fit the body of the larva on the inside, overspread with a dainty outer covering, raised in parallel ridges of exquisite weaving.

This pearly white, finely wrought, ribbed cocoon cover gave the first hint as to the systematic position of the species. Well-known apple pests of the genus *Bucculatrix* make similar ribbed cocoons. This specimen, however, I was unable to rear. The ants got it; little yellow ants so small that they could go through a needle's eye in double columns; and there ended that season.

I returned to Sarasota in January 1946 to finish the job. Other enemies than ants had plagued my rearing jars during two preceding winter seasons, two kinds that were much harder to deal with than ants. Mordellid beetle larvæ and mites were thwarting my attempts at rearing the gallmaker; and I had first to study their habits.

Mordellid beetle larvæ are well-known pith borers; generally accounted herbivorous, but hitherto only vaguely suspected to be partly carnivorous in their feeding habits. They are regular residents in the stems of this species of *Helianthus.* Hardly a stalk in a whole field was without their burrows, running up and down through the pith. The burrows vary greatly in diameter as the larvæ do in size.

Larvæ may be found by chipping off a bit of the stem wall, but when so exposed, they make haste to get under the next chip. One of them may be chased to the end of its burrow by removing successive chips.

The form of the larva is roughly cylindric, with great humps upon the back of several abdominal segments that look and function like prolegs. Travel up or down the burrow is done by pushing or pulling one end of the body forward while holding fast with the other.

The larva is superbly fitted for its tube-dwelling life, and un-fitted for any other. Dumped out of its burrow and lying on a plane surface, it is helpless. It can only lie on its side and squirm and roll over. Other animals have been termed "side winders" but this one surely best deserves that name. The manner in which it uses its locomotor appendages may be seen in detail by putting an uninjured larva in a glass tube of proper diameter of bore (methods used by Anna May French in studying the larva of *Mordellistina nigricans* Melsh.: see Psyche, 44: 34, 1933).

In November and early December, when nearly every gall contains a living larva of the gall-maker and while the Helianthus stems are still green, the beetle larvæ are to be found in the pith below the galls. Later the beetle larvæ extend their burrows upward and enter the galls. They pass by the frass-filled conical pit at the center of the gall base. They seek out the softer parenchyma of the middle layer of the side wall and often burrow through it and beyond it before penetrating the inner brittle layer that is the gall-maker's last wall of defense. There is abundant evidence that they enter and kill the moth larva.

A sample count of the contents of 80 galls, collected near Woodmere on February 19, 1946, will show this. Inside 80 of these apparently normal galls were found:

20 living bucculatricid larvæ, with no signs of mordellids present.
11 dead bucculatricid larvæ.
30 empty, with conecting mordellid burrows.
8 living mordellid larvæ with dead bucculatricid larvæ alongside them.
1 living mordellid pupa.
10 aborted galls, with bulging inner-gall tissues and no larvæ of either species present.

Often, in an empty gall with a connecting mordellid burrow, there would be a little tuft of hard fibro-vascular bundles of *Helianthus,* lying loose in the bottom of the gall. I guess that these were from the gall wall (for they seemed to be of special hardness), and were stripped of their surrounding softer pith cells by the entering larva and pushed inside.

Probably the predator leaves by the way it enters, and goes back down the stem to pupate, for mordellid pupæ generally were found in burrows lower down on the stems, often near the ground level.

The mites (*Pediculoides ventricosus* Newport) are even more destructive. They follow the mordellids in season, and seem to be more or less dependent on the beetle larvæ for gaining access to the tightly closed galls. I found mites only in galls that had an opening to the outside.

After slicing the side of a gall off smoothly and finding a healthy moth larva inside, I tried many times by various means to fasten the piece back in place securely, but never succeeded in keeping the mites out. I lost every one. Sometimes when finally re-examined there would be only a few mites present, sometimes scores of them. But even if only one or two, the moth larva would be dead or dying. It probably exhausts its store of energy by continuous repetition of its extremely vigorous avoidance reaction. Where touched ever so lightly it lashes its body and springs away.

These very little 8-legged mites (about length 0.5 mm.) are well-known enemies of various lepidopterous larvæ. When a mite begins sucking up the juices of the moth larva, its abdomen quickly swells up to spherical form, and takes on a shining honey-yellow color. With its abdomen swollen to full rotundity, it presents a miniature parallel, in appearance, to the storage-individual honey-ant of Texas. With many mites sucking together, the moth larva quickly shrivels to an empty, crumpled skin.

I finally succeeded in rearing a series of the bucculatricid moths by collecting selectively in the field several hundred apparently sound galls, cutting off the stem close to the gall and examining the cut end to see that no mordellid burrow had penetrated it. Then I divided the sound galls into lots, and put them in ant-proof cages. I placed some outdoors, one exposed to rain and sun, one under shelter and one in the shade; kept some indoors, in cool rooms and warm, in moist air and in dry. I soon saw that the larvæ in several of the cages were coming out to spin, and before the first of March, when I had to leave Sarasota, moths had emerged in all the cages.

The larvæ spurned every sort of pupation shelter that I offered them, and came out into the open and settled down in the most exposed places available. Each larva spun for itself the ribbed, silken coverlet and then the tight-fitting cocoon closely wrapped around its body underneath.

OTHER INHABITANTS OF THE GALLS: INQUILINES, ETC.

There is a little moth larva that lives in a burrow of its own in the softer middle tissue of the wall of the gall. This larva is less than half an inch long, of the ordinary lepidopterous form (with setæ and prolegs); pale yellowish, with a mid-dorsal line of red, and a row of diffuse reddish spots along each side on the lateral prominences of the segments. I did not rear it. Only two specimens were encountered and both were damaged in opening the galls. The burrows entered from pith below the gall, and this species is probably to be ranked as a stem borer.

Hippopsis lemniscata (F.). A small collection of galls with stems attached yielded (on dissection) a score or more of larvæ of this curious little cerambycid (long-horn) beetle. Some of these came from the softer tissues in the walls of the galls.

Toxotropis submetallicus Schaeffer. Of this small fungus weevil (Curculionidæ) hitherto reported from Texas and known also (to Dr. Henry Dietrich) from Mississippi, many specimens emerged in one of my rearing jars. Aborted galls often contain growths of fungi, and this beetle may have developed in these.

A minute tenebrionid (darkling beetle) larva occurred sparingly in the pith of both stem and gall. Mr. R. A. St. George reported on it as being "close to *Aphanotus*." It has a very slender, strictly cylindric body, smooth on the surface, like a "wireworm," with a pair of sharp upcurving hooks on the tip of its tail end.

Ormiscus sp.? A single larva of this genus (family Anthribidæ) was found in dissecting a gall; the genus, reported heretofore as "removed from dead twigs."

Schizoprynus sp.? This braconid parasite emerged in one of my rearing jars on April 21, 1945, among the late emergences from that jar. When sent to Dr. C. F. W. Muesebeck, he reported the above name, and commented: "This genus is wholly unworked. Specific distinctions have not been established.

Therefore we have as yet no basis for specific identification.'' I can make no suggestion as to whether the Bucculatricid larva or some other resident species is its host.

Such is the gall that set my knife to whittling, and such the moth that causes the gall to grow, and to provide shelter for its own curious larvæ and for other insects besides: for its pith-dwelling mordellid neighbors, that come up the stalk from below and become its ememies; for hordes of devastating mites, seeking entrance at every crevice; for the guests that take up their abode in the outer wall of the gall and live apart; and for at least one species of parasite.

Not least in interest concerning this little tatterdemalion moth is its way of entering upon the pupal stage. As a larva it has lived secure inside the gall with all its wants supplied. And in form it has departed far from the ancestral pattern. It must get back on the beaten track. Before it can enter the pupal stage it must regain caterpillar form and functions. This requires a making-over into the normal, with a restoration of jaws for hard chewing and silk for spinning during a non-feeding stage. This is *hypermetamorphosis:* an added change of form. There is no other way it can become a pupa and then a moth than the old way by which ancestral moths developed. Herein appears the force and the meaning of biological tradition.

And when this restoration of form and of primeval powers has been accomplished, the larva builds its pupal shelter out of gossamer threads of pearly whiteness, weaving its coverlet with marvelous artistry.

A NEW CALIFORNIAN APAMEA (LEPIDOPTERA, PHALÆNIDÆ)

By J. McDunnough

Recently an old friend, Mr. J. E. Cottle, sent in for identification a pair of moths taken at Arrowhead Lake, San Bernardino Co., California. These proved to belong to the genus *Apamea*, the species being apparently undescribed. It is with much pleasure that this new species is dedicated to Mr. Cottle and described as follows:

Apamea cottlei, new species

Male antennæ finely ciliate. Palpi upturned, deep purplish, red with tinges of pale yellowish at apex of joint II. Anterior portion of the front deep purplish red, the vertex and section adjacent to the antennæ pale yellowish. Basal half of collar pale yellowish, apical half, as well as the entire thorax, deep purplish red. Primaries rather evenly deep purplish red overlying and almost obscuring a pale ochreous ground color which is best evident in the filling between the geminate crosslines. Maculation much as in other species of *Apamea*. There is an obscure purplish patch at base of wing. The t. a. line is widely geminate, the lines being deep purplish red with the filling of the pale ochreous ground color; there is a sharp outward angle below the cubital vein and a shorter inward angle on vein I. A rather obscure dark median line runs from middle of costa to below the reniform, then forms a right-angle running inwardly oblique and close to t. p. line to inner margin beyond middle. Orbicular fairly distinct, small, circular, yellowish, ringed with purplish red. Reniform kidney-shaped, yellowish, obscured by a brownish shade which leaves a yellow central lunule and a band of the same color along the outer margin, the whole outlined in deep purplish red. T. p. line broadly geminate, the lines deep purplish, the inner being lightly dentate on the veins, the filling of the pale ground color; this line is bowed gently outwards between costa and vein 3. Veins in terminal area marked in deep purplish. Some yellowish shading mixed with purplish along outer margin. Apex of wing slightly paler than remainder of terminal area. A brownish terminal line and fringes deep purplish with a fine paler line at base. Secondaries pale yellowish, lightly sprinkled with purplish red outwardly, more so in the female than the male. Fringes light purplish with a pale yellowish line at base. Beneath light ochreous with purplish sprinkled in the costal area of both wings. Fringes of primaries deep purplish, of secondaries considerably paler. Expanse 30 mm.

Holotype, ♂ and allotype, ♀, Arrowhead Lake, San Bernardino Co., California, July 10, 1941 (J. E. Cottle). The holotype, through the courtesy of Mr. Cottle, in the collection of The American Museum of Natural History, the allotype in Mr. Cottle's collection.

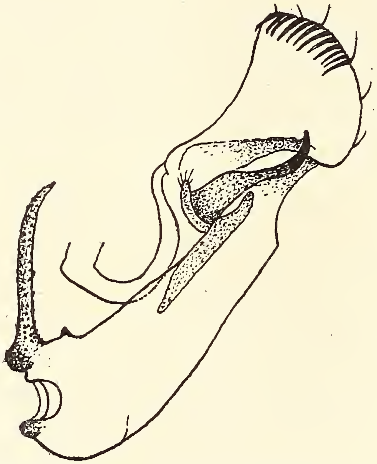

Figure 1. Right clasper of male genitalia of *Apamea cottlei.*

The male genitalia are very similar to those of *pacifica* Smith; the long spined clavus is thinner and less outcurved apically, and the small adjacent spine on the dorsal margin of the sacculus is more pronounced. The harpé is more sinuate and terminates in a single sharp upcurved point, not bifid as in *pacifica.* The cucullus is rather chunkier with more rounded apical margin. In the apical cluster of cornuti in the aedeagus the two cornuti closest to apex are much longer than the others and also than the corresponding ones in *pacifica.*

DERALLUS ALTUS (LECONTE), A SOUTHERN WATER BEETLE, IN NEW JERSEY

By Grace E. Pickford
Osborn Zoölogical Laboratory and Bingham Oceanographic Laboratory, Yale University

Among a small collection of water beetles from southern New Jersey, the author discovered a little, somewhat compressed, black, striate hydrophilid of unfamiliar appearance. A specimen was sent to Mr. K. F. Chamberlain who identified the species as *Derallus altus* (LeConte), a supposedly rare and, up to the present, little known southern form. Mr. Chamberlain pointed out that this discovery provides an interesting addition to our knowledge of southern elements in the New Jersey fauna and, at his suggestion, the following note has been prepared for publication.

The locality from which the specimens were taken is situated at the head of Magnolia Lake, Cape May County, N. J., at a place where a dirt road crosses the inflowing stream. It is not an entirely natural habitat since Magnolia Lake is itself the result of an artificial damming of Mill Creek, and moreover the grassy bank of the road, sloping down to the stream on the side opposite the lake, is obviously in part the result of human construction. *D. altus* was taken among debris obtained by stomping up the submerged grass roots and marginal vegetation of the stream bank in this place. It was not found among the reed beds, water lilies, or other aquatic vegetation bordering the open water. Five specimens were taken on August 17, 1947, by the author. Five more were taken on September 13, by Prof. A. Petrunkevitch and Mr. W. D. Hartman, who revisited the locality at my request, and to whom my best thanks are due.

Within the continental limits of the United States previous records of this species are confined to the south-east. LeConte (1855) recorded the original specimens from New Orleans and the species was redescribed by Horn (1873). Louisiana is the only record mentioned in Leng's Catalogue, or its supplements to date. Nevertheless *D. altus* was collected by Blatchley (1919) in Florida and, more recently, it has been taken by Löding (1945) in Alabama. I am indebted to Dr. F. N. Young, of the University of Florida, for calling my attention to the last mentioned record. Dr. Young informs me that he has taken this species from a number of localities in Florida and expects to publish the full records shortly. In regard to the habits of this species he states (*in litt.*): "My collecting notes indicate that the species is fairly abundant at times, but usually rather local. I think one reason for its rarity in collections may be due to its secretive habits. It does not appear to be strictly coastal, nor highly seasonal."

Outside of the United States, d'Orchymont (1943) has recorded the occurrence of *D. altus* in the Brasilian provinces of Pernambuco, Ceará and Piauhy, collected by Dr. O. Schubart, and notes that it also occurs on the island of Guadeloupe. According to d'Orchymont it is found chiefly in quiet water. J. Balfour-Browne informs me (*in litt.*) that he has seen specimens from Argentina and Bolivia, in addition to the Brasilian specimens in the British Museum. I am greatly indebted to him for permission to include this interesting extension to our knowledge of the southern range of the species. New Jersey thus appears to be the northern limit for a species of rather wide, and possibly even of peregrine, neotropical distribution.

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A NEW SUBSPECIES OF LYCÆNA EPIXANTHE BOISDUVAL & LECONTE WITH COMMENTS ON THE IDENTITY OF TYPICAL EPIXANTHE (LEPIDOPTERA, LYCÆNIDÆ)

By George W. Rawson
Summit, N. J.

Type material of *Lycæna epixanthe* (Boisduval and LeConte) (1) exists in the form of two female specimens (cotypes) which were formerly in the Oberthür collection, later acquired by Dr. Wm. Barnes, and now in the United States National Museum in Washington, D. C. (For more detailed information about these specimens, see Barnes and Benjamin (2), Doubleday (3), and Kirby (4).) Both cotypes are labeled under the Boisduval manuscript name as "*Chrysoph. hypoxanthe* (*epixanthe*) Type," but no data as to the date of capture or the locality are attached. In their original description, the authors mention New Harmony, Indiana as the type locality of *epixanthe.* However, some error must have occurred because a number of circumstances strongly suggest that the cotypes were *not* taken at New Harmony in the extreme southwestern portion of Indiana, but probably somewhere along the eastern seaboard—quite likely in the State of New Jersey. I have carefully examined large series of *epixanthe* from most of the territory where the species is known to range and it would appear that aside from the northern subspecies *L. e. amicetus* (Scudder) (*phœdrus* Hall), intermediate forms, and a new mideastern subspecies about to be described, the eastern race (represented by the form occupying the southeastern extent of the range, namely, southern New England, lower New York and New Jersey) is recognizably distinct, chiefly by having a shade of straw yellow as the ground color of the under surface of the wings. It is advisable to mention here that a number of authors have described *epixanthe* as having the ground color of the under surface of the wings "various shades of grey," apparently overlooking the fact that Boisduval and LeConte's original description calls for "whitish-yellow" ("Le dessous des ailes est d'un jaune blanchâtre") (5). Furthermore, the under surface of the figure of *epixanthe* illustrated in Boisduval and LeConte's original description (fig. 5, pl. 38) is definitely yellowish and not grey or white. It is therefore difficult to understand what various writers had in mind when describing *epixanthe* as greyish below. Could it be that they based their description on faded specimens, the occasional lighter colored (albinic) aberrational form of the eastern race or the midwestern subspecies? This should be taken into consideration; otherwise, it may lead to a great deal of confusion in regard to the type of *epixanthe* or to the taxonomy of the species. It should be mentioned that in isolated cold bogs in some sections of the eastern states, minor local races differ slightly from what may be considered as the normal eastern subspecies. Specimens from the Passadumkeag Bog in Maine presented to me a number of years ago by Mr. L. Paul Grey of Lincoln, Maine, appear to be intermediate between *L. e. amicetus* (Scudder) and the new midwestern subspecies; that is, the under surface of the secondaries is grey and the dark brown maculations are very much reduced in size. Furthermore, these particular specimens are smaller than typical *epixanthe.* The occurrence of minor, local or ecological races is what might be expected of a butterfly with decidedly local habits after becoming isolated from the main stem or population, during the course of perhaps thousands of years. Minor or local races may be insignificant taxonomically, although they may be of decided interest to the students of Ecology, Genetics or Evolution. A great deal more study is necessary before the status of the races of *epixanthe* is clearly understood, but for the present, I believe that the species is represented by at least three recognizably distinct subspecies; namely, *amicetus* (Scudder) in the extreme north (Newfoundland and Nova Scotia), *epixanthe* (B. & L.) (subject to further study and possible division) in the eastern states as far south as southeastern New Jersey, and a midwestern subspecies, described below, occurring in Wisconsin, Michigan, possibly northern Indiana and perhaps other adjacent states.

The evidence which indicates that the authors of *epixanthe* were probably in error as to the type locality, New Harmony, Indiana, is as follows: If Boisduval and LeConte's type was taken in New Harmony, it is logical to assume that it should correspond with the midwestern race. But in comparing the cotypes in the United States National Museum with specimens of typical eastern and midwestern material, it can be clearly seen that these cotypes are close to or identical with the eastern subspecies. For instance, one of the cotypes has the under surface of the wings "straw color" while the other is somewhat lighter in shade but yellow enough to be recognized as belonging to the eastern subspecies. They resemble particularly specimens from the southern portion of the range, namely, southern New York and New Jersey.

After corresponding with Indiana lepidopterists, I cannot find any evidence that *epixanthe* has ever been taken in the vicinity of New Harmony, or in fact, in the State of Indiana except in Lake County which is approximately 250 miles north of New Harmony. Blatchley (6) in 1892, recorded *epixanthe* as occurring in Indiana (Lake County) in July and August and the most recent list of Indiana butterflies by Montgomery (7) repeats Blatchley's record without adding any new ones. Blatchley's specimens do not appear to be available for study which is unfortunate since they would undoubtedly correspond with the midwestern subspecies judging by the geographical position of Lake County, Indiana.

A report kindly sent by Professor B. Elwood Montgomery of Purdue University (July 3, 1947), states that he could find no evidence of either *Lycæna epixanthe* or its food plant (cranberry) while on a collecting trip of several days in South-central Indiana from Jefferson to Orange Counties.

Information which I have been able to obtain from botanists also suggest that Boisduval and LeConte's cotypes were not taken in the neighborhood of New Harmony, Indiana, because there are no records of the food plant of the species; namely, cranberry (*Vaccinium macrocarpon* Ait. or *V. oxycoccus* L.) occurring in Indiana nearer to New Harmony than Delaware County. Dr. Charles E. Olmstead, Associate Professor, Department of Botany, University of Chicago, advises me that so far as he knows *V. oxycoccus* is entirely northern in its distribution, occurring only in the northern counties of Indiana, Ohio and further northward.

In "Shrubs in Indiana," Dean lists cranberry as being confined to northern Indiana. It is, of course, possible that plants other than cranberry may be used by *epixanthe* larvæ as a food plant. However, this is not very likely because no lepidopterist to my knowledge has reported finding the larvæ of *epixanthe* feeding on other than cranberry plants or the imagoes inhabiting other than cranberry bogs. According to Scudder (8), "*epixanthe* occurs only in cranberry bogs where it flies near the ground and frequently rests on cranberry and sumac bushes." Cook and Watson (9) also describe the food plant as cranberry. Judging by the evidence presented above, it would appear very improbable that Boisduval received the specimens of *epixanthe* on which he founded the type from New Harmony. As to why such a possible error was made, there does not seem to be any satisfactory explanation. However, a note received from Mr. Wm. D. Field, of the United States National Museum, Washington, D. C., offers a plausible explanation. With Mr. Field's permission, I am publishing his note as follows:

> The only entomologist known to have lived and collected at New Harmony, Indiana, prior to 1833, was Thomas Say. This gentleman was one of the original founders of the community in 1825. Prior to 1825, Say's home was in Philadelphia and he collected a great deal around this area as well as in New Jersey forming quite a large collection of insects. This collection he took with him to New Harmony. I suggest that it is quite possible that Boisduval received *epixanthe* from Say. This material was probably unlabeled and Boisduval assumed they were taken at New Harmony—the address of his correspondent at that time. I can find no evidence in Boisduval's or Say's writings that they did correspond or exchange or that Say sold or gave Boisduval any material. Say did write to numerous important entomologists of the period. Major John LeConte (Boisduval's American collaborator) may have been the person who received *epixanthe* from Say and the latter sent the specimens to Boisduval. If all this were true, then the real type locality would probably be somewhere in New Jersey or the environs of Philadelphia. It is recorded that Say collected in and around Great Egg Harbor, New Jersey (see pages 109–110 of "Thomas Say, Early American Naturalist," by Harry B. Weiss and Grace M. Ziegler, 1931).

Apparently no lectotype has been selected from the cotypes in the National Museum. Therefore, the female specimen labeled "*Chrysoph. hypoxanthe* Bdv. (*epixanthe*) Type," *showing the least yellow on the under surface of the wings* has been selected and labeled "lectotype." The other female specimen automatically becomes a paratype. Furthermore, I have added to the United States National Museum collection, a small series of *Lycæna epixanthe,* comprising five ♂♂ and four ♀♀ as representing the eastern subspecies because they correspond with the Boisduval and LeConte type material. These specimens were all taken July 6, 1947 in a cranberry marsh near Lakehurst, New Jersey. As we are not sure of the actual type locality of Boisduval and LeConte's type, this small series will serve as a criterion or basis of comparison by representing the eastern subspecies. Each one has been labeled, "homotype."

A new subspecies of *Lycæna epixanthe* (Boisduval and Leconte) from Michigan and Wisconsin is described as follows:

Lycaena epixanthe michiganensis, new subspecies

Holotype, Proud Lake, Oakland County, Michigan, July 1, 1945.
Collector: George W. Rawson.
Full expanse: 22.5 mm.

Description of upper surface:

Forewings: Similar to or identical with eastern *epixanthe* (as represented by Boisduval and LeConte's cotypical material in the United States National Museum, Washington, D. C.)

Hindwings: Similar to typical *epixanthe* except that the submarginal band or chain of orange-red lunules extends about two-thirds the length of the submarginal border. In the majority of specimens of the eastern subspecies the lunules extend along about one-half the length of the submarginal border.

Under surface:

Forewings: The ground color, greyish-yellow, is paler than in the eastern subspecies of *epixanthe,* the maculations standing out in bolder contrast against the lighter background. The black maculations running parallel with the outer border are narrowly margined with reddish-brown outwardly.

Hindwings: Ground color light grey, somewhat pearly or with a trace or suggestion of light blue when seen by reflected light. *This is the chief or distinctive feature of this subspecies.* The blackish maculations on the under surface of the secondaries are quite distinct and somewhat larger than in average specimens of the eastern subspecies. The band of orange-red lunules occurring on the lower surface is similar to that above although it does not extend quite as far towards the coastal margin. The lunules are also of somewhat brighter hue than in the eastern subspecies.

Allotype, Proud Lake, Oakland County, Michigan, July 5, 1944.

Collector: John H. Newman.
Full expanse: 25.5 mm.

Description of upper surface: Similar to the eastern subspecies on the upper surface of both the primaries and secondaries except the maculations are a trifle longer and broader. The band or chain of orange-red lunules extends about one-half the length of the submarginal border.

On the under surface, the orange-red lunules of the secondaries are about the same as on the upper surface and the ground color and the maculations are practically the same as described for the holotype. As in the case of the holotype, the pearly-grey ground color is the chief feature which distinguishes this new subspecies from the eastern race. Both the holotype and allotype have been deposited in the United States National Museum, Washington, D. C.

Paratypes:

Thirty-two specimens have been designated as paratypes and so labeled. Of these, eleven males and one female taken July 1–4, 1944–45, Oakland County, Michigan, are in the possession of Mr. John H. Newman, South Lyons, Michigan. A male specimen taken July 4, 1947 at the same place has also been added. Five males and one female taken in Washburn County, Wisconsin, July 20, 1946, and one female same locality, July 18, 1944 by Mr. Edward S. Thomas, Curator of Natural History, Ohio State Museum, Columbus, Ohio, are in the collection of the latter institution. Ten males and one female taken July 1–6, 1944–45 in Oakland County, Michigan are in my possession. Another female specimen (used for genitalic study) is in the collection of Mr. C. F. dos Passos, Mendham, New Jersey. Mr. Newman or I will make arrangements to have a few paratypes, or at least topotypical material deposited in the collections of the Museum of Zoology, University of Michigan, Ann Arbor, the American Museum of Natural History, New York City and in other institutions.

So far as the distribution of *Lycæna epixanthe michiganensis* is concerned, very little is yet known. We do know that this subspecies occurs in Washburn County, Wisconsin, and in Oakland County, Michigan, as well as in five other counties in Michigan according to Moore (10), namely, Alger, July 25, Chippewa, July, Dickinson, July 10–August 18, Keweenaw (Isle Royal) and Schoolcraft, August 21. Macy and Shepard's (11) reference to *epixanthe* as occurring in Minnesota and Kansas undoubtedly applies to the subspecies, *michiganensis*. Intensive search for the species by Edward S. and John S. Thomas in the few cranberry bogs which remain in Ohio has so far proved unsuccessful.

It may be of interest to mention that so far as we have observed there appears to be no tendency towards noticeable variation in this new subspecies; in fact, it seems to be very stable and uniform. However, a comparatively small number of specimens have been collected and it is of course, possible that variants or aberrations may be found when a sufficient number of specimens have been obtained. Pale atypical or aberrant specimens of *epixanthe* are occasionally found in colonies associated with the typical eastern form. These closely resemble the new subspecies *michiganensis* in lacking the straw yellow-colored under surface of the wings. The principal difference is that the band of orange-red lunules on the under surface of the hind wings is not so extensive or so brightly colored as in *L. e. michiganensis.*

The total width or expansion of thirty paratypes are as follows:

	Minimum	*Maximum*	*Average*
27 males	23 mm.	26 mm.	24.0 mm.
3 females	25 "	26 "	25.6 "

Acknowledgements

I wish to express my thanks for advice and assistance to Mr. Wm. P. Comstock and Dr. Chas. D. Michener of the American Museum of Natural History, New York, Mr. Wm. D. Field of the National Museum, Washington, D. C., Professor W. T. M. Forbes of Cornell University, Professor B. Elwood Montgomery of Purdue University, Mr. Cyril F. dos Passos, Mendham, N. J., Mr. Edward S. Thomas, Ohio State Museum, Mr. W. S. McAlpine of Birmingham, Michigan, Mr. John H. Newman, South Lyons, Michigan and to others whose names may have been inadvertently omitted but whose assistance or cooperation is nevertheless acknowledged and appreciated.

Note:

Slides of the male genitalia of *amicetus,* eastern *epixanthe* and the new subspecies *michiganensis* have been prepared by Mr. Cyril F. dos Passos with the following comments: "There appears to be no substantial differences between *amicetus* (Scudder) and your subspecies, except that the former is somewhat smaller. However, both seem to differ from eastern *epixanthe* in that the latter appears to have larger labides, especially the distal section thereof. Further dissections should be made to ascertain if this is due to a distortion in my mount or whether the particular specimen dissected is somewhat aberrant.''

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A BRIEF ANALYSIS OF VIVIPARITY IN INSECTS

By HAROLD R. HAGAN
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Viviparity may be defined as the birth of offspring without an enveloping egg shell. By way of contrast, oviparity means the extrusion of eggs or offspring that are surrounded at birth with such a membrane. To speak of the first case as the deposition of living young and to say that eggs are laid in the second are frequently misleading and erroneous statements which appear in the literature. Birth products are usually living offspring in more or less advanced stages of development. Only deposited eggs that require subsequent fertilization contain no living offspring.

Every known variation in the production of the next generation may be found. There are parthenogenetic eggs requiring no male contribution, inseminated eggs in which the culminating act of fertilization is still to ensue after deposition, and extruded, fertilized eggs in the zygotic stage. Eggs are also laid that may contain embryos of any developmental age, even eggs with fully grown embryos ready to fend for themselves immediately upon extrusion and, finally, insects give birth to living offspring which have hatched from the egg within the mother's body, or the eggs may never have been initially provided with a shell. All these may be cited as examples of reproductive processes in insects. It is with the last phenomenon that we are now concerned, and even viviparous reproduction shows several variations in its expression.

A few years ago, the writer undertook a study of the reported methods of viviparous reproduction in the hope of discovering some underlying factor, or factors, common to all of them. The study revealed, first, that a surprisingly large number of orders possess at least some viviparous species; second, despite profound differences in viviparous reproduction, each species conforms to one of four general patterns, or types, in the reproductive process; third, the taxonomic relationship between orders gives no clue to the viviparous reproductive pattern followed by their species; fourth, related families within an order may possess species differing from one another as greatly as may the orders with respect to their viviparous patterns. From these facts we can, perhaps, conclude that viviparity has arisen independently several times without regard to the length of the evolutionary history of the species concerned.

It should at once be evident that viviparity makes necessary special cooperative adjustments on the part of both mother and offspring beyond the comparatively simple demands of oviparity. The viviparous types and some of the modifications required of parent and offspring may now be reviewed.

1. Ovoviviparity is that type in which the egg contains sufficient yolk to nourish the embryo till hatching occurs and the offspring is deposited. This is by far the most commonly encountered kind of viviparity, occurring, or said to occur, in Thysanoptera, Blattodea, Anoplura, Plectoptera, Homoptera, Lepidoptera, Coleoptera, Hymenoptera and many Diptera, especially in the families Sarcophagidæ, Tachinidæ and Anthomyidæ.

In ovoviviparity the maternal uterus is often greatly enlarged in saccular form or as an elongate, spirally-twisted, wide tube. The chorion, or egg-shell, is frequently reduced to a thin, delicate, elastic membrane. Maternal physiological processes are altered to limit ovulation to a single egg or a few eggs at a time over a prolonged reproductive life. Her nervous system is adjusted for the retention of eggs till hatching is accomplished rather than to deposit them at once after the manner of oviparous species.

The offspring that hatches from the egg must escape from the shell in the maternal uterus. This process is quite different from rupturing the dry and brittle chorion of a deposited egg with an abundance of room. The larva also must have undergone physiological changes, too, for it does not attack the maternal tissues but, upon deposition, will readily and immediately feed on the tissues of its host if it happens to belong to a predatory or parasitic species.

2. Adenotrophic viviparity includes those insects whose retained eggs contain sufficient yolk to nourish the embryo till hatching occurs. After hatching, special maternal organs nour-

ish the offspring throughout larval life. All the pupipara (Hippoboscidæ, Nycteribidæ, Streblidæ) and all species of the family Glossinidæ are of this type.

Females having this type of viviparity are physically and physiologically limited to very few ovulations, perhaps ten or fifteen, during their reproductive life. Further, the ovaries alternate in the production of eggs so only one offspring at a time is cared for by the mother. Accessory glands are altered to function as nutrient organs, from which the larva derives its sustenance till ready to pupate. The larva has lost most of its ability to move, retaining only sufficient musculature to carry on respiratory functions and, in the Glossinidæ, to burrow in the soil far enough to hide during the pupal stage.

3. Metagonadic viviparity is distinguished by the haemocoelous development of the offspring for the ovaries do not discharge the ova into genital ducts. Embryonic nutriment is derived from maternal tissues by absorption through a trophamnion or a trophserosa. The developed larva often devours practically all of the mother's internal anatomy. Examples of this type of viviparity occur in certain Diptera (*Miastor,* etc.) and all species of Strepsiptera.

Diptera with metagonadic viviparity exhibit parthenogenesis in their viviparous phase although functional males appear seasonally and the species then becomes oviparous for a generation. The embryo absorbs nutriment from the surrounding maternal tissues. The larva becomes a parasite and, contrary to the larva of ovoviviparous species, immediately acts as a predator within its mother. It devours her internal organs and must eventually cut its own opening in the mother's body wall in order to escape. Strepsipterous females never develop into the adult form typical of most insects but remain larva-like in appearance. The reproductive organs have disappeared except for the ovaries which cast their ova into the hæmocœlar space where they lodge in the vicinity of the lobes of the fat body. This tissue is absorbed by the embryo. When the larva is ready to emerge from the maternal body cavity it does so, not by way of reproductive ducts, but through minute canals segmentally distributed along the maternal abdomen.

4. Pseudoplacental viviparity includes insects whose embryos within the genital tract obtain at least part of their nutriment by means of a pseudoplacenta. In every instance of this type of viviparity one notes that the offspring has succeeded in adapting itself to uterine life by the utilization of accessory, extra-embryonic structures normally quite passive, so far as has been ascertained in oviparous species, or it has recalled to active service degenerating organs, thought to be no longer of critical importance, and has given them new functions never before assigned to them. In the first case, the serosa or the amnion, or both, have taken over the rôle of nutrition while in the second, the much-discussed first abdominal appendages (pleuropodia) have assumed this function. It is the sole type of reproduction in which the embryo is more than a passive recipient of embryonic nutrition. Insects possessing this type of viviparity are some Dermaptera, Blattodea, Anoplura, Hemiptera and all Aphididæ.

The maternal and larval adjustments to the viviparous condition more nearly approach those recited for the ovoviviparous type. The offspring are deposited at the same developmental age in both types, corresponding to the freshly hatched embryo of an oviparously produced insect. There is no retention in the maternal body of later larval stages nor their oral nutrition as was the case in adenotrophic and metagonadic types of viviparity.

From this review of the types of viviparity, we may now draw a second conclusion, that is: the viviparous condition has developed in several instances to its present manifestations by different evolutionary processes in closely related species. As two examples to illustrate the meaning of this conclusion it is sufficient to recall that polyembryony appears in some Strepsiptera while the majority lack this interpolation in their metagonadic reproduction. More conclusively, the Diptera have representative species in three of the four types of viviparity.

As in the preceding discussion, we must content ourselves now with a very brief consideration of the evolutionary significance of the viviparous condition. Ovoviviparity may be considered the most elementary type of viviparity and the one most easily achieved. This type digresses least from the oviparous condition and, indeed, some insects show it only infrequently and usually are not viviparous in most of their reproductive activity. Others, such as the examples furnished, are constantly ovoviviparous but show relatively minor adjustments to viviparity in contrast to the three remaining types. However, these three types can, conceivably, be derived from ovoviviparity and it is possible they have thus arisen. In the adenotrophic type, for example, evolutionary progression has resulted, perhaps, from changes foreshadowed by a few extreme cases in ovoviviparity (*Mesembrina meridiana, Musca larvipara*). Pseudoplacental viviparity, too, may merely employ in a different way structures commonly present in ovoviviparous species, while the gradual loss of the reproductive ducts in the metagonadic type could be considered a reduction of the parts originally present before evolution removed them.

These statements would lead one to assume that oviparity preceded viviparity: this seems to be a sound conclusion. There is, certainly, much evidence in favor of this position with none to prove the reverse might be true. It is an evolutionary axiom that lost parts are not regained. If viviparity arose from oviparity then several absent parts in various viviparous species, (seminal receptacles, chorion of the egg, oviducts and yolk) can be explained away as evolutionary losses. It would certainly be more difficult to account for their uniform appearance in oviparous species as new developments from viviparous ancestors, especially for those who also believe in the polyphyletic origin of insects.

Finally, it would appear from a careful examination of the maternal structures affected in the known ovoviviparous insects, and in those that are occasionally ovoviviparous under certain conditions, that viviparity is a potentially important reproductive process, destined to supplant oviparity in a vast number of species. It entails some additional hardships on the mother but is, in the long run, the more economical process of perpetuating the species. With few exceptions viviparous species are numerous, specialized and highly successful in survival values. A population is maintained, not alone by the reproductive rate but equally by its death rate. Viviparous insects possess a very restricted biotic potential compared with related oviparous species but maternal care and protection, the lessened drain of yolk production in bearing limited numbers of offspring, and the reduced death rate of these offspring are essential savings that make it appear that viviparity is a decidedly favorable survival factor in hexapod life.

BOOK NOTICE

A Generic and Subgeneric Synopsis of the United States Ants, Based on the Workers (Hymenoptera: Formicidæ) by Marion R. Smith. *The American Midland Naturalist,* Vol. 37, pp. 521–647. May, 1947.

It is a peculiarity of the Formicidæ, more markedly than of any other of the social insects, that the sexual forms, the normally alate males and females, are much rarer insects than the workers. Not only are they rarer in numbers, but in the majority of cases they are either much more narrowly seasonal in occurrence or more retiring in habits so that they are much less often taken by collectors. Thus the males in the majority of forms appear in some abundance only during a period of a very few weeks, or even less, during a season. The winged females appear above ground only during this same short period. For the rest of the year the dealate forms are widely scattered in their individual colonies and are more or less inaccessible underground.

As a consequence, ants as a group are much better represented in most collections by worker specimens than they are by the sexual forms. This situation has posed very considerable practical obstacles to taxonomic workers in the field who do not have constant access to the largest and most modern collections. The difficulty has been much increased by the marked sexual dimorphism characteristic of nearly all ants and by the further remarkable morphological polymorphism characteristic of the female sex among many of them. So pronounced are these differences that workers and females, workers and males, and males and females of the same species, when taken separately, have frequently been described as entirely different forms, and in some cases, as in the males of many Dorylines, have so remained in the literature for many years before they were properly correlated. In consequence of this situation, ants have presented a very difficult arena for the average taxonomist, and many entomologists have been discouraged from entering the field who undoubtedly would have done so if adequate keys to the Formicidæ, based on worker characters, had been available.

The present very complete and beautifully organized paper supplies this need most admirably for the ants of the United States. It will undoubtedly find a warm welcome among myrmecologists as the answer to a very long standing and imperative demand which has never before been adequately met, and it should result in turning the efforts of a number of entomologists who have not hitherto concerned themselves with the Formicidæ into this field, where additional workers are badly needed.

There is probably no entomologist in the United States at present so well qualified to undertake this task as Dr. Smith. For thirty years he has been engaged in an intensive study of North American Formicidæ and for the last ten, in Washington, he has had continuous and intimate contact with all of the material in the Wheeler collections, in addition to the even more extensive material in the Smithsonian Institution. His knowledge of North American Formicidæ is profound.

This paper is very complete. The descriptions are extensive and the arrangement is such that any worker concerned with the group, even if he is but a tyro in the field, can readily use them. The plates are numerous and clear. The format is excellent and the historical background of the subject is very completely covered. Altogether, too much praise can hardly be given to this complete, clear, thorough, and very much needed contribution to myrmecological literature.—C. P. HASKINS.

DECEASED

We regret to announce that Professor T. D. A. Cockerell, an honorary member of the New York Entomological Society and widely known for his entomological work, died at the age of 81 years on January 26, 1948, at San Diego, California, where he and Mrs. Cockerell were spending the winter. Several months ago he suffered a stroke, but recovered sufficiently to resume work on the bees of Honduras, when the end came. An extended account of Professor Cockerell will appear in the next issue of this JOURNAL.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

MEETING OF JANUARY 7, 1947

A regular meeting of the New York Entomological Society was held January 7, 1947, in the American Museum of Natural History. President Stanley W. Bromley was in the chair. Fourteen members and six guests were present.

The Nominating Committee's recommendation for the officers for 1947 were read by Mr. Teale as follows and all nominees were elected.

President	Dr. Harold R. Hagan
Vice-President	Dr. T. C. Schneirla
Secretary	Frank A. Soraci
Assistant Secretary	Lina Sordillo
Treasurer	Dr. James C. King
Assistant Treasurer	Leonard J. Sanford
Editor	Harry B. Weiss
Trustees:	Dr. Harold R. Hagan William P. Comstock Dr. Stanley W. Bromley Dr. T. C. Schneirla E. I. Huntington
Publication Committee:	Harry B. Weiss John D. Sherman Dr. Charles D. Michener

Dr. Bromley then turned the meeting over to the new president, Dr. Harold R. Hagan.

Dr. Stanley W. Bromley spoke on ''The Last Few Years'' (illustrated by Kodachrome slides). His paper will be published in the Journal.

LINA SORDILLO, *Secretary*

MEETING OF JANUARY 21, 1947

A regular meeting of the New York Entomological Society was held January 21, 1947, in the American Museum of Natural History.

In the absence of the President, Doctor Hagan, Dr. T. C. Schneirla, Vice-President, was in the chair. Fifteen members and four guests were present.

Doctor Spieth, chairman of the Auditing Committee reported that the books of the society were audited and found to be correct. The report was accepted as read.

Doctor Schneirla appointed Dr. Charles D. Michener, Chairman of a Committee on the Zoological Record. As such, Dr. Michener is soliciting contributions for that publication. He reported that he had collected about

$85.00 for this purpose and that he is hopeful that additional funds might be subscribed.

Mr. Albert Zerkowitz who was to speak on the topic "Collecting Lepidoptera in Europe" was unable to attend and in his absence, Dr. Schneirla presented a very interesting paper on "The Coming and Passing of Males of the Genus *Eciton,*" an abstract of which follows.

Dr. Schneirla's remarks were confined mostly to the species *burchelli.* This is a species of raiding ant, colonies of which are regularly nomadic and statary, raiding for 17 days, then statary for about 20 days. Doctor Schneirla's observations were made on Barro Colorado Island during a four-month period commencing February 7, 1946, in the dry season of 1946. *E. burchelli* is a "swarm" raider, the males of which appear specifically confined to the dry season. As many as 21 colonies of *E. burchelli* and 30 of *E. hamatum* were studied from mid February to late April. Conditions are similar for the column-raiding species *E. hamatum,* except that in this species the males appear about one month later than in *E. burchelli.*

Doctor Schneirla observed that male eggs are laid by the one true queen in each colony and that she lays at least 18,000 to 20,000 eggs during her egg-laying period which occurs regularly every 35 days. It is believed that a given colony has only one male brood per dry season. The eggs are laid during the early statary period. At the time male eggs are laid, worker eggs are not found in the colony. With regard to the behavior relations of the males to the colony, it is believed that the workers are stimulated by the larvæ into raids. When the callow males (about 3,000) emerge from cocoons, large daily raids and nightly nomadic movements of the colony begin. At other times a similar behavior change occurs when callow workers (about 30,000) appear.

The alate males remain within the bivouac during the day. After dusk they are seen around the bivouac. Usually one or more workers cling to the males as they run about in the bivouac vicinity. Some workers are actually carried off in this manner. Each evening many of the alate males fly from the colony, probably for a distance of more than two or three hundred yards. They soon lose their wings and after about 21 days all are gone. It has been observed that the males often respond to raiding trails of colonies other than their own but it is thought that only a few might make their way into their own or those of another colony.

In the discussion that followed his remarks, Doctor Schneirla spoke of the abundance (number and species) of "ant birds" that followed the swarm raiders, taking prey flushed by the ants, but apparently not feeding on the ants themselves.

FRANK A. SORACI, *Secretary*

MEETING OF FEBRUARY 4, 1947

A regular meeting of the New York Entomological Society was held February 4, 1947, in the American Museum of Natural History. Ten members and five visitors were present. In the absence of President Hagan and of Vice-President Schneirla, Mr. Soraci, secretary, was in the chair.

The meeting was called to order at 8:15 P.M. Mr. Albro T. Gaul, speaker of the evening, proceeded with his paper on "Recent Observations of Vespine Wasps."

Mr. Gaul described the seven distinct forms commonly found in a colony, and related his interesting experiences in transplanting a colony of *Vespula* *squamosum* from Mr. Edwin Way Teale's grounds at Baldwin, L. I., to his own home in Brooklyn. This colony, found in 1945 by Mr. Gaul, was the first one reported from New York. Mr. Gaul described the formation of a new nest by this colony, and the build-up in numbers from 90 workers on August 19 to 400 workers on September 9. The colony declined from that point and by October 11, only a few males remained. Mr. Gaul was able to introduce some specimens of *Vespula maculifrons* workers into the colony with no apparent deleterious effects, finding on the contrary that the two species got along very well.

F. A. SORACI, *Secretary*

MEETING OF FEBRUARY 18, 1947

A regular meeting of the New York Entomological Society was held February 18, 1947, in the American Museum of Natural History. Eleven members and four visitors were present. President Harold R. Hagan was in the chair.

Mr. Edwin A. Reddoch, 303 Fourth Avenue, New York City, was proposed for membership.

Dr. James C. King, the speaker of the evening, presented an interesting talk on the topic, ''Notes on the Genetics of *Calasymbolus excœcatus.*''

The adults of this sphingid moth appear in late June and early July, and it is one brooded in Westchester County, where Doctor King conducted his work. The moths occur commonly on wild cherry, willow, poplar, oak and many other common trees.

From the eggs of one moth taken in July 1943, he found that 75 per cent of the caterpillars molted four times and 25 per cent molted five times. Then 25 per cent of the adults were very yellow-green and 75 per cent were very blue-green. Thus there were two mutant characters appearing in proper, one to three, fashion. However, all 35 adults reared in this trial were females. Since then, Doctor King has reared nine broods, and from 350 pupæ he has obtained only 13 males. Usually only about half of the eggs hatch, and males have been reared only from eggs with a high rate of hatch. From one batch of eggs, 90 per cent of which hatched, 11 males emerged, and two males came from a batch, 61 per cent of which hatched. Doctor King concludes that this moth is not good genetics material. He suspects that three pairs of alleles are concerned with the molting factor, since a ratio of one to seven existed in caterpillars that molted four and five times. With regard to the two color forms, two pairs of alleles are thought to be present. He found that two blue-greens could give some yellow-green progeny, and that two yellow-greens could give some blue-green progeny.

It was concluded that both these phenotypic differences are genetically controlled. Doctor King observed that similar mutations are common in the Sphingidæ, and in the Lepidoptera generally.

F. A. SORACI, *Secretary*

MEETING OF MARCH 4, 1947

A regular meeting of the New York Entomological Society was held March 4, 1947, in the American Museum of Natural History. Nine members and seven visitors were present. President Harold R. Hagan was in the chair.

Mr. Edwin A. Reddoch was elected to membership. Mr. Albro T. Gaul, 401 Washington Avenue, Brooklyn, New York, was proposed for membership.

The following committees were appointed:

Field Committee
Mr. Chris Olsen, Chairman
Miss Lucy Clausen

Program Committee
Mr. Sam Harriot, Chairman
Mr. William P. Comstock

Mr. Albert Zerkowitz, speaker of the evening, presented a talk on ''Collecting Lepidoptera in Europe.'' He spoke of his arrival in the United States in 1941, and of his first catch in his new world. It was *Pieris rapæ.* He gave a brief history of collecting in Europe, mentioning the large European collections that had been established by the middle 1800's. Mr. Zerkowitz had the opportunity to see some of the Linnæus types, and showed pictures of these types which are still in fairly good condition. He spoke of the many collections that had been lost and of the fact that the greatest collection is that of the British Museum.

Mr. Zerkowitz spoke of the thousands of Lepidopterists in Europe and the fact that each of its capitol cities has a Lepidopterological Club. It would seem that preservation of the species rather than control is a problem in many parts of Europe.

The talk was accompanied with a series of beautiful colored slides of places in Europe where the speaker had collected.

F. A. SORACI, *Secretary*

MEETING OF MARCH 18, 1947

A regular meeting of the New York Entomological Society was held March 18, 1947, in the American Museum of Natural History. Sixteen members and eleven visitors were present. President Harold R. Hagan was in the chair.

Mr. Albro T. Gaul was elected to membership.

Mr. Frank A. Soraci, speaker of the evening, presented a talk on ''Experiences in Medical Entomology in Japan,'' touching on his work in Insect Survey and Sanitation, as a member of the Sanitary Corps in the Army of the United States, during the recent war.

F. A. SORACI, *Secretary*

MEETING OF APRIL 1, 1947

A regular meeting of the New York Entomological Society was held April 1, 1947, in the American Museum of Natural History. President Harold R. Hagan called the meeting to order at 8: 00 P.M. Twelve members and four visitors were present.

Dr. Theodore L. Jahn, Associate Professor of Zoology, The State University of Iowa, Iowa City, Iowa, was proposed for membership.

Doctor Hagan reported that the Society had need for additional funds and that it was hoped that such funds might be obtained by additions to our present membership.

Mr. William P. Comstock, speaker of the evening, spoke on ''Modification of Veins in the Wings of the Genus *Anaea.*'' This is a genus of butterflies of the family *Nymphalidæ.* He has divided the genus, containing over 100 species, into twelve groups on the basis of the structure of the wings. His research leads to the conclusion that the genus *Anaea* is of South American origin and that its extension into Central and North America was subsequent. He does not find at present any justification for the division of this large group of species with its subspecies into separate genera or even subgenera. While the species present very diverse wing structure, genitalia and color patterns, they are all bound together by a number of definite characters in common which separate them from all other butterflies. It is Mr. Comstock's suggestion that this large group had a single origin from some stem from which the genera *Agrias* and *Prepona* may also have been derived. For simplicity of taxonomy the retention of all the *Anaea* species in one genus seems advisable.

F. A. SORACI, *Secretary*

MEETING OF APRIL 15, 1947

A regular meeting of the New York Entomological Society was held April 15, 1947, in the American Museum of Natural History. President Harold R. Hagan was in the chair. Fourteen members and twelve visitors were present.

Dr. Theodore L. Jahn was elected to membership.

Under a suspension of rules Dr. H. Elishewitz of Caracas, Venezuela, was proposed and elected to membership.

Mr. Robert P. Owen of the Bureau of Entomology and Plant Quarantine, Inspection House, 209 River Street, Hoboken, was proposed for membership.

The field committee reported that an outing was planned to the home of Mr. Chris E. Olsen at West Nyack, N. Y., for June 7. The Society voted to accept with thanks Mr. Olsen's kind invitation. It was further reported that a second outing to the home of Edwin Way Teale, on Long Island, would be announced at a later date.

Dr. Mont Cazier, speaker of the evening, then addressed the Society on his army experiences. As a Sanitary Corps officer, during the recent war, he experienced a rather rough trip by water to India, then rougher trips by land across that country, and then by air to China. His talk touched on his work with *Anopheles phillipinensis* and *Anopheles subpictus,* carriers of human malaria in India, and with *Anopheles hyrcanus sinensis* and *Anopheles minimus* in China. Dr. Cazier also mentioned that non-malaria carrying mosquitoes came in for some attention, although his efforts were concerned primarily in reducing the malaria rate in our troops. His talk was illustrated with some excellent photographs of general interest.

F. A. Soraci, *Secretary*

Meeting of May 6, 1947

A regular meeting of the New York Entomological Society was held May 6, 1947, in the American Museum of Natural History. President Harold R. Hagan was in the chair. Thirteen members and seven visitors were present.

Mr. Robert P. Owen was elected to membership.

Directions for the field trip on June 7, to the home of Mr. Chris Olsen at West Nyack, N. Y., were received and the secretary was instructed to mail these to all members living in the New York City area. He was also instructed to mail out the directions for the later field trip to the home of Mr. Edwin W. Teale, when arrangements have been completed.

Dr. James Forbes, speaker of the evening, talked on ''Observations on the Anatomy of Ants.'' His observations were limited to the carpenter ant, *Camponotus herculeanus pennsylvanicus,* and to the reproductive organs of the male, primarily. Diagrammatic illustrations of the male reproductive system were shown and the unusual form of the various organs evoked considerable discussion.

F. A. Soraci, *Secretary*

Meeting of May 20, 1947

A regular meeting of the New York Entomological Society was held May 20, 1947, in the American Museum of Natural History. President Harold R. Hagan was in the chair. Fourteen members and twelve visitors were present.

Dr. Caryl P. Haskins, speaker of the evening, gave his talk on the subject, ''The Ponerine Ants as Subjects for Systematic and Experimental Study.'' He proceeded with a history of the taxonomy of ants, discussing the basic works of Linnæus, Fabricius, Latreille, and others, then Lubbock's separation of the family Formicidæ into subfamilies, Formicinæ, Ponerinæ and Myrmecinæ was mentioned. Wheeler suspected the colony foundation of the ponerines and under the present classification this subfamily is one of eight subfamilies of the super-family Vespoidea.

Some characteristics of this subfamily are that they have functional and well developed stings and poison glands. The larvæ have well developed mandibles and feed on solid food. Cast distinctions are ill defined. Colonies are in many cases pliometric. In general queen fertility is low and the colonies generally have few individuals. A colony of a thousand individuals is unusual in this subfamily, while some comprise only as few as 12 individuals. All but two species nest in the soil. Of the two exceptions, one nests in wasps nests and the other in epiphytic plants. No ponerines keep or tolerate other species, and none keep aphids. In the subfamily there are no fungus growers or seed sowers and social or internal parasites are practically unknown. Since regurgitation is practically impossible in these insects, the larvæ make their way to the food which is usually just dumped into the nest. Larval exudates are licked up by the nurses. The ponerines are largely confined to the tropics.

Doctor Haskins then showed a series of slides and colored movies. He also had several live colonies on hand which were viewed with interest by the audience.

Following Doctor Haskins' talk, President Hagan mentioned that our next regular meeting would be held on October 7, 1947.

FRANK A. SORACI, *Secretary*

INSECTS ATTRACTED TO SMOKE

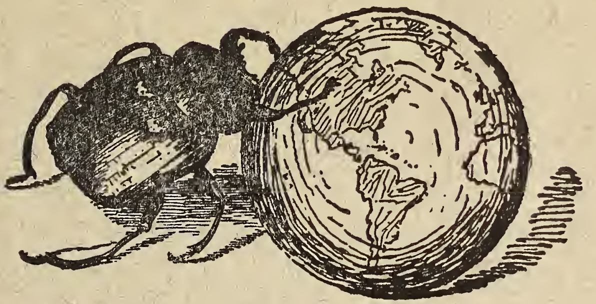
Apropos of the observations of Edward L. Kessel relative to the attractiveness of smoke to the fly *Microsania occidentalis* as noted in this JOURNAL, vol. 58, p. 146, Vincent G. Dethier in his recent book "Chemical Insect Attractants and Repellents," 1947, mentions the behavior of various species of beetles of the genus *Melanophila* and their positive responses to the smoke, from burning conifers, burning oil, from a distillation plant, a smelter plant, a sugar refinery and even to the smoke from cigarettes, that hangs over a stadium during a big game. E. G. Linsley investigated the behavior of these beetles to fire and smoke and his interesting paper appeared in the Journal of Economic Entomology, vol. 36, 341–342, 1943.—H. B. W.

Vol. LVI No. 2

JUNE, 1948

Journal
of the
New York Entomological Society

Devoted to Entomology in General



Edited by HARRY B. WEISS

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Subscription $4.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1948

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NOTICE: Volume LVI, Number 1, of The Journal of The New York Entomological Society was published on April 24, 1948.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

VOL. LVI JUNE, 1948 No. 2

A SURVEY OF THE ARTHROPOD VECTORS OF EQUINE ENCEPHALOMYELITIS AND ENCEPHALITIS*

BY M. A. MANZELLI, RESEARCH FELLOW
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Equine encephalomyelitis is a disease that attacks horses, mules, donkeys, and other animals, causing a combined inflammation of the brain and spinal cord. The causative agent of this disease is a filterable virus with neurotropic properties (28). The three known strains of equine encephalomyelities virus, western, eastern, and Venezuelan, are serologically and immunologically distinct from one another.

Within the boundaries of North America occur both the western and eastern strains. The western strain of the virus, since its discovery in California during 1930–31, has been recovered in the states of Alabama, Arizona, Colorado, Idaho, Illinois, Iowa, Kansas, Kentucky, Michigan, Minnesota, Montana, Nebraska, Nevada, North Dakota, South Dakota, Texas, Utah and Washington. The eastern strain has been found in Alabama, Connecticut, Delaware, Florida, Georgia, Louisiana, Maryland, Massachusetts, Michigan, Missouri, New Jersey, North Carolina, South Carolina, Texas, and Virginia. As may be seen both strains have been found in Alabama, Michigan, and Texas. With the exception of Pennsylvania, Tennessee and West Virginia, from which epizootic encephalomyelitis had not been

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* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, Department of Entomology.

reported during the fifteen years preceding 1946, unidentified strains of the virus have been found in the remaining unnamed fourteen states (4, 6, 40, 72).

In the report of the Chief of the Bureau of Animal Industry for the year 1937 it was stated that the virus of equine encephalomyelitis had been definitely recovered in 22 states, and that during the summer and fall of 1937 more than 169,000 cases and approximately 40,000 deaths among horses had been reported (32, 68). In 1938, 184,662 cases among horses were recorded. The number of cases tabulated from 1935 through 1944 was 500,000, and Shahan and Giltner (72) have estimated that at least 1,000,000 cases occurred in the United States between 1930 and 1945. As the average mortality rate is about 30 per cent, it is possible therefore that since 1930 as many as 300,000 horses and mules have died of infectious equine encephalomyelitis.

In Canada, the western strain of the virus is predominant, with a few cases of the eastern strain occurring only in the region of Ontario. The eastern strain has also been identified in Mexico (72).

Equine encephalomyelitis is found in many of the Central and South American countries. Panama and Brazil have had cases of eastern strain virus within their borders. The western strain has been found in Argentina, where, according to Rosenbusch, "Outbreaks of equine encephalomyelitis occurred in horses over the whole agricultural zone of Argentina in the summer of 1919, another of less intensity in the centre and north of the country in 1933, and a third one in the eastern provinces in 1935–36. There were a few isolated cases in 1938–39" (41).

The Venezuelan strain of the virus has been found in Venezuela, Trinidad, Colombia, and Ecuador. In Trinidad, the Venezuelan strain had killed, as of October, 1943, approximately 70 horses and mules (37, 55, 72).

In recent years the equine encephalomyelitis disease has been observed also in Uruguay, Chile, Peru, and Cuba. During 1944 five samples of equine encephalomyelitis virus obtained from Cuba were typed and found to be all of the eastern type (37, 72).

Encephalitis, a disease of man in which the brain becomes inflamed, is caused by either the same virus strains that are responsible for equine encephalomyelitis or by other strains. The virus strains involved are serologically and immunologically distinct from one another.

These strains of human encephalitis virus are known as: St. Louis, Russian spring-summer, Russian autumn or Japanese "B," West Nile, and Semliki Forest. The St. Louis strain occurs in the United States and has been found in many of the states ranging from Massachusetts in the East to Washington on the Pacific Coast.

The virus of the tick-borne spring-summer encephalitis has been found in several parts of the Russian Union, including European districts not in the forest zone, and in Siberia (3, 21, 30). The virus of this disease is closely related to, or identical with, the virus of louping-ill of sheep in Scotland, which is also tick-borne (2). The virus of the autumn encephalitis has been found in the maritime district and is identical with the Japanese "B" virus.

The Japanese "B" virus was isolated about the year 1934, ten years after it had caused one of the most severe epidemics of encephalitis described. During the summer of 1924 there had occurred in Tokyo over 6,000 cases of encephalitis with 3,797 resultant deaths. This virus was named "B" to distinguish it from "type A," or the von Economo type which was responsible for many cases of encephalitis between the years 1918 and 1926, but which has since vanished (63).

The virus of West Nile encephalitis was first isolated in 1937 from the blood of a native woman in the West Nile district of Uganda, Africa (36, 73).

Smithburn and Haddow, while investigating the vectors of the yellow fever virus in the Semliki Forest, Western Uganda, Africa, isolated a neurotropic virus from mosquitoes of the *Aedes abnormalis* Theobald group. The virus has been named the Semliki Forest virus (74).

EQUINE ENCEPHALOMYELITIS

In 1933, R. A. Kelser reported the first successful transmission of the virus of equine encephalomyelitis (western strain) by an insect vector. Female adults of *Aedes ægypti* L., fed on guinea pigs 48 to 72 hours after the inoculation of the latter with virus of equine encephalomyelitis, became infected. Sixteen to eighteen days after the infective meal the mosquitoes transmitted the disease to guinea pigs and to a horse on which they were fed. The infected animals died (17).

Under natural conditions, *Culex tarsalis* is the chief vector of western equine encephalomyelitis, as has been shown by the works of Hammon and his associates. They isolated strains of western equine encephalomyelitis virus from *C. tarsalis* collected in areas in which the disease was both epidemic and epizootic, and later this species transmitted the western virus in laboratory experiments (10–13, 61–62). *Culiseta inornata* has been proved to be a natural vector of western strain virus as it has been found naturally infected, and has transmitted the virus in laboratory tests (62). *Culex pipiens* and *Anopheles maculipennis freeborni* have been found naturally infected with western equine encephalomyelitis virus, but no experimental transmission has been demonstrated with them. Therefore, these two species are not generally considered to be vectors of the western strain.

To date, no arthropod vector has been found in the United States for eastern equine encephalomyelitis virus. A Japanese report of 1940 (given by Hammon and Reeves, Amer. Jour. of Public Health, Vol. 35, pp. 994–1004, 1945) claims transmission of eastern strain by *Culex pipiens* var. *pallens* and by *C. tritæniorhynchus*. *C. pipiens* var. *pallens* gave negative results with American workers.

Arthropod transmission of the viruses of encephalomyelitis and encephalitis has been summarized in Tables 1 and 2.

Relationship of Virus to Vectors.—Merrill *et al.* (25) found by laboratory experiments that in order for *Aedes ægypti* and *Aedes sollicitans* to become vectors of either western equine encephalomyelitis or eastern equine encephalomyelitis, they must be fed on infected animals at a time when the virus content of the blood is such that 0.0001 cc. or less will produce the disease when it is injected into a guinea pig. When these two mosquitoes fed on infected animals that had a lower virus content in their blood, the virus was soon lost and the mosquitoes did not transmit the disease.

A period of 4–5 days must elapse after *A. œgypti* has fed on an adequately infected guinea pig or on a brain suspension containing the virus before it can transmit the virus of the western strain (26).

Aedes nigromaculis and *Aedes dorsalis,* fed on infected guinea pigs at intervals of from 12 to 72 hours after the latter had been injected with the virus of the western type, were allowed to bite healthy guinea pigs after intervals ranging from 3 to 24–25 days. Positive transmission was obtained with the mosquito *A. nigromaculis* when individuals had fed 18–66 hours after injection of the guinea pigs and had bitten healthy guinea pigs 4–10 days after their infecting meal. The greatest percentage of positive transmissions was obtained on the 6th, 7th, and 8th day. In tests using *A. dorsalis,* the positive results obtained were not very definite, but those that did occur were obtained with mosquitoes that had fed 18–42 hours after injection of the diseased guinea pigs and had bitten healthy animals 9–19 days after the infective meal (20, 24).

Merrill *et al.* (25) demonstrated that in both *A. œgypti* infected with western type and *A. sollicitans* infected with eastern type, the quantity of virus increased 1000–10,000 times within the mosquito.

Merrill and Ten Broeck (27) presented proof of the multiplication of equine encephalomyelitis virus within the mosquito vector by means of serial passage of the virus from mosquito to mosquito. The method used is quoted as follows:

> Thirty female *A. aegypti* infected five days previously by feeding on brain virus of the western strain of equine encephalomyelitis were suspended in 4 cc. salt solution plus 1 cc. normal horse serum. An equal amount of defibrinated horse blood was added and a pledgit of cotton in a Petri dish was moistened with the mixture. A small amount of sugar was sprinkled over the surface of the cotton and the Petri dish was placed in a cage containing female *A. aegypti* that had had no sugar solution for four days and no water for one day. Since the virus deteriorates rapidly when in contact with the air at room temperature, the Petri dish was replaced in an hour's time by one containing the mixture that had been kept in the refrigerator. After another hour this was removed, so that the mosquitoes that fed took up active virus. Those that did not feed were

> eliminated by withholding water for 24 hours and sugar solution for 48 hours from the entire lot. The infected mosquitoes were kept in cages at a room temperature of 24–28° C.
>
> At six to seven day intervals from 25–30 mosquitoes from the last feeding have been suspended and fed to starved females as outlined above. At each transfer virus has been demonstrated in the suspension of crushed mosquitoes by guinea pig inoculations and in many instances dilutions as high as 10^{-5} have proven infectious. Control inoculations of three kinds into guinea pigs have all been negative: a suspension of mosquitoes from our healthy stock; the horse serum and saline used; and a boiled suspension of infected mosquitoes. Since the virus has now been passed in series through ten lots of mosquitoes and since the dilution at each transfer is at least 1:100 we must conclude that multiplication has taken place.
>
> No difference has been demonstrated between the mosquito passage virus and the original strain. Its serological characters are unchanged, the virulence has been modified little if at all, and it passes Berkefeld N filters readily. Mosquitoes infected with the passage strain readily infect guinea pigs by biting.

Merrill and Ten Broeck (27), in the course of their investigations on the multiplication of western equine encephalomyelitis virus in mosquitoes, concluded that the virus appeared to be generally distributed in the body of the mosquitoes. This was determined by inoculating guinea pigs with suspensions of legs removed from uncrushed infected insects, as well as with suspensions of the body fluid, heads, thoraces, and abdomens.

In 1934, Merrill *et al.* determined that the eastern strain virus appeared to persist in at least some of the vectors as long as the latter lived. *A. sollicitans* transmitted the virus of eastern equine encephalomyelitis 33 days after the infective meal. Females of *A. ægypti* were able to transmit the western type after 63 days, and 93 days after the infective meal the virus was shown to be still present within the mosquitoes, although they were not transmitting it at the time (25).

Davis (4) found that the longest time after the infective meal at which *A. ægypti* transmitted the virus of equine encephalomyelitis was 41 days.

Merrill and Ten Broeck (26) found in the course of their investigations with *A. ægypti* as vector of western equine encephalomyelitis that the virus strain could not be demonstrated in eggs from females known to be infected or in larvæ, pupæ, and adults reared from such eggs. The larvæ did not take up the virus when it was added to their rearing water.

In laboratory experiments, Syverton and Berry (48, 49) demonstrated that *Dermacentor andersoni*, a wood tick vector of western equine encephalomyelitis could, in its early stages, acquire the virus, carry it to later stages in its life cycle and also to its progeny. No naturally infected ticks have been found.

Merrill and Ten Broeck (26) showed by laboratory experiments that males of *A. œgypti* could become infected with the virus of western equine encephalomyelitis by feeding on a suspension of virus containing brain tissue and horse blood. Eighteen to twenty-five days after the mosquitœs fed, virus was demonstrated in two suspensions of fifteen and twelve male mosquitoes respectively. However, the remaining infected males did not transmit the virus to normal females, nor did they transmit it from infected to normal females by coition.

It was found that the virus of western equine encephalomyelitis was apparently not injurious to the vector, *A. œgypti*, for the mortality of caged infected mosquitoes was no higher than that of caged uninfected mosquitoes (25).

Reservoirs of Eastern Equine Encephalomyelitis Virus.—In 1935 Ten Broeck *et al.*, (77) favored the view that equine encephalomyelitis of the eastern type was insect-borne, and mentioned the possibility that the disease was not primarily an infection of horses but that it was transmitted to them from birds. Again, in 1938, Ten Broeck (78) after finding neutralizing antibodies in the blood of chickens and turkeys injected with equine encephalomyelitis virus, concluded that domestic and probably wild birds may be infected with equine encephalomyelitis, and that birds may play a part in the transmission of the disease.

In 1939, Van Roekel and Clarke reported the isolation of eastern type equine encephalomyelitis in ring necked pheasants. The pheasants had been obtained from New Jersey during the 1938 outbreak of encephalomyelitis in New Monmouth, Monmouth County (52, 80).

During 1938, Tyzzer *et al.*, (79) found the eastern type equine encephalomyelitis virus in three ring-necked pheasants. At the same time Fothergill and Dingle (58) recovered the eastern type from the brain of a pigeon which had spontaneously contracted the disease in an area where equine encephalomyelitis was prevalent among horses. Sellards *et al.* recovered encephalomyelitis virus (eastern type) from dying pheasants in Connecticut (71).

Following laboratory experiments, Davis (4) maintained that mourning doves (*Zenaidura macroura*), redwings (*Agelaius phœnicens*), cowbirds (*Molothrus ater*) and grackles (*Quiscolus quiscula*), all migratory species often seen in close association with livestock, might serve as reservoirs from which mosquitoes become infected. The above listed birds were susceptible to the virus, and for a short time following inoculation, Aedes mosquitoes recovered the virus from the blood and transmitted it.

Beaudette reported the presence of eastern type equine encephalomyelitis in pheasants in New Jersey during 1939 (three distinct outbreaks), 1940, 1943, and 1944 (two outbreaks) (52, 53, 54).

Reservoirs of Western Equine Encephalomyelitis Virus.—In 1941 Hammon *et al.* (9) found that in the annual epidemics of western equine encephalomyelitis and St. Louis encephalitis in horses and man in the Yakima Valley, Washington, the antibodies of these two viruses could be demonstrated in fowls, ducks, geese, pigeons, turkeys, other birds, cows, dogs, goats, horses, pigs, sheep, and rodents by means of mouse protection tests. Apparently the antibodies in many of the animals listed above are the result of specific infection, either mild or inapparent. The principal foci of infection could be the many barnyards and fowl runs in small towns, rural and suburban areas. The domestic species of animals produced a higher percentage of positives than did the wild species.

Cox *et al.* reported in 1941 the finding of western equine encephalomyelitis virus from a naturally infected prairie chicken. As of 1941, the western strain of virus had been isolated from the brain tissues of eight human cases, three horses, one prairie chicken and one deer (57).

Hammon *et al.* (13) found that in the 1943 survey made in eastern Nebraska, in which neutralization tests were conducted on the sera of 91 mammals and birds, positive results were obtained with pheasants and horses for St. Louis encephalitis and with cows for western equine encephalomyelitis. The investigators concluded that as all results with fowls, rabbits, and pheasants were negative for western equine encephalomyelitis the virus may be adapted to some other host in that locality.

In 1940 Howitt (67) reported that no western equine encephalomyelitis virus was isolated from the brains of 43 wild animals and birds, representing 14 different species taken in the endemic area of the Central California Valley regions as well as from certain coastal districts. Included among those tested for the virus were Gambel sparrows, Kangaroo rat, harvest mouse, pocket gopher, mourning doves, painted finch, wood rat, cottontail rabbit, mallard ducks, pintail duck, and the ring necked pheasant.

Reeves *et al.* have reported the recovery of western strain virus from wild bird mites, (*Liponyssus sylviarum*), in Kern County, California (70). The mites were taken from the nests of two wild birds, and in laboratory tests were shown to harbor the virus.

A variety of birds have been found to be susceptible to infection by either the western or eastern strain of the virus in laboratory tests. Giltner and Shahan (59) made the first successful experimental inoculation of equine encephalomyelitis (western strain) into birds. The following workers have contributed additional information on experimental infection in avian hosts: Beaudette (52), Gwatkin and Moynihan (60), Howitt (67), Sellards *et al.* (71), Syverton and Berry (76), Ten Broeck (78)), Tyzzer *et al.* (79), and Van Roekel and Clarke (80).

Winter Reservoir of Equine Encephalomyelitis Virus.—Hammon and Reeves (64) indicate that the problem of finding a true reservoir (or winter carry-over) of western equine encephalomyelitis virus remains unsolved. The relationship between the vectors and the summer reservoirs of the virus has been well established, but nothing is known concerning its winter reservoirs. Hibernating *C. tarsalis* adults have been tested for the presence of virus and found negative. No transovarian infection has been found in *C. tarsalis*, and no persistent latent infection has been found in mammals.

The true reservior of eastern equine encephalomyelitis is also completely unknown.

Encephalitis in Horses.—Cox et al. have presented data demonstrating that horses are susceptible to the virus of St. Louis encephalitis. Typical clinical symptoms were produced in experimental infections. Horses that showed antibodies for western equine encephalomyelitis in high titer were susceptible to St. Louis encephalitis virus, while horses demonstrating St. Louis encephalitis antibodies as the result of natural infection were apparently resistant to subsequent infection by St. Louis encephalitis virus (56).

ENCEPHALITIS

Several years after Kelser had demonstrated the transmission of equine encephalomyelitis by *Aedes ægypti*, definite proof was obtained that mosquitoes were involved in the transmission of human encephalitis. Epidemics of encephalitis had occurred in Yakima Valley, Washington, in 1939 and 1940 but it was not until 1941 when many cases of encephalitis again occurred in Yakima Valley that routine collections of insects were made in the area, and subsequent work resulted in the isolation of the St. Louis strain from *Culex tarsalis*. Experimental transmission of the virus to laboratory animals by the bite of this species was obtained at a later date. (Virus of western equine encephalomyelitis was also isolated from some of the specimens of *C. tarsalis*.) (10, 61).

Culex pipiens and *Aedes dorsalis* have been found naturally infected with virus of St. Louis encephalitis, and transmission has been demonstrated in the laboratory for *C. pipiens*. Therefore, *C. tarsalis* and *C. pipiens* are now considered established vectors (12, 64). Hammon and Reeves have demonstrated experimental transmission by *Aedes lateralis, A. tæniorhynchus, A. vexans, A. nigromaculis, Culiseta inornata, Culiseta incidens* and *Culex coronator*. Japanese workers have reported the transmission of St. Louis virus by *C. pipiens* var. *pallens*, *C.*

tritæniorhynchus and *Aedes albopictus* (given by Hammon and Reeves, Amer. Jour. of Public Health, Vol. 35, pp. 994–1004, 1945).

Previously, in 1939, E. N. Pavlovskii (46) asserted that three ticks, *Ixodes persulcatus, Dermacentor silvarum*, and *Hæmophysalis concinna*, had been found naturally infected with virus of Russian spring-summer (or taiga) encephalitis in localities where cases of the disease had occurred.

Smith *et al.* (44) and Sulkin (45) reported in 1945 the presence of both the St. Louis encephalitis virus and the western equine encephalomyelitis virus in the chicken mite, *Dermanyssus gallinæ.* The mites were collected from chicken houses in areas where outbreaks of these diseases had occurred.

Infection of Man with Virus of Equine Encephalomyelitis.—Webster and Wright reported in 1938 the recovery of eastern equine encephalomyelitis virus from fatal human cases of encephalitis in the state of Massachusetts. By doing so they confirmed the findings of Fothergill *et al.,* who in 1938 reported the isolation of the eastern strain virus from a human case (51).

During the same year Howitt reported the recovery of the western equine encephalomyelitis virus from the brain of a child (65, 66).

In 1943 the first proved case of natural infection of man with Venezuelen virus was recorded, a fatal case occurring in Trinidad. A virus strain isolated from the brain tissue of the fatal human case and five strains from donkeys, mules, and horses all produced typical symptoms of equine encephalomyelitis in laboratory animals. Injections of these strains into guinea pigs immunized against the western or eastern strains of equine encephalomyelitis resulted in the deaths of the animals. However, the injections failed to infect guinea pigs immunized aganst the Venezuelan strain of equine encephalomyelitis (37).

Relationship of Virus to Vectors.—Parker reported in 1942 that in the case of *Ornithodoros moubata,* Murr., tick harborer of Russian spring-summer encephalitis virus, the interval between the ingesting of the blood of the infected animal and the recovery of the virus by injection was forty days (33).

Experiments with suspensions made from the various organs of *Hæmophysalis concinna*, tick vector of Russian spring-summer encephalitis, showed that the virus circulates in the body of the tick. The virus concentrates in the salivary glands and is probably transmitted to man through the saliva (46).

Several specimens of *Ixodes persulcatus*, Schulze, a tick vector of Russian spring-summer encephalitis virus, were allowed to feed on mice infected with a large dose of the virus. Tests showed that the ticks conserved the virus within their bodies for 60 days (46).

In 1945 Smith *et al.* (44), working on the transmission of St. Louis encephalitis virus by the chicken mite *Dermanyssus gallinæ,* demonstrated that mites harboring the virus could transmit it through the egg and larva to the first stage nymph. Mites infected in nature have retained the virus after 5 months of propagation in the laboratory.

Experiments with nymphs and adults of the tick *Dermacentor silvarum* (a vector of Russian spring-summer encephalitis) that had fed in the larval stage on infected mice transmitted the virus by feeding on laboratory animals. The virus was also present in larvæ of *D. silvarum* and *I. persulcatus* that were the progeny of naturally infected females. Injection of a suspension of larvæ of *I. persulcatus* that hatched from eggs laid by females collected in an endemic area produced infection in mice (46).

During 1939, it was shown in Japan that virus of Japanese epidemic or summer encephalitis was present in eggs deposited by artificially infected *Culex pipiens* var. *pallens,* a vector of the virus disease. The virus was also demonstrated in the first instar larvæ hatching from such eggs. In addition, twelve mice became infected out of 511 bitten by females of this species that had developed in the laboratory from larvæ and pupæ taken in nature (31).

No infection was found in the immature stages of *C. pipiens* L. and *C. tritæniorhynchus,* vectors of Russian autumn encephalitis (35).

Reservoirs of St. Louis Encephalitis Virus.—As mentioned in the discussion of the virus reservoirs of western equine encephalomyelitis, Hammon *et al.* (9) demonstrated antibodies of St. Louis encephalitis in fowls, ducks, geese, pigeons, turkeys, birds, cows, dogs, goats, horses, pigs, sheep, and rodents. Later, in

1943, Hammon *et al.* (12) demonstrated that *Culex tarsalis,* a vector of St. Louis encephalitis and western equine encephalomyelitis, fed readily on fowls. St. Louis virus was transmitted by it from fowls and from ducks to fowls in laboratory tests.

Philip *et al.* reported in 1941 that the presence of antibodies for St. Louis encephalitis virus had been demonstrated in the serum of man and horses. The investigators suggested that the virus existed as a natural infection in horses, thereby contributing to the summer encephalitis epidemics in both man and horses (69).

Hammon *et al.* (13) reported that in the 1943 eastern Nebraska survey in which neutralization tests were conducted on the sera of 91 mammals and birds, positive results were obtained with pheasants and horses for St. Louis virus.

Reservoirs of Russian Spring-Summer Encephalitis Virus.—Pavlovskii (34) found a mole, a hedgehog, and a vole naturally infected with the virus of Russian spring-summer encephalitis. The hedgehog and vole are known hosts of *I. persulcatus* and *H. concinna,* two tick vectors of the virus. Pavlovskii maintained that it is probable that an inapparent infection in man and animals, followed by immunity, is of common occurrence, as antibodies were present in the sera of cows, horses, and healthy persons in an endemic locality.

Reservoirs of Japanese Encephalitis Virus.—In Japan, dogs are often inapparent reservoirs for the virus of Japanese epidemic encephalitis, as shown by the presence of antibodies. (31).

Winter Reservoirs of Encephalitis Virus.—The true reservoir of St. Louis virus during periods or seasons when it is apparently not present is unknown. The two chief vectors, *C. pipiens* and *C. tarsalis,* do not demonstrate transovarian passage of the virus, nor do the hibernating adults of these two species appear to be infected. Experimentally infected dog ticks (*Dermacentor variabilis*) are capable of transmitting the infection, and transovarian infection can occur, but no naturally infected tick has been found (64). Chicken mites (*Dermanyssus gallinæ*), which have been found naturally infected with St. Louis virus, can transmit the virus transovarially with resultant infected progeny. But the mites cannot transmit the virus by bite, thus eliminating themselves as potential reserviors (44, 64).

The tables summarize the following data:

Table 1. Mosquito transmission of equine encephalomyelitis and of encephalitis.
Table 2. Arthropod (other than mosquito) transmission of equine encephalomyelitis and of encephalitis.
Table 3. Mosquitoes that failed to transmit equine encephalomyelitis in laboratory experiments.
Table 4. Arthropods (other than mosquitoes) that failed to transmit equine encephalomyelitis in laboratory experiments.
Table 5. Animals demonstrating antibodies of equine encephalomyelitis and encephalitis.
Table 6. Animals found infected in field with either equine encephalomyelitis or encephalitis.

TABLE 1

MOSQUITO TRANSMISSION OF EQUINE ENCEPHALOMYELITIS AND OF ENCEPHALUS

Vector	Virus strains transmitted								Virus demonstrated in	
	Equine encephalomyelitis			Encephalitis						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	Field	Lab.
1. *Aedes ægypti*	x	x	x							x (a) (b) (c)
2. *Aedes sollicitans*	x	x								x (a) (b)
3. *Aedes cantator*	x	x								x (a) (b)
4. *Aedes nigromaculis*	x			x						x (a) (d)
5. *Aedes dorsalis*	x			x					x (d)	x (a)
6. *Aedes albopictus*	x		x	x		x	x		x (a) (g)	x (a) (c) (d) (g)
7. *Aedes taeniorhynchus*	x			x						x (a) (d)
8. *Aedes vexans*	x	x		x						x (a) (b) (d)
9. *Aedes triseriatus*		x								x
10. *Aedes atropalpus*		x								x
11. *Aedes geniculatus*			x							x
12. *Aedes lateralis*				x						x
13. *Aedes togoi*						x				x
14. *Aedes japonicus*						x				x
15. *Aedes abnormalis* Theobald group								x		x
16. *Culex stigmatosoma*	x								x	
17. *Culex pipiens*	x			x	x				x (d) (e)	x (a) (d)
18. *Culex tarsalis*	x			x					x (a) (d)	x (a) (d)
19. *Culex pipiens* var. *pallens*	x	x		x		x			x (f)	x (a) (b) (d)
20. *Culex tritæniorhynchus*		x		x	x	x			x (e) (f)	x (b) (d) (e) (f)
21. *Culex coranator*				x						x
22. *Culiseta inornata*	x								x	
23. *Culiseta incidens*	x			x						x (a) (d)
24. *Mansonia titillans* complex			x						x	
25. *Anopheles maculipennis freeborni*	x								x	

Note: Lower case letters refer to virus strain: (a) Western, (b) Eastern, (c) Venezuelan, (d) St. Louis, (e) Russian Autumn, (f) Japanese, (g) West Nile, (h) Semliki Forest.

TABLE 1. (*Continued*)

Vector	Virus transmitted experimentally		Reference
	From	To	
1. *Aedes ægypti*	(a) Guinea pigs	Guinea pigs & horse	(a) 18, 25, 26, 40; (b) 4; (c) 42
	(b) Birds & mammals	Birds & mammals	
	(c) Guinea pigs	Guinea pigs	
2. *Aedes sollicitans*	(a) Guinea pigs	Guinea pigs	(a) 25, 40; (b) 4, 25
	(b) Mouse & sparrow	Mouse & sparrow	
3. *Aedes cantator*	Mouse	Mouse	(a) 40; (b) 4, 25
	Guinea pigs	Guinea pigs	
4. *Aedes nigromaculis*	(a) *A. nigromaculis*	Lab. animals & horses	(a) 23, 24, 40; (d) 64
	(a) Guinea pigs	Guinea pigs	
5. *Aedes dorsalis*	(a) *A. dorsalis*	Lab. animals & horses	(a) 20, 23, 24, 40; (d) 64
	(a) Guinea pigs	Guinea pigs	
6. *Aedes albopictus*	(a) (c) Guinea pigs	Guinea pigs	(a) 40, 43; (c) 42; (d) 64; (g) 36
	(g) Hamsters	Hamsters	
7. *Aedes tæniorhynchus*	(a) Guinea pigs	Guinea pigs	(a) 18, 40; (d) 12
	(d) Blood virus suspension	Fowls	
8. *Aedes vexans*	(a) *A. vexans*	Lab. animals & horses	
	(b) Birds & mammals	Birds & mammals	
	(d) Blood virus suspension	Fowls	(a) 40; (b) 4; (d) 12
9. *Aedes triseriatus*	Birds & mammals	Birds & mammals	4
10. *Aedes atropalus*	Birds & mammals	Birds & mammals	4

Note: Lower case letters refer to virus strain. Numerals refer to reference list.

TABLE 1. (*Continued*)

Vector	Virus transmitted experimentally		Reference
	From	To	
11. *Aedes geniculatus*	Guinea pigs	Guinea pigs	42
12. *Aedes lateralis*	Blood virus suspension	Fowls	12
13. *Aedes togoi*	*A. togoi*	Mice & monkeys	64
14. *Aedes japonicus*	*A. japonicus*	Mice & monkeys	64
15. *Aedes abnormalis* Theobald group	Inoculations	Mice, guinea pigs, rabbits rhesus & red tailed monkeys	74
16. *Culex stigmatosoma*			64
17. *Culex pipiens*	(d) Virus suspension	Doves & mice	(a) (d) 38, 39, 10; (a) 5; (e) 35; (d) 12
18. *Culex tarsalis*	(a) Duck & guinea pig	Fowls	(a) (d) 10, 11, 12, 39; (a) 13
	(d) Fowls & ducks	Fowls & ducks	
19. *Culex pipiens* var. *pallens*	*C. pipiens* var. *pallens*	Mice	(a) (b) (d) 64; (f) 31
20. *Culex tritæniorhynchus*	(e) (f) *C. tritæniorhynchus*	Mice	(b) (d) 64; (e) 35; (f) 31
21 *Culex coranator*	Blood virus suspension	Fowls	12
22. *Culiseta inornata*			39, 62
23. *Culiseta incidens*	(a) (d) Blood virus suspension	Fowls	(a) (d) 12
24. *Mansonia titillans complex*			7
25. *Anopheles maculipennis freeborni*			39, 62

TABLE 2

Arthropod (other than mosquito) Transmission of Equine Encephalomyelitis and Encephalitis

Vector	Virus strains transmitted				Virus isolated in	
	(a)	(b)	(c)	(d)	Field	Lab.
1. *Dermacentor andersoni*	x					x
2. *Dermacentor marginatus*				x	x	x
3. *Dermacentor variabilis*			x			x
4. *Dermacentor silvarum*				x	x	x
5. *Dermanyssus gallinæ*	x		x		x (a) (c)	x (a) (c)
6. *Triatoma sanguisuga*	x				x	x
7. *Triatoma infestans*		x				x
8. *Ixodes persulcatus*				x	x	x
9. *Hæmaphysalis concinna*				x	x	x
10. *Ornithodoros moubata*				x		x
11. *Liponyssus sylviarum*	x				x	x

Note: Lower case letters refer to virus strain: (a) Western, (b) Venezuelan, (c) St. Louis, (d) Russian Spring-Summer.

TABLE 2. (*Continued*)

Vector	Virus transmitted experimentally		Host in field	Reference
	From	To		
1. *Dermacentor andersoni*	Guinea pigs	Gophers	Gophers (*Citellus richardsoni*)	47, 48, 49
2. *Dermacentor marginatus*	Rabbits	Rabbits	Horses	16
3. *Dermacentor variabilis*	Mice	Mice		1
4. *Dermacentor silvarum*	Mice	Mice	Man, domestic animals, rodents, thrush	34, 46
5. *Dermanyssus gallinæ*	(a) Triturated mites	Mice & guinea pigs	Fowls	(a) 45; (c) 44
	(c) " "	Mice		
6. *Triatoma sanguisuga*	Guinea pigs	Guinea pigs		8, 19
7. *Triatoma infestans*	Guinea pigs	Guinea pigs		22
8. *Ixodes persulcatus*	Mice	Mice	Man, domestic animals, rodents, thrush	3, 46
9. *Hæmaphysalis concinna*	Mice	Mice	Man, domestic animals, rodents, thrush	46
10. *Ornithodoros moubata*				33
11. *Liponyssus sylviarum*	Mice	Mice, guinea pigs, hamsters	Wild Birds	70

TABLE 3

Mosquitoes That Failed to Transmit Equine Encephalomyelitis in Laboratory Experiments

Mosquito	Strain of virus used in attempted transmission	Attempted virus transmission		Reference
		From	To	
1. *Mansonia perturbans*	Eastern	Birds & mammals	Birds & mammals	4
2. *Anopheles punctipennis*	Eastern	" "	" "	4
3. *Anopheles maculipennis* var. *atroparvus*	Venezuelan	Guinea pig	Guinea pig	42
4. *Anopheles quadrimaculatus*	Eastern and Western	"	"	25
5. *Culex salinarius*	Eastern	Birds & mammals	Birds & mammals	4
6. *Culex pipiens*	Eastern	" "	" "	4
7. *Aedes tæniorhynchus*	Eastern	Guinea pig	Guinea pig	18

Note: Numerals refer to reference list.

TABLE 4

ARTHROPODS (OTHER THAN MOSQUITOES) THAT FAILED TO TRANSMIT EQUINE ENCEPHALOMYELITIS IN LABORATORY EXPERIMENTS

Arthropod	Strain of virus used in attempted transmission	Reference
1. *Siphona irritans* L. (horn fly)	Western	15
2. *Tabanus punctifer* (horse fly)	"	15
Tabanus sp.	"	60
3. *Stomoxys calcitrans* (stable fly)	"	32
Stomoxys sp.	"	60
4. *Dermacentor variabilis* (tick)	"	8
5. *Cimex lectularius* (bedbug)	"	13
6. *Zelus audax* (assassin bug)	"	60
7. *Sinea diadema* (assassin bug)	"	60
8. *Chrysops* sp. (deer fly)	"	60
9. (Black crickets*)	"	60
10. (Grasshoppers*)	"	60
11. *Simulium vittatum* (black fly)	" (results inconclusive)	20

Note: Numerals refer to reference list.

* Scientific name not given in reference.

TABLE 5

ANIMALS DEMONSTRATING ANTIBODIES OF EQUINE ENCEPHALOMYELITIS AND ENCEPHALITIS

Animal	Virus strain antibodies			Reference
	Equine encephalomyelitis	Encephalitis		
	(a) Western	(b) St. Louis	(c) Others	
1. Fowls	x	x		(a) 9, 61, 62; (b) 9, 62
2. Ducks	x	x		(a) 9, 61; (b) 9
3. Geese	x	x		(a) (b) 9
4. Pigeons	x	x		(a) (b) 9
5. Turkeys	x	x		(a) (b) 9
6. Cows*	x	x	Russian Spring-Summer	(a) (b) 9; (a) 13; (c) 34
7. Dogs	x	x	Japanese	(a) (b) 9; (c) 31
8. Goats	x	x		(a) (b) 9
9. Horses*	x	x	Russian Spring-Summer	(a) 9; (b) 13, 56, 69; (c) 34
10. Pigs	x	x		(a) (b) 9
11. Sheep	x	x		(a) (b) 9
12. Rodents	x	x		(a) (b) 9
13. Pheasants	x	x	Eastern	(a) 61; (b) 13; (c) 52, 53
14. Man	x	x	(1) Russian Spring-Summer (2) Semliki Forest	(a) 61; (b) 61, 62, 69; (c_1) 34; (c_2) 75
15. Primates (other than man)			Semliki Forest	(c) 75

Note: Lower case letters refer to virus strain. Numerals refer to reference list.

* Doubtful for Eastern Equine Encephalomyelitis (Ref. #13).

TABLE 6

ANIMALS FOUND INFECTED IN FIELD WITH EITHER EQUINE ENCEPHALOMYELITIS OR ENCEPHALITIS

Animal	Virus strain								Reference
	Equine encephalomyelitis			Encephalitis					
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	
1. Gopher	x								47
2. Pheasant		x							4, 52, 53, 54, 79
3. Pigeon		x							4, 58
4. Syrian hamster	x	x					x		50
5. Rodent					x				46
6. Thrush					x				46
7. Horse	x	x	x		x				(a) 6, 32, 40, 57; (b) 6, 25, 32; (c) 37, 41; (e) 16
8. Cattle					x				46
9. Mule			x						37
10. Mole					x				34
11. Vole					x				34
12. Hedgehog					x				34
13. Man	x	x	x	x	x	x	x	x	(a) 9, 40, 57; (b) 4; (c) 37; (d) 9, 14; (e) 3, 29, 46; (f) 31; (g) 36, 73; (h) 75
14. Donkey			x						37
15. Prairie chicken	x								57
16. Deer	x								57

Note: Lower case letters refer to virus strain: (a) Western, (b) Eastern, (c) Venezuelan, (d) St. Louis, (e) Russian Spring-Summer, (f) Japanese, (g) West Nile, (h) Semliki Forest. Numerals refer to reference list.

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BOOK NOTICE

The Insect Guide. By Ralph B. Swain. Illustrations by Suzan N. Swain. New York, Doubleday & Co., Inc. 261 pages. $3.00.

As a guide to the principal families of insects of North America, north of Mexico, this book accomplishes its purpose very nicely. The beginner in entomology, or the general reader, is bound to come away with some orderly understanding of insect classification. Representatives of 175 families in 26 orders and two suborders are illustrated, mostly in color. By a simple numbering system the reader is then referred to the relevant text. In lay language the text provides some of the important distinguishing characteristics of the family and some of the general habits of the immature and mature forms. The economic importance of the family is also recorded. This simple, orderly presentation is an outstanding feature of the book. Outstanding also are Mrs. Swain's fresh and life-like illustrations.

There is an informative introduction to the guide. The place of insects in the phylum of Arthropoda is explained. The relationships of insects to plants, animals and man are discussed. Important basic features of structure, growth and development are illustrated and explained. Much of Doctor Swain's enthusiasm for his vocation is woven into the pages, adding interest to the text.—F. A. Soraci.

THE SPECTRAL SENSITIVITY OF DYTISCUS FASCIVENTRIS

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The spectral sensitivity of various insects has been determined by a number of methods, most of which are based on the behavior pattern of the experimental animal (review, Weiss, 1943, 1945). Recently, however, the electroretinogram has been used as an index of spectral sensitivity of grasshoppers and moths (Crescitelli and Jahn, 1939; Jahn and Crescitelli, 1939; Jahn, 1946). In certain beetles (*e.g.*, *Dytiscus* and *Hydrous*) there are diurnal changes in several aspects of visual function, and these can be detected through changes in the electroretinogram (Jahn and Crescitelli, 1940; Jahn and Wulff, 1941a, 1941b, 1943; Wulff and Jahn, 1943). Therefore, it was considered worthwhile to determine by means of the electroretinogram the spectral sensitivity of *Dytiscus fasciventris* during the phases of its diurnal rhythm. The data resulting from this investigation are given in the present paper.

METHOD

The sensitivity to various wave length bands in the visible spectrum of the beetles was determined by measuring the electrical response of the eye. The technique used for stimulating and recording from the eye has been described previously (Crescitelli and Jahn, 1939). The wave length of the stimulating light was controlled by a series of Corning glass filters used in appropriate combinations to yield the following wave bands:

Filter Comb.	Width of Band mμ	Peak of Band mμ
1	680–740	720
2	640–680	645
3	600–640	620
4	560–600	575
5	530–570	545
6	500–550	515
7	470–520	490
8	470–470	440

The energy transmitted by the filter combinations was determined with a thermopile, and the stimulating intensity was varied by use of Wratten neutral tint filters. The animals were maintained in a state of complete dark adaptation throughout the experiments. The exposure duration was 17 milliseconds, and the exposures separated by a time interval of 15 or 20 minutes, depending upon the intensity.

RESULTS

Three or four responses were recorded at different intensities with each filter combination. The magnitude of the initial spike-like deflection of these responses in microvolts (ordinate) were plotted against the common logarithm of the intensity (abscissa), resulting in a curve for each filter combination (Fig. 1), which is part of a sigmoid curve relating the response magnitude to the logarithm of the intensity (Wulff and Jahn, 1943; Wulff, 1943). The resulting family of curves was treated as follows: (1) a constant response magnitude was selected which would intersect all the curves (180 micro-volts in 8 experiments and 90 micro-volts in 2 experiments); (2) a vertical line was dropped from the point of intersection to the abscissa; (3) the logarithm of the intensity corresponding to the points on the abscissa were tabulated opposite the wave length of the peak transmission of the filter combination. These values for 10 experiments are plotted in Figure 2.

In order to examine the results in more compact form the data were manipulated as follows: (1) the reciprocal of the intensities for constant response magnitudes were calculated; (2) the peak value for each curve was set at 100 per cent and the remaining points of each curve were recalculated in terms of this maximum; (3) the values of the reciprocal of the intensity in per cent of maxima were then averaged and tabulated in relation to wave length of the peak transmission by the filter combination, Table I, and plotted in Figure 3. The two uppermost curves (numbered 10 and 3) were obtained from animals in the day phase, and all of the others were obtained from animals in the night phase.

DISCUSSION

The spectral sensitivity curves of Figure 2 are dispersed along the ordinate. These variations may be explained as follows: (1)

eight curves were obtained from animals in the night phase of their diurnal rhythm and two curves were obtained from animals in the day phase. In view of the marked differences in sensitivity of the *Dytiscus* eye during these phases a spread is to be expected in the above instance; (2) the experiments were of long duration (4–6 hours) and, although the times of experimentation

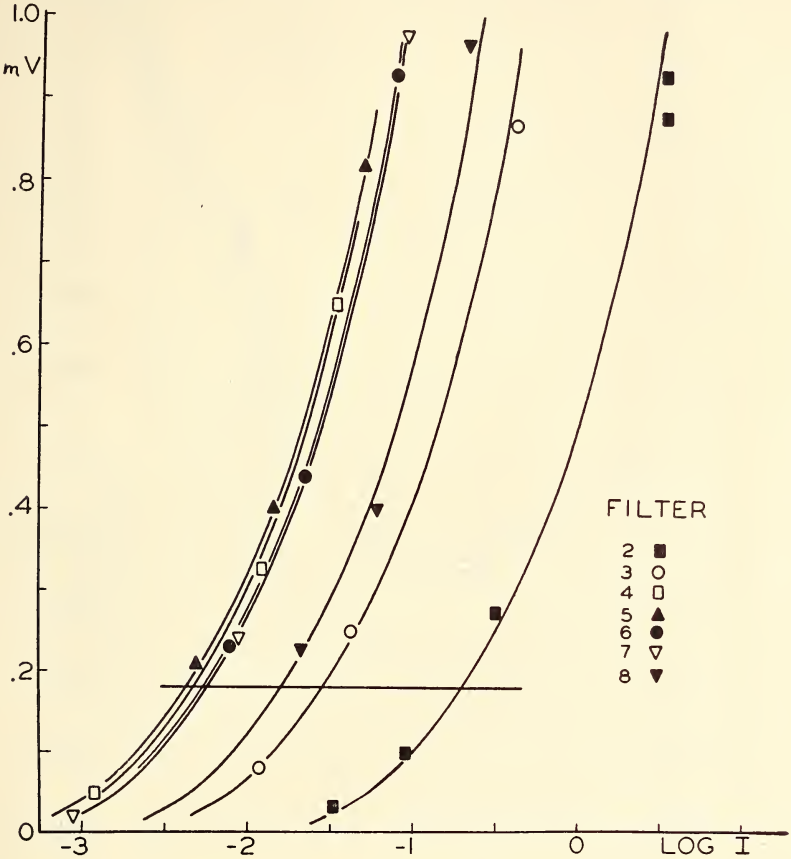

Figure 1. Curves for each filter combination relating the magnitude, in millivolts, of the initial spike-like deflection of the retinal electric response to the common logarithm of the stimulus intensity. These data represent one experiment. The points of intersection of the 180 micro-volt constant response line give the values of Log I for constant magnitude response for each filter combination.

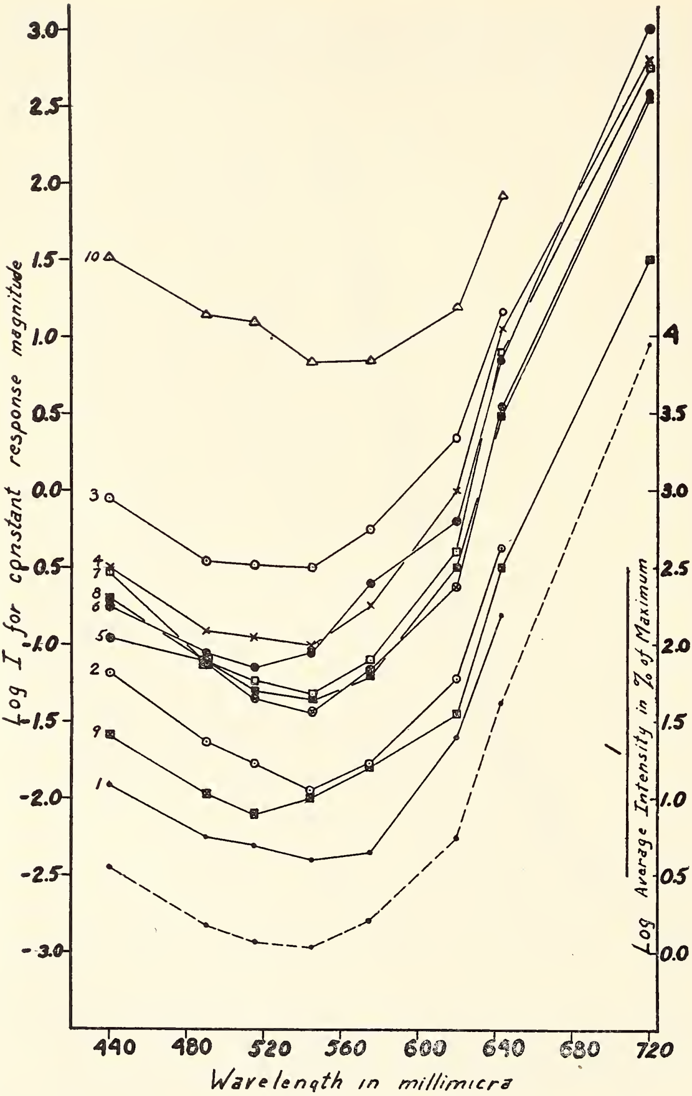

Figure 2. Continuous lines—curves relating the logarithm of the stimulating intensity required to produce a constant magnitude response to the wave length of maximum transmission of each wave length band. Each curve represents an individual experiment and the numbers correspond with the numbers in Table I. Curves 3 and 10 were obtained from animals in the day phase and all others from animals in the night phase. The broken line represents the average of the ten experimental curves.

TABLE I

Data Plotted in Figure 2 Relating Wave-Length to the Logarithm of Intensity for Constant Magnitude Response. Last Column Relates Wave-Length to Log Reciprocals of Values Plotted in Figure 3.

Wave-length of max. transmission filter combination	Logarithm of stimulating intensity for constant magnitude response										Logarithm of reciprocal of average intensity in per cent of maximum
	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10	
720 mμ, 1	......	......	......	2.80	2.60	3.0	2.75	2.57	1.50	......	3.96
643 mμ, 2	−0.80	1.16	−0.37	1.07	0.55	0.86	0.65	0.50	−0.62	1.92	1.62
620 mμ, 3	−1.60	0.35	−1.22	0.00	−0.62	−0.18	−0.40	−0.50	−1.45	1.2	0.75
575 mμ, 4	−2.35	−0.25	−1.72	−0.74	−1.16	−0.60	−1.10	−1.20	−1.80	0.85	0.21
545 mμ, 5	−2.40	−0.50	−1.95	−1.00	−1.43	−1.05	−1.32	−1.34	−2.00	0.85	0.04
515 mμ, 6	−2.30	−0.48	−1.77	−0.95	−1.35	−1.15	−1.23	−1.30	−2.10	1.10	0.07
490 mμ, 7	−2.25	−0.45	−1.62	−0.90	−1.16	−1.05	−1.10	−1.10	−1.96	1.15	0.18
440 mμ, 8	−1.90	−0.05	−1.18	0.50	−0.95	−0.74	−0.50	−0.70	−1.58	1.52	0.56

Note: Constant response magnitude is 180 μV, except in Exp. 6 and 10, where it is 90 μV.

were chosen to correspond to the theoretical time of maximum day and night phase, they may have not corresponded to the actual time of maximum day and night phase in each particular beetle; (3) minor variations occurred in the mounting of the animal, placing of the animal in the light beam and in the placing

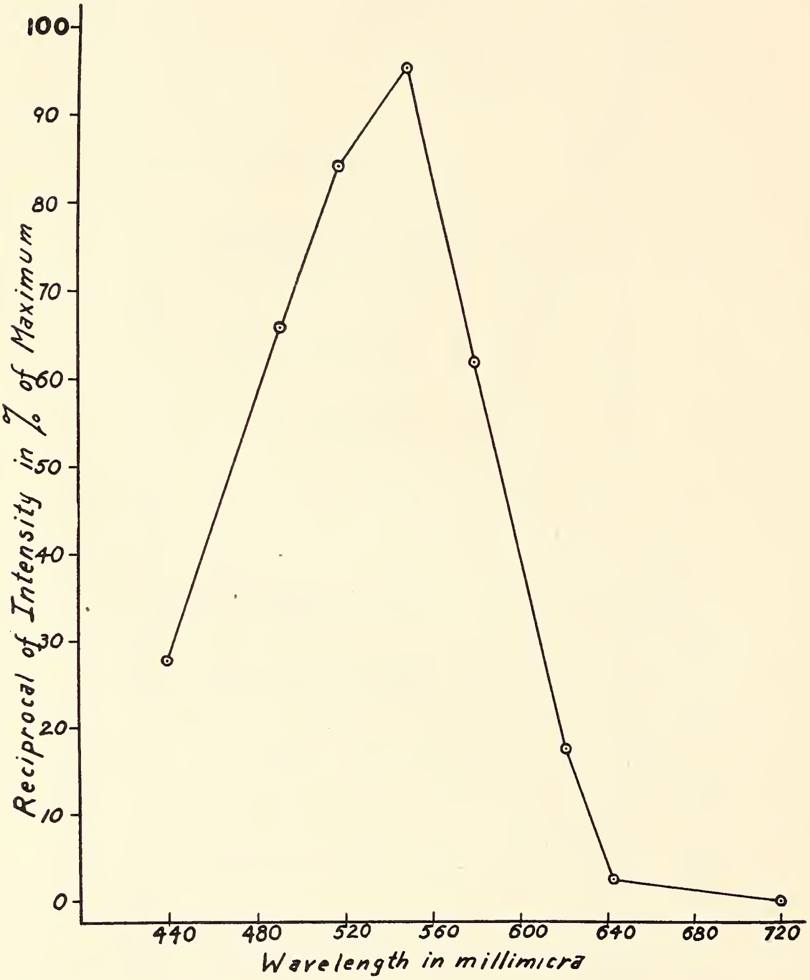

Figure 3. The average spectral sensitivity curve for *Dytiscus* obtained from data presented in Figure 2.

of the filter, and all of these factors would contribute to dispersion along the ordinate.

The curves of Figure 2 resulting from individual experiments are quite uniform with maximal sensitivity in the region 520 to 575 mμ and correspond generally to data from grasshoppers obtained in a similar manner (Crescitelli and Jahn, 1939; Jahn, 1946). In the figures published by Jahn (1946) the data for 500 and 530 mμ were inadvertently transposed from the original data of Crescitelli and Jahn (1939). If this transposition is corrected and the maximum for the grasshopper taken as 530 mμ, then the limits of the data do not permit the assumption of any real differences between *Melanoplus* and *Dytiscus.* At present the data on *Dytiscus* seem to be the most accurate insect spectral sensitivity data obtained by the electrical method.

The data agree well with results of Graham and Hartline (1935) obtained from electrical studies of the *Limulus* photoreceptor and with results obtained from *Cecropia* moth eyes (Jahn and Crescitelli, 1939) using similar techniques. Spectral sensitivity data obtained from behavior studies of insects placed in an environment of equal energy monochromatic wave bands yield data which are grossly similar to that here described but differ in the spectral location of maximal sensitivity. Bertholf (1931) presented data which indicate that for the honey bee the region of maximal sensitivity in the visible spectrum in 553 mμ and for *Drosophila* (1932) the maximum lies at 487 mμ. Weiss and his co-workers (1941, 1942, 1943a, b, and c, 1944a, and b) reported data on a wide variety of insects which indicate sensitivity maxima at 436, 492, 515, 606 and 642 mμ in the visible spectrum, with an average maximal sensitivity in the wave-length band whose peak transmission is at 492 mμ. It is not possible at present to state whether the differences exhibited by the data obtained from behavior and electrical studies are significant or, if so, to what the differences may be attributed.

The data obtained from *Dytiscus fasciventris* indicate that no significant difference exists in the spectral sensitivity of the eye in the day and night phase of its diurnal rhythm. The dispersion on the ordinate may be explained partly on the basis of a different absolute sensitivity of the photoreceptor during the day and night phases (Jahn and Wulff, 1943).

SUMMARY

1. The spectral sensitivity of the dark adapted eye of the beetle, *Dytiscus fasciventris,* was determined by using the electrical response of the photoreceptor as an index of sensitivity.

2. The region of maximal sensitivity in the visible spectrum as indicated by individual data is 520 to 575 mμ. The region of maximal sensitivity as indicated by the averaged data is 530–540 mμ.

3. No significant difference was found in the wave length sensitivity of the photoreceptor during the day and night phases of its diurnal rhythm.

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THE NEW YORK ENTOMOLOGICAL CLUB AND "PAPILIO"

By HARRY B. WEISS

About eighteen years ago I tried to induce the late William T. Davis to write an account of the New York Entomological Club in view of his possession of the Club minutes. However Mr. Davis never got around to it and after his death the minutes became the property of the Staten Island Institute of Arts and Sciences. Through the kindness of Miss Mabel Abbott, librarian of the Institute I was able to borrow these minutes from which the following account has been partly prepared.

On Sunday afternoon of October 3, 1880, at the home of Wm. B. Neumoegen, 76 West 45th Street, New York City, A. R. Grote, Edward L. Graef, Albert Koebele, Henry Edwards and Berthold Neumoegen met and organized the New York Entomological Club. Mr. Grote was temporary chairman and Edwards temporary secretary. The permanent officers elected were President, Augustus R. Grote, Treasurer, Berthold Neumoegen, and Secretary, Henry Edwards. The name of the society was agreed upon as the New York Entomological Club, and the object was the study of various orders, particularly species of the United States and the publication of papers thereon. The society was to consist of resident, corresponding and honorary members. There were no limits upon the number of corresponding members, but the honorary members were restricted to fifty. All members were to be chosen by ballot and two black balls were sufficient for exclusion. Various resolutions were adopted which served as a sort of constitution. Corresponding and honorary members were exempt from dues and initiation fees. Meetings were to be held twice each month. Messrs. Grote, Neumoegen and Edwards enrolled themselves at once as members of the Club, but Graef and Koebele declined for the time being. Sunday afternoons were selected for meetings and the second meeting was to be at the home of Mr. Edwards, 185 East 116th Street, New York City.

From October 3, 1880, to December 19, 1882, inclusive the Club held thirty-two meetings. The first ten alternated between the homes of Mr. Neumoegen and Mr. Edwards. The remaining ones all took place at Mr. Edwards' house. In other words, Mr. Neumoegen supplied a meeting place five times and Mr. Edwards, twenty-seven times. From the start until September 1881, two meetings were usually held each month. Beginning with September 1881 only one monthly meeting was held and this practice continued until the end. No meetings were held during July and August. The attendance of resident members ranged from one to nine and averaged about five per meeting. Occasionally there were one or two visitors. There were about twenty active or resident members and these, with the dates of their election, are noted as follows.

October 3, 1880.
  B. Neumoegen, 76 West 47th Street, New York.
  A. R. Grote, New Brighton, S. I., New York.
  Henry Edwards, 185 East 116th Street, New York.
November 14, 1880.
  Theo. L. Mead, 674 Madison Ave., New York.
  Julius E. Meyer, 61 St. Felix Street, Brooklyn.
  Albert Koebele, 419 West 24th Street, New York.
December 12, 1880.
  Otto Seifert, 7th Ave., and 24th Street, New York.
January 9, 1881.
  William T. Davis, Tompkinsville, S. I., New York.
February 6, 1881.
  James Angus, West Farms, New York.
February 20, 1881.
  Jacob Doll, 35 Graham Ave., Brooklyn.
March 6, 1881.
  Jno. Akhurst, Brooklyn.
  S. Bridgham, New York.
April 3, 1881.
  S. L. Eliot, 439 East 87th Street, New York.
April 17, 1881.
  W. S. C. Putman Cramer, 227 East 93rd Street, New York.
  A. W. P. Cramer, 227 East 93rd Street, New York.
May 1, 1881.
  W. E. Waters, 103 Fulton Street, New York.
  W. Woodworth, Sing Sing, N. Y.
  G. H. VanWaggenen, Rye, N. Y.

September 11, 1881.
Mark L. Hubbell, 211 West 23rd Street, New York.
January 29, 1882.
W. Schaus, Jr., 38 West 30th Street, New York.

Instead of writing a general, condensed summary of the minutes of the Club it was thought best to present the more important proceedings, as recorded for particular dates. A large portion of the minutes of many meetings is occupied with lists of entomological publications that were received, and with the names of corresponding members who were elected and of a repetition of their names when they wrote letters of acceptance. These will be excluded from this account.

Meeting of October 17, 1880

Mr. Grote wanted the Club to be worthy of the great city of New York and to have some building devoted to entomology in the forthcoming Exposition of 1883. This was the centennial anniversary of the evacuation of New York by the British. He suggested that collections could be deposited in such a building for study by visiting entomologists and it was the hope of the Club that the type collections of Grote and Edwards might find a home there and be used to foster the study of entomology. Mr. Grote stated that his collection contained nearly 1,500 types of Noctuidæ and Pyralidæ. Franz G. Schaupp who was present as a visitor at this meeting expressed the hope that the Club would eventually consolidate with the Brooklyn Entomology Society. Apparently he never joined the Club. Schaupp, a coleopterist was a prominent member of the Brooklyn society and editor of their Bulletin, and his room on the top floor of Schaeffer's saloon at 9 Broadway, Williamsburg was a favorite meeting place for entomologists around 1873.

Meeting of November 14, 1880

At this time it was decided not to collect dues or initiation fees, pending the adoption of a constitution. In addition it was agreed that the first duty of the Club was to publish a monthly journal of entomology, and a committee on publication consisting of Messrs. Edwards, Mead and Grote was appointed. The name of the journal was decided upon as "Papilio." Seventeen corresponding members were elected.

Meeting of November 28, 1880

Mr. Mead, reporting for the publication committee, had gotten an estimate from a firm on the cost of printing the transactions of the Club. For 500 copies—14 pages, thick white paper, cover and title (small pica type)—size of page, $10 \times 6\frac{1}{4}$ inches—size of type page, $7 \times 4\frac{1}{8}$ inches—price $23.00 based on six issues. This figure was accepted and referred to the publication committee.

Upon a motion by Neumoegen, Messrs. Grote and Mead were asked to call upon the trustees of the Central Park Museum to ask about the possibility of their receiving type specimens of insects belonging to the Club or to its members. Mr. Grote read a description of a new species *Catocala dulciola*. Three corresponding members were elected.

The publication committee met after the regular meeting and decided to devote "Papilio" entirely to Lepidoptera at least until future members joined who were interested in other orders. Messrs. Grote, Edwards and Neumoegen agreed to subscribe a sum sufficient to pay the expense of the first three numbers.

Meeting of December 12, 1880

Three corresponding members were elected. Edwards read a paper describing two new forms of Parnassius. The publication committee voted to prepare copy for the first number of "Papilio" and accepted six papers for publication. Mr. Edwards was asked to prepare a brief introduction for the first issue.

Meeting of January 9, 1881

Six corresponding members were elected and the following distinguished entomologists were enrolled as honorary members.

Lord Walsingham, England
Arthur G. Butler, British Museum, London
Dr. O. Staudinger, Dresden
Dr. C. von Felder, Vienna
Prof. P. C. Zeller, Prussia
Dr. A. Speyer, Saxony
W. J. Macleay, Australian Club, Sydney.
Alfred Russell Wallace, England
H. W. Bates, Geographical Society, London

Mr. Grote read a paper on some new species of Agrotis.

Meeting of January 23, 1881

Mr. Achille Guénee, of France, was added to the list of honorary members and four corresponding members were elected. Prof. Fernald, a corresponding member was present at this meeting. The secretary had a letter from the editor of ''Science'' offering to incorporate ''Papilio'' with his publication but this offer was refused, with thanks. The publication committee presented the first number of ''Papilio.'' Five hundred copies were printed.

Meeting of February 6, 1881

Mr. Tunnison was present as a visitor. To the list of honorary members, the names of Charles Darwin, F.R.S., and Sir John Lubbock were added. Sixteen corresponding members were elected and various papers were read. A letter was read from S. H. Scudder of Boston offering a paper on the life history of *Retina frustrana,* but as this needed illustrations costing $130.00 of which Scudder offered to pay $50.00, action was postponed.

Most of the persons who were elected to corresponding and honorary membership accepted and replied gracefully. For example Charles Darwin wrote as follows:

Feb. 21, 1881

Down
Beckenham, Kent.
Railway Station
Orpington

Dear Sir

I have the pleasure to acknowledge the receipt of your letter of Feb. 7th in which you inform me that the Entomological Club of New York has conferred on me the honour of electing me an honorary member; & I request that you will be so good as to return to the association my sincere thanks.

I remain Dear Sir
Your sincere & obedient servant
Charles Darwin

H. Edwards Esq.
New York Ent.
185 East 116th st.
New York
U. States.

Meeting of February 20, 1881

C. V. Riley and J. Akhurst were present as visitors. John Akhurst was the taxidermist and dealer in entomological supplies of 78 Ashland Place, Brooklyn. His advertisement appeared in the first number of the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY and for some years later, in succeeding numbers. Eight corresponding members were elected at this time and Mr. Grote presented a paper on new species of Noctuidæ. A "conversation ensued" between Prof. Riley and Mr. Grote relative to variations among certain examples of the genus Acrobasis. Messrs. Neumoegen, Edwards and Grote were appointed as a standing committee on all matters relative to the coming "World's Fair" so that the entomological interests of the United States would be presented properly.

Meeting of March 6, 1881

Seven corresponding members were elected and three honorary ones, the latter being Prof. J. O. Westwood, England, Dr. Felipe Poey, Cuba and Dr. Herman C. C. Burmeister, Buenos Aires. Mr. Neumoegen was made a member of the publication committee and a committee on nomenclature consisting of Mead and Edwards was appointed to investigate all doubtful points connected with synonymy. A committee was also appointed to draft a constitution and a set of by-laws, but no further reference to these two committees was ever made later. The secretary reported that he had had 1,000 one-page circulars printed advertising "Papilio." According to this circular "Papilio" was to appear about the 15th of each month, except July and August. The names of distinguished contributions were mentioned and the projectors believed that "Papilio" had "entered upon a long and prosperous existence." The cost was $2.00 per year and two numbers had already been published. The circular was dated, February, 1881 and signed by the four editors, A. R. Grote, Theo. L. Mead, Hy. Edwards and B. Neumoegen.

Meeting of April 3, 1881

Four corresponding members were elected at this meeting and eight at the meeting of March 20. Mr. Eliot reported the capture of rare Lepidoptera in Central Park and showed a magnificent series of *Papilio philenor* (24 specimens). Mr. Edwards exhibited a new air-tight insect case and also a new collecting bottle contributed by Mr. J. S. Johnson of Philadelphia, the poison vapor being communicated through a perforated floor.

During the course of the next four meetings nine corresponding members were elected, and four honorary members, the latter being as follows:

H. T. Stainton, England
H. B. Moeschler, Germany
P. C. T. Snellen, Rotterdam
C. R. Ritzema, Leyden

Meeting of June 19, 1881

A letter from B. P. Mann was read in which it was stated that he was about to dispose of the whole of his stock and entomological goods at greatly reduced prices. Two corresponding members were elected. Mr. Edwards showed a series of drawings of Lepidoptera by Emily L. Morton, who had promised Edwards that she would make a plate for "Papilio." Miss Morton's work was greatly admired by the members.

Meeting of September 11, 1811

Prof. C. V. Riley was present as a visitor and exhibited Crambidæ and other insects from Georgia which were mostly identified by Mr. Grote. Insects were also shown by Mr. Eliot and Mr. Neumoegen and there was much talk about the abundance of certain species of Lepidoptera during the summer.

Meeting of October 2, 1881

The treasurer reported a considerable deficit and urged new efforts for new subscribers to "Papilio." Mr. Edwards said that business engagements would take him from the city for six weeks and Mr. Grote consented to get out the ninth number of "Papilio." Two corresponding members were elected and there was some conversation about the escape of Prof. Francis H. Snow of Kansas from the hands of Apache Indians during a collecting trip in New Mexico.

Meeting of November 27, 1881

It was reported that Mr. Grote had left suddenly for Europe and would return around February, 1882. Three corresponding members were elected and a "conversation ensued" about the many personalities contained in an article by Grote that was published in the last number of "Papilio." In this article the Rev. George D. Hulst and Mr. Herman Strecker were attacked by the writer. The members thought that the publication of such a paper was unjustified. Mr. Grote had acted without conferring with anyone or with the publication committee. It was decided that personalities should be excluded.

Meeting of December 11, 1881

Four corresponding members elected, and a discussion about Lepidoptera took place. A letter was read, from C. A. Blake of Philadelphia referring to some napthaline cones prepared by him for preserving specimens in cabinets. The members agreed to order a quantity for experimental use. A letter from Rev. G. D. Hulst was read after which a recess was taken. The meeting was again called to order and a resolution was adopted empowering the secretary to alter and modify Mr. Hulst's letter of rejoinder to Mr. Grote so as to omit all personalities. The modified letter was to be sent to Mr. Hulst and if satisfactory to him, it was to be published immediately. If Mr. Hulst's original rejoinder was printed the secretary was to publish in the same number of "Papilio" all the evidence in his possession relative to the dispute, over the names of Catocalas, between Strecker and Grote, in which it was charged that Hulst was the mouthpiece of Strecker.

The secretary in his yearly report reviewed the activities of the Club which then had nineteen active members, seventeeen honorary members, and ninety-one corresponding members. Outstanding entomologists all over the world were selected and elected as corresponding members. Many of them, of course, became subscribers to "Papilio" and I am of the opinion that the Club had this in mind when the selections were made. Except for the entomologists who corresponded regularly with Edwards, Grote, Neumoegen and perhaps a few other members, most of the corresponding members had nothing to correspond about and so far as recorded in the minutes of the Club their only correspondence as the acceptance of the honor of becoming a corresponding member.

At this time "Papilio" had 100 subscribers, with a promise of six more. Mr. Edwards reported at this meeting on the success of the journal and of his plans for the future, and also stated that Grote had gone to Europe because of ill health. The number of copies of "Papilio" printed monthly was 500, of which 200 were kept in reserve. However it was believed that a printing of 350 would be ample.

Mr. Neumoegen reporting, as treasurer, said that the position of the treasury was not good. Revenues from January 1 to December 1, 1881 amounted to $194.46. Printing and other expenses totalled $415.73. This left the Club in debt to Mr. Neumoegen for $221.27. A long "conversation ensued" upon the subject of finances and it was resolved to pay off the indebtedness by voluntary contributions from members. Those present agreed to pay the following amounts:

B. Neumoegen	$50.00
Hy. Edwards	15.00
A. W. Cramer	10.00
J. Akhurst	10.00
S. L. Eliot	10.00
Jacob Doll	10.00
W. Woodworth	5.00
Otto Seifert	10.00
Another source	25.00
	$145.00

For the balance of $76.00 still owing to Mr. Neumoegen, the secretary was instructed to canvass other members.

Meeting of January 8, 1882

At this meeting the secretary reported the receipt of a letter from Mr. W. H. Edwards complaining of the numerous errors in the Checklist of Lepidoptera which had been published in the "Bulletin of the Brooklyn Entomological Society" and offering to submit a corrected list to "Papilio," the reprints of which might be sold by the Club for fifty cents per copy. This proposal was deferred and never again referred to in the minutes—sharing the same fate as the proposed constitution and by-laws and several other proposals.

A new estimate for printing 350 copies per month of "Papilio" was received. The new charge for a 20-page journal including covers was to be $22.50 per month and $1.25 for each additional page. Mr. Edwards proposed that "Papilio" carry advertising and the members agreed to help in soliciting "ads."

Meetings January 29 to December 19, 1882

The minutes of the remaining nine meetings contain little of interest. During this period only one active member was admitted and only four corresponding members were elected. Mr. Edwards presented a paper on butterflies taken in Arizona by Jacob Doll. Mr. Schaus exhibited a fine collection of Mexican Lepidoptera collected by himself near Vera Cruz. On March 5, 1882 Mr. Neumoegen reported that President Grote had returned from Europe and the secretary was instructed to write to him expressing gratitude at his return and wishing for his speedy recovery to good health. Mr. Neumoegen exhibited Lepidoptera. At the May 28, 1882 meeting only Edwards and Akhurst were present. On June 18, 1882, although six members were present, little activity was recorded and the Club adjourned subject to the call of the president or secretary. On October 15, 1882, Edwards, Akhurst and Neumoegen appeared, but as there was no quorum, no business was transacted. At the next two meetings, October 29 and December 19, 1882 only the secretary Mr. Edwards was present and from then on, the record is blank, and the New York Entomological Club came to an end.

The minutes of all meetings are signed "Hy. Edwards, Hon. Sec'y." Apparently the members paid no dues as neither the reports of the secretary nor those of the treasurer mention receipts from such a source. Of course more conversation went on at the meetings than was recorded in the minutes or than is indicated in the summaries that have been presented. And at the early meetings it was customary for Edwards and Grote to read descriptions of new species that were intended for publication in "Papilio."

The most active members of the New York Entomological Club were Henry Edwards, B. Neumoegen, A. R. Grote, John Akhurst, Theo. L. Mead, S. L. Eliot and A. W. P. Cramer. At least their attendance records indicate active interest. Of the thirty-two meetings held during the Club's brief existence, Henry Edwards the secretary was present at all of them. Neumoegen attended twenty-three meetings, Akhurst twenty including the four times he was present as a visitor, A. R. Grote sixteen, T. L. Mead eleven, A. W. P. Cramer thirteen, Eliot ten. Koebele attended six, Davis five, Doll five, Seifert seven and the balance of the members each showed up from one to four times. Graef attended four as a visitor. At the time the Club was organized in 1880, the approximate ages of some of the most active members and visitors were—Edwards fifty, Grote thirty-nine, Graef thirty-eight, Neumoegen thirty-five, Seifert thirty-two, Koebele twenty-eight, Schaus twenty-two, Davis eighteen.

Considering the smallness of the Club a singularly large proportion of the members had either already achieved distinction as entomologists, or did so later. Augustus Radcliffe Grote started his entomological activities around 1862, and became an extensive author, describing over 1,000 new species of Lepidoptera, especially North American Noctuidæ. His collection was sold to the British Museum. At the time of his death in Germany in 1903 he was director of the Roman Museum. Berthold Neumoegen who spoke five or six languages fluently was in business as a banker and broker at 40 Exchange Place, New York City. He was enthusiastic about Lepidoptera and began collecting around 1874. He described many new species and wrote papers in conjunction with H. G. Dyar. At one time he employed Jacob Doll to work on his collection. Henry Edwards or Hy. Edwards as he signed all the minutes of the Club and his various writings, was well known as an actor and lepidopterist. In 1879 he was hired by Lester Wallack as a member of his stock company and became stage manager of the theatre. He traveled extensively in South America, Australia, and the United States as an actor and was a student of Pacific coast Lepidoptera and North American Aegeridæ. He had numerous friends and correspondents.

Otto Seifert was a prosperous druggist of New York City who was interested in the Arctiidæ and who published on this family. His collection was purchased by the New York Entomological Society and presented to the American Museum of Natural History. John Akhurst, as has been noted, was a taxidermist and dealer in butterflies and entomological supplies of Brooklyn. Edward Louis Graef was in business at 58 Court Street, Brooklyn for 50 years as an importer of wines, and the first treasurer of the Brooklyn Entomological Society when it was organized in 1876 in Prof. Franz G. Schaupp's rooms at the foot of Broadway, Williamsburg. Both Graef and Grote while boys attended Prof. Joseph Deghuée's school in Brooklyn 1853–1858 and formed a friendship that lasted many years. Both were interested in Lepidoptera. His collection of 10,000 specimens of Lepidoptera, including about 80 types based on his own descriptions in the early volumes of the Brooklyn "Bulletin," was given to the Brooklyn Museum in 1900.

William Schaus made extensive contributions to the knowledge of world Lepidoptera and described numerous new species from South America. At one time he was Honorary Curator of Lepidoptera in the United States National Museum. Albert Koebele attracted the attention of Prof. C. V. Riley in 1881, while Riley was attending a meeting of the Brooklyn Entomological Society. Riley was impressed by the beautiful condition of Koebele's specimens and as a result he offered him a job. Koebele went to Washington early in 1882, where he first worked in the office and later in the field. In November 1882 he was sent to Brazil to investigate pests of cotton and later to California to experiment with washes against the cottony cushion scale of orange. While in Australia in 1888 he found the ladybird *Vedalia cardinalis* that was introduced with success into California as an enemy of the cottony cushion scale on orange. This discovery and subsequent successful introduction made Koebele's reputation. In 1893 he was made entomological expert for the Department of Agriculture and Forestry of Hawaii. He then investigated the insect fauna of Hawaii and visited Australia, New Zealand and other countries for predators and parasites that might prove useful in Hawaii. His work in biological control was extensive. He pioneered in this field and made numerous contributions to the technique of handling and shipping such material. With the exception of Henry Edwards who was born in England, all the entomologists who have just been noted, from Grote to Koebele inclusive, were born in Germany. In conclusion mention should be made of Theodore L. Mead, a son-in-law of William H. Edwards, who accompanied the Denver party of the Wheeler Survey during the summer of 1871. The material that he collected was determined and described by his father-in-law W. H. Edwards. In the June 1934 number of the Journal of the New York Entomological Society, F. Martin Brown wrote on "The Localities of T. L. Mead's Collection of Butterflies from Colorado in 1871," tracing the localities for Edwards' types and a schedule of Mead's travels, from a study of Mead's Report of the Wheeler Survey and other sources.

"Papilio: The Organ of the New York Entomological Club" was published by the Club during the years 1881 and 1882. It was devoted exclusively to Lepidoptera during its entire short life. Its size was 8½ × 5½ inches. Volume I (11 numbers) ran to 244 pages and volume II (10 numbers) to 189 pages. Henry Edwards was the editor of these two volumes. In fact Edwards also edited volume III (10 numbers, 193 pages) but after the cessation of the activities of the Club at the end of 1882, the wording "Organ of the New York Entomological Club" disappeared from the title page and apparently Edwards was both editor and publisher of "Papilio" during 1883. In a delayed notice to the subscribers, written by Edwards June 10, 1884, after he had completed the index to volume III, he wrote of the foundation of the Club three years before and of the intense enthusiasm of the promoters of "Papilio." After a little while the excitement abated and Edwards was gradually saddled with all the editorial work as well as being secretary of the Club. In addition to proofreading he had to go to the printer's place a distance of about fifty blocks four or five times each month and he even folded and mailed the numbers. Added to this was the burden of a heavy correspondence, all on top of the duties of his profession. In view of this he was compelled to relinquish the journal and take a personal loss of $200.00 upon the three volumes. As he still had back numbers on hand he was willing to sell the three volumes for $5.00 a set. The subscription price per volume had been $2.00.

The fourth and last volume of "Papilio" (1884) appeared under the editorship of Eugene M. Aaron of Philadelphia with George B. Cresson (eldest son of E. T. Cresson) as "Entomological Printer." In the January 1884 issue of the journal Edwards wrote a notice to the subscribers in which he asked them to transfer their support to his good friend Mr. Aaron who was "eminently fitted for the task" of running "Papilio" and cited as a reason for his withdrawal, the pressure of business engagements. However Mr. Aaron had not taken over a flourishing magazine as he shortly discovered. In the May 1884 issue Mr. Aaron complained that up to June 1, less than 45 per cent of the subscribers had paid their subscriptions. This was discouraging and Mr. Aaron found that he was $100.00 poorer after the year's work was only half done, and after he had given the magazine many hours of time taken from profitable employment. When he sent out bills, to those who had not paid by March 15, answers were received only from 17 per cent and almost half of these cancelled their subscriptions. He compares this condition with the comparatively large number of European subscribers among which there was only one debtor. He finally predicted that "Papilio" would cease at the end of 1884, and was of the opinion that his editorial labors were for the most part undervalued and largely thrown away.

In the September 1884 issue a notice states that the Brooklyn Entomological Society will consider the advisability of taking over "Papilio" and publishing it in connection with their "Bulletin." At this time Mr. Aaron said that of its 250 subscribers, less than 100 had paid for the journal. His personal loss then amounted to $200.00 and, unless the Brooklyn Society took over, "Papilio" would stop with the December 1884 number.

In the November 1884 issue (Nos. 9 and 10), p. 187, the editor, Mr. Aaron, said that the question of publishing an American magazine devoted to entomology was discussed by the Entomological Club of the American Association for the Advancement of Science at their meeting in Philadelphia, last September. A committee which included the editors of "Psyche," The "Bulletin of the Brooklyn Entomological Society" and "Papilio" reported adversely, not so much on account of their dis-approval as on account of their disinclination to commit the Club to what they believed would turn out as a failure. Even before this meeting the doom of ''Papilio'' had been sealed because of the failure of subscribers to pay their just debts. The representatives of the Brooklyn Society advised Mr. Aaron that they were ready to publish a monthly journal devoted to general entomology provided ''Papilio'' would discontinue and give its subscription list to the new publication. To this Mr. Aaron agreed immediately. Between the time the agreement was made and the publication of Mr. Aaron's comments in the November 1884 issue of ''Papilio,'' two numbers of ''Entomologia Americana'' had been published by the Brooklyn Society.

During its brief existence ''Papilio'' carried various articles devoted to the Lepidoptera, descriptions of new species, notes, larval habits, discussions of nomenclature, etc., many by well-known authors in the field of descriptive entomology. The first two volumes included several colored plates, but nothing of the sort appeared in the last two, probably because neither Mr. Edwards or Mr. Aaron were willing to spend more of their money on a losing venture.

In volume I, number 9, October, 1881 of ''Papilio'' may be found the article by A. R. Grote on ''New Moths from Arizona, with Remarks on Catocala and Heliothis'' which proved so embarrassing to the publication committee of the New York Entomological Club because of its personal criticisms of Herman Strecker and George D. Hulst, to which the latter objected. Of Strecker, Grote wrote that his work was of ''such an indifferent character'' that he (Grote) was unwilling to criticize it. ''He (Strecker) has made proportionately more and more unexcusable synonyms than any other writer, and his slovenly descriptions and confessed unacquaintance with structure place him on a level with the worst amateur who has 'coined' a 'species.' In vulgarity and misrepresentation he is, fortunately, without a rival. No amount of 'industry' or 'facility with the pencil' can condone his conduct.'' As for Hulst, Grote in referring to a paper on Catocala by Hulst, which appeared in the ''Bulletin of the Brooklyn Entomological Society,'' said that its publication was ''entirely unnecessary from a scientific point of view.''. . .

''Neither from the literary or biological point of view did the author possess sufficient information to warrant his writing extendedly upon the subject.''. . . ''Mr. Hulst prefers, for instance, the name *Amestris* to *Anna,* on the ground 'that' one is 'strictly Catocaline' (?), while the other is 'not.' It appears from this that 'Catocaline' is a new euphemism for loose behavior, and that the Rev. Mr. Hulst approves the names of Swinburne's heroines being applied to a group of moths whose conduct is no worse, so far as I have observed, than their neighbors. To prefer the 'strange woman' to a prophetess is singular taste in a clergyman.'' Mr. Hulst's reply without personalities appeared in the December 1881 number of ''Papilio'' under the title ''Some Remarks Upon Catocalæ, in Reply to Mr. A. R. Grote,'' and beneath this reply the publication committee added a note regretting that ''anything like personalities'' should have crept into ''Papilio.'' Grote's paper was printed while the editor was absent from the city and it was stated that no further personal remarks should again be permitted in ''Papilio.'' The entire controversy of course was due to a difference of opinion between specialists.

In volume III of ''Papilio,'' the amusing controversy between Prof. C. V. Riley and A. R. Grote and W. H. Edwards appeared relative to the capitalization of specific names. Riley wrote to the editor asking upon what grounds and for what purpose had American lepidopterists adopted the ''vicious'' habit of capitalizing the specific names of their insects. W. H. Edwards, who answered for the editor admitted being a sinner in this respect and asked ''if some sort of function attached to the office of Entomologist in Chief at Washington'' made it his duty ''to have an eye to entomological obliquities of all sorts.'' He said that his purpose was not wicked and that the Professor might rest in peace. And in addition the usage was not new, having been indulged in by Linnæus, Fabricius and Kirby. If Riley believed the old way to be vicious, then he (W. H. Edwards) could say with just as much reason, that the new way was ''vile.'' To this and to the replies of Grote and Kirby, Prof. Riley answered in a lengthy paper, in which he apparently had the last word.

I cannot find any evidence indicating that there was any connection between the New York Entomological Club and the New York Entomological Society. The former went out of existence at the end of 1882 and the latter was organized June 29, 1892. In the Proceedings of the New York Entomological Society for May 5, 1936, printed in the Journal, volume 45 (2): p. 259, Mr. W. T. Davis is credited with saying that the Club started in 1880 and was incorporated in 1893. The Club was never incorporated at all and it was the Society that was incorporated in that year. In the same Proceedings it is further recorded that "Grote," present at the meeting, stated that the Club started when the New Yorkers rebelled at the idea of going to Brooklyn to attend the meetings of the Brooklyn Entomological Society. Mr. "Grote" said that he was president in 1902 and 1903, after having been treasurer for several previous years. Mr. "Grote" was not present at the May 5, 1936 meeting, having died in Germany, September 12, 1903. However Mr. C. F. Groth (not Grote) was present and the statements he made are true not for the New York Entomological Club, but for the New York Entomological Society. This confusion probably resulted from the fact that the secretary who recorded the proceedings thought that the Club and the Society were synonymous. I suppose the editor of the Journal should have caught these errors, but as a matter of fact, he was not familiar with the history of the Club at the time they were made.

Some of the former members of the Club joined the New York Entomological Society. In the lists of members of the Society printed in the Journal vol. 12, p. 192, 1904, and vol. 13, p. 52, 1905 may be found the names of W. T. Davis, Jacob Doll, Otto Seifert, and Edward L. Graef. Other members of the Club may also have belonged to the Society previous to 1904. In any event papers by A. R. Grote, William Schaus, and B. Neumoegen appeared in its Journal between 1893 and 1898.

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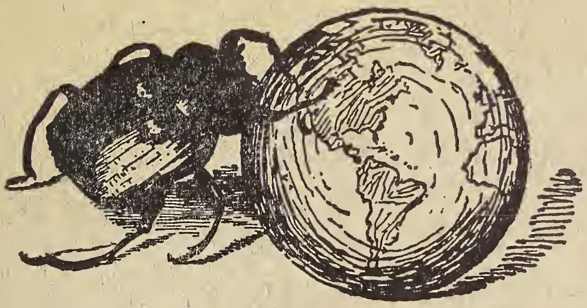
Vol. LVI No. 3

SEPTEMBER, 1948

Journal
of the
New York Entomological Society

Devoted to Entomology in General



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Subscription $4.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1948

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NOTICE: Volume LVI, Number 2 of the Journal of the New York Entomological Society was published on August 10, 1948.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

Vol. LVI September, 1948 No. 3

RECORDS AND DESCRIPTIONS OF NEOPTROPICAL CRANE-FLIES (TIPULIDÆ, DIPTERA), XXIII

By Charles P. Alexander
Amherst, Massachusetts

The preceding part under this general title was published in this Journal (vol. 55: 173–184; June 1947). The types of the novelties described herewith are preserved in my collection through the appreciated kindness of the various collectors. Two species are based on materials in the United States National Museum, sent to me for determination by Dr. Alan Stone.

Genus *Austrolimnophila* Alexander

Austrolimnophila (Austrolimnophila) bulbulifera, new species.

General coloration of thorax yellow, the pleura with a transverse brown girdle occupying the mesepisternum; femora obscure yellow, the tips narrowly blackened, remainder of legs brown, the tarsi extensively whitened; wings subhyaline, restrictedly patterned with brown; *m–cu* about three-fourths its length beyond the fork of *M;* male hypopygium with the median region of tergite produced into a narrow lobe, its tip shallowly emarginate; dististyle complex, the main body with long coarse nodulose setæ; face of style with a low blackened flange.

Male.—Length about 11 mm.; wing 10 mm.; antenna about 1.9 mm.

Rostrum and palpi black. Antennæ short; scape and pedicel obscure yellow, flagellum black; flagellar segments subcylindrical to cylindrical, the longest verticils unilaterally arranged, much longer than the segments. Head brown.

Pronotum testaceous, paling to yellow on the sides and on the propleura. Mesonotal præscutum obscure yellow, the stripes not or scarcely indicated; lateral præscutal borders slightly darkened, representing the upper end of the pleural girdle described below; scutum and scutellum chiefly pale;

mediotergite dark brown; pleurotergite yellow, its posterior border more darkened. Pleura pale yellow, with a narrow dark brown transverse girdle extending from the præscutum, as described, across the entire mesepisternum and sternum. Halteres elongate, stem obscure yellow, knob dark brown. Legs with the coxæ and trochanters pale yellow; femora obscure yellow, the tips narrowly blackened; tibiæ and proximal half (hind) to three-fourths (fore) of basitarsi medium brown, the remainder of basitarsi and segments two to four white, the terminal segment infuscated. Wings with the ground yellow on cephalic third, more grayish on posterior portions; a restricted brown pattern, including spots at origin of *Rs*, cord, outer end of cell *1st* M_2, R_2 and adjoining veins, fork of M_{1+2}, and near outer end of cell R_3; a faintly indicated dusky wash in center of cell *R*; veins dark brown, conspicuous. Venation: Sc_1 ending shortly beyond the fork of R_{2+3+4}, Sc_2 a short distance from its tip; R_{2+3+4} about one-half longer than *m–cu*; R_{1+2} shorter than R_{2+3+4}; anterior cord oblique, cell R_3 most proximad; petiole of cell M_1 about twice *m*; *m–cu* about three-fourths its own length beyond the fork of *M*.

Abdominal tergites dark brown, the caudal margins of the more basal segments narrowly yellow, the outer segments more uniformly darkened; hypopygium chiefly black; sternites bicolored, chiefly yellow, with a narrow blackened ring before midlength. Male hypopygium with the tergite produced caudad into a medium depressed-flattened lobe, its apex shallowly emarginate. Basistyle on mesal face near apex with a small tubercle tufted with long yellow setæ. Interbase a small curved yellow structure, the tip acute. Dististyle complex, the main body more or less triangular, extended into a long slender rostrum, the concave mesal face of style with several strong yellow setæ that are provided for most of their length with globular excrescences; on face of style a low blackened lobe or flange, its surface with dense microscopic setulæ.

Habitat.—Southeastern Brazil.

Holotype, ♂, Boracea, São Paulo, altitude 800 meters, August 1947 (John Lane).

Although generally similar to species such as *Austrolimnophila* (*Austrolimnophila*) *candiditarsis Alexander, A.* (*A.*) *pallidistyla* Alexander, and other regional forms, the type of structure of the male hypopygium is more as in the various species of the subgenus *Limnophilella* Alexander, as *A.* (*L.*) *multipicta* Alexander, all of which have the much retracted *m–cu* crossvein. I am deeply indebted to Dr. John Lane for many fine Tipulidae from São Paulo and Rio de Janeiro.

Genus *Pseudolimnophila* Alexander

Pseudolimnophila plutoides, new species.

Allied to *pluto;* size large (wing, male, over 9 mm.); general coloration black, the præscutum and scutal lobes more reddish brown; legs and wings strongly blackened; R_{2+3+4} from two to three times as long as R_2; abdomen dark brown, the hypopygium more yellowish brown.

MALE.—Length about 9–10 mm.; wing 9–10 mm.; antenna about 1.5 mm.

Rostrum and palpi black. Antennæ black, the pedicel a very little paler; flagellar segments passing through long-oval to subcylindrical, the verticils, especially of the outer segments, long and conspicuous. Head black; anterior vertex relatively broad, about two and one-half times the diameter of the scape.

Pronotum black. Mesonotal præscutum and scutal lobes dark reddish brown, virtually unpatterned; posterior sclerites of notum more brownish black. Pleura, including the dorsopleural membrane, blackened. Halteres infuscated. Legs with the coxæ brownish black; trochanters obscure yellow; remainder of legs dark brown, the femoral bases restrictedly obscure yellow. Wings with a strong blackish tinge, especially in the outer radial field; stigma and narrow seams over cord and outer cell *1st* M_2 still darker brown; veins brown. Venation: Rs long, subequal to vein R_4; R_{2+3+4} from two to three times R_2; veins R_3 and R_4 extending generally parallel to one another, the former arched at near midlength, slightly widening the cell at this point; cell M_1 more than three times its petiole; *m–cu* at near two-fifths to three-fifths the length of cell *1st* M_2.

Abdomen dark brown, the hypopygium a trifle brighter, more yellowish brown. Male hypopygium with the ninth tergite bilobed, the lobes narrower than the U-shaped median notch. Outer dististyle with the entire mesal face densely covered with erect setæ. Gonapophyses small, bispinous.

Habitat.—Peru.

Holotype, ♂, Carpish, Huanuco, in dwarf fog forest, altitude 2800 meters (9100 feet), November 4, 1946 (Woytkowski). Paratopotype, ♂, November 14, 1946.

The nearest ally of the present fly is *Pseudolimnophila pluto* Alexander, from the Tropical Zone of Amazonian Ecuador, a smaller and much paler fly. The male hypopygia of the two species are very similar and indicate a close relationship.

Genus *Teucholabis* Osten Sacken

Teucholabis (Euparatropesa) lætifica, new species.

Size small (wing, female, 5 mm.); allied to *lindneri*; head, pronotum and pleura orange; mesonotum shiny black, restrictedly patterned with yellow; femora yellow, the tips blackened, broadest on the fore femora; wings whitish subhyaline, restrictedly patterned with brown; dark areas at arculus and origin of Rs interconnected in the costal field; Sc_1 ending about opposite one-third the length of Rs; R_2 nearly twice R_{2+3+4}; abdominal tergites dark brown, sternites obscure yellow.

FEMALE.—Length about 5 mm.; wing 5 mm.

Rostrum reddish yellow, shorter than remainder of head; palpi brown. Antennæ with scape and pedicel yellow, flagellum brown; flagellar segments oval, much shorter than the verticils. Head orange.

Pronotum orange. Mesonotum shiny black, restrictedly patterned with yellow, including the suture and most of the scutum, the lobes of the latter with polished black centers; humeral region of præscutum extensively yellow; pleurotergite black. Pleura uniformly orange yellow. Halteres with stem weakly darkened, knobs light yellow. Legs with all coxæ and trochanters orange or orange-yellow; femora yellow, the tips broadly black, on the fore legs including the outer three-fourths, on middle and hind legs about the distal fifth or sixth; fore tibiæ and tarsi black; middle and hind tibiæ dirty white, blackened at base and tip; middle basitarsi obscure yellow at proximal end, remainder of tarsi black. Wings whitish subhyaline, restrictedly patterned with brown; dark areas at arculus and origin of *Rs*, interconnected without a break in cells *C* and *Sc*, the latter area completely crossing the wing, widest in cell *Cu*; a narrower but darker band at cord, extending from *C* to *Cu*, deepest in color at the stigma, nearly parallel-sided; no darkening at wing-tip; veins brownish yellow, darker in the patterned areas. Venation: Sc_1 ending about opposite one-third the length of *Rs*, Sc_2 a short distance before the origin of the latter; R_2 nearly twice R_{2+3+4} or R_{1+2}; cell R_3 small, vein R_4 subequal to R_{3+4}; cell M_2 open by atrophy of basal section of M_3, cell *2nd* M_2 subequal in length to its petiole; *m–cu* about two-thirds its length beyond the fork of *M*; vein *2nd A* nearly straight for most of its length. In *lindneri*, the darkened area at and beyond arculus and that at origin of *Rs* broadly interrupted in cells *C* and *Sc*; vein *Sc* longer, ending beyond one-third the length of *Rs*; R_2 at fork of *Rs*; *m–cu* at or close to the fork of *M*.

Abdominal tergites dark brown, sternites obscure yellow; subterminal segment orange; genital shield extensively darkened. Ovipositor with the valves orange; cerci strongly upcurved.

Habitat.—Peru.

Holotype, ♀, Yarinacocha, Loreto, near Pucallpa, on the Upper Ucayali River, altitude 180 meters (Schunke).

Teucholabis (*Euparatropesa*) *laetifica* is closest to *T.* (*E.*) *lindneri* Alexander, of the Bolivian Chaco (Konowia, 12: 42-44, figs. 1–2; 1933), differing in the coloration of the body, especially the mesonotum and pleura, and in the details of wing pattern and venation, as compared above.

Teucholabis (Teucholabis) atrolata, new species.

Antennæ dark brown throughout; anterior vertex black, elevated into a small tubercle; præscutum yellow, with three chestnut brown stripes, darker behind; scutellum broadly yellow behind; pleura brown, heavily pruinose with silvery; femora yellow, the tips and a medial band broadly blackened, mid-femur with the base similarly darkened; wings subhyaline, with three dark bands, the apical one narrow; costal fringe short; abdomen yellow, sternites two to six with broad black lateral areas; male hypopygium with the spine of the basistyle relatively large, strongly curved; outer dististyle long and slender, unequally bidentate at tip; inner dististyle conspicuously bifid, both arms terminating in points.

Male.—Length about 9.5–10 mm.; wing 7.5–8 mm.

Rostrum obscure yellow medially above, dark brown on sides; palpi black. Antennæ dark brown; flagellar segments passing through oval, long-oval to elongate-cylindrical, the verticils long and conspicuous. Front yellow; anterior vertex narrow, black, raised into a small tubercle near its anterior end; posterior vertex paler brown or yellowish brown.

Pronotum chiefly yellow, variegated with chestnut brown. Mesonotal præscutum with three chestnut brown stripes, paler in front, darker and almost contiguous behind, the humeral triangles yellow, lateral præscutal borders more obscure; median region of præscutum before suture and the central portion of scutum more grayish yellow; scutal lobes extensively darkened, almost black, their posterior portions yellow; scutellum broadly yellow behind, the base more testaceous yellow; mediotergite testaceous yellow, with almost the posterior half dark brown. Propleura chestnut; remainder of pleura darker brown, heavily silvery pruinose; mid-mesosternum narrowly yellow, the posterior thoracic sternites entirely yellow. Halteres yellow, knob brown, the apex paler. Legs with coxæ orange-yellow, the middle and posterior pairs more pruinose; trochanters chestnut-yellow; femora yellow, the tip broadly and conspicuously blackened; middle femora with a basal and a median dark ring, alternating with yellow annuli, the black tip a little narrower than the subterminal yellow ring; darkened basal annulus wider than the subbasal yellow one; hind femora similar but with the basal darkening less evident; tibiæ yellow, the tip narrowly to scarcely darkened; tarsi yellow, the outer two segments blackened. Wings subhyaline, trivittate with brown, including a broad complete band at cord, darkest at stigma; wing-tip narrowly darkened; subbasal band at level of origin of *Rs* and across vein *2nd A*; veins yellow, darker in the patterned areas. Costal fringe short. Venation: Sc_1 ending about opposite midlength of *Rs*, Sc_2 at near one-fifth the length; R_2 slightly oblique, in cases weakly sinuous; *m–cu* about one-third to one-half its length beyond the fork of *M*.

Abdomen conspicuous hairy; tergites and hypopygium yellow; sternites yellow, segments two to six each with a conspicuous brownish black lateral darkening. Sternal pocket of segment five close to the posterior end of segment, more or less triangular in outline, the longest setæ at the sides; pocket of segment six consisting of six or seven strong curved setæ in a vertical row on either side, directed mesad. Male hypopygium with the apical spine of the basistyle relatively large, strongly curved, the apical third narrowed into a long straight spine; mesal flange coarsely and irregularly toothed. Outer dististyle long and slender, unequally bidentate at apex, the surface with long scattered setæ. Inner dististyle conspicuously bifid, the larger beak terminating in a strong spine; lateral lobe terminating in a short conical point.

Habitat.—Panama (Canal Zone).

Holotype, ♂, Barro Colorado Island, January—March 1944 (Zetek No. 5126); United States National Museum. Paratopotypes, 2 ♂♂; one of these is much paler, including the leg pattern and may not prove conspecific.

The allied species include *Teucholabis* (*Teucholabis*) *angustapicalis* Alexander, *T.* (*T.*) *catharinensis* Alexander, *T.* (*T.*) *melanocephala* (Fabricius), *T.* (*T.*) *neosalva* Alexander, *T.* (*T.*) *perangusta* Alexander, and *T.* (*T.*) *salva* Alexander, all having the legs and wings banded and with the sternal pockets of the fifth and sixth abdominal segments of approximately the same type. The present fly differs in coloration of the body, legs and wings, especially the unusually heavy leg pattern. There are further differences in the male hypopygium, especially the basistyle and inner dististyle.

Teucholabis (Teucholabis) hypomela, new species.

Allied to *flavithorax*; size small (wing, female, 6 mm.); pronotum black; mesonotum and dorsal part of pleura orange, the ventral pleura and sternum black; legs with all coxæ and trochanters black; remainder of legs black, the basal two tarsal segments obscure yellow; wings with a strong brownish suffusion; Sc_1 ending about opposite three-fifths Rs; vein R_2 transverse, about one-half R_{2+3+4}; ovipositor with the cerci yellow.

Female.—Length about 6 mm.; wing 6 mm.

Rostrum and palpi black. Antennæ black throughout; basal flagellar segments subglobular, the outer ones more oval. Head black.

Pronotum black, the sides of the scutellum orange. Mesonotum orange, the cephalic third of the præscutum with a triangular black area. Propleura, sternopleurite, anepisterum and meral region black, the remainder of mesonotum and the pleurotergite orange. Halteres infuscated. Legs with all coxæ and trochanters blackened; femora and tibiæ black, the basal two tarsal segments obscure yellow, the outer tarsal segments black. Wings with a strong brownish suffusion, stigma a trifle darker; veins dark brown. Venation: Sc relatively long, Sc_1 ending about opposite three-fifths Rs, Sc_2 at near one-third the length; vein R_2 transverse, about one-half R_{2+3+4} and longer than R_{1+2}; cell *1st* M_2 slightly widened outwardly, *m* slightly longer and more arcuated than the basal section of M_3; *m-cu* about one-half its length beyond the fork of *M*.

Abdomen black; cerci slender, yellow strongly upcurved.

Habitat.—Peru.

Holotype, ♀, Yahuarmayo, February 8, 1910 (C. H. T. Townsend); United States National Museum.

The most similar species are *Teucholabis* (*Teucholabis*) *cuneiformis* Alexander, *T.* (*T.*) *dileuca* Alexander, *T.* (*T.*) *rufithorax* (Wiedemann), *T.* (*T.*) *rufula* Alexander, and *T.* (*T.*) *schineri* Enderlein, occurring from Mexico to southeastern Brazil, all differing in details of coloration of the body and legs and in the venation. The black prothorax and narrowly blackened pleura and mesosternum, in conjunction with the small size, should be emphasized.

Teucholabis (Teucholabis) subargentea, new species.

Allied to *argentea*; general coloration polished black, the mesonotum variegated with yellow; pronotum pale yellow; pleura black, with a broad silvery white stripe; femora yellow, the tips of the fore pair blackened; wings yellowed, crossbanded with brown; sternal pockets of male strongly developed; male hypopygium with the inner dististyle very unequally bidentate, with two approximated setæ on disk of style; ædeagus a moderately compressed blade, the lower edge with two long setæ.

Male.—Length about 6.5 mm.; wing 7–7.1 mm.

Rostrum orange; palpi black. Antennæ black throughout; flagellar segments passing through subglobular, short-oval to long-oval, the verticils longer than the segments. Head dull black.

Pronotum and pretergites pale yellow. Mesonotum polished black, the posterior portions of the scutal lobes, posterior border of scutellum and lateral margins of mediotergite obscure brownish yellow. Dorsal thoracic pleura chiefly polished black, the dorsopleural region yellow; a broad silvery white longitudinal stripe extending from behind the fore coxæ to base of abdomen, widened behind; ventral sternopleurite blackened, the remainder of venter pale. Halteres black, the apices of the knobs obscure yellow. Legs with the fore coxæ blackened the remaining coxæ yellow; trochanters yellow; femora yellow, the tips of the fore pair blackened, of the remaining femora scarcely darkened; fore and middle tibiæ and tarsi black; hind tibiæ obscure yellow, the tips narrowly blackened; tarsi black; posterior basitarsi dilated on about the proximal fourth. Wings with a weakly yellowed ground, the prearcular and costal fields more whitened; a medium brown crossbanded pattern, including a narrow band at cord, crossing the wing from the dark brown oval stigma to the posterior margin; wing tip broadly darkened, extending basad about to the level of the outer end of cell *1st* M_2, the posterior margin of cell M_3 pale; a third band at one-third the wing length, extending from *R* to the anal margin at vein *2nd A*; veins light brown, darker in the patterned areas. Venation: Sc_1 ending just beyond midlength of *Rs*, Sc_2 a moderate distance from its tip; R_2 about twice R_{2+3+4}; branches of *Rs* extending generally parallel to one another, cell R_2 correspondingly wide at margin; cell R_4 slightly widened at basal third; *m–cu* close to fork of *M*.

Abdominal tergites dark brown, sternites paler; sternal pockets dark colored and conspicuous; hypopygium black. Sternal pocket of segment five large and conspicuous, with very numerous setæ; sternite six with a narrowly transverse oval area on posterior half; on anterior half of sternite with a vertical row of six or seven very long setæ that are directed mesad, the rows widely separated. Male hypopygium with the appendage of the basistyle subterminal in position, stout at base, the outer third narrowed into a straight spine; two darkened marginal lobes nearer mesal part of style. Outer dististyle a sinuous elongate rod that is gradually narrowed into a terminal spine, the surface with long coarse setæ from scabrous tubercles. Inner dististyle with beak very unequally bidentate, the outer spine elongate; two approximated elongate bristles on disk of style. Aedeagus a moderately compressed flattened blade, at apex produced into a blackened beak or spine; surface just back from tip with a few microscopic scabrous points; lower edge of aedeagus with two long setæ.

Habitat.—Southeastern Brazil.

Holotype, ♂ Boracea, São Paulo, altitude 800 meters, August 1947 (John Lane). Paratopotypes, 4 ♂♂.

The most similar described species is the smaller *Teucholabis (Teucholabis) argentea* Alexander, which differs in the details of coloration and in the structure of the male hypopygium.

Teucholabis (Teucholabis) elissa, new species.

Allied to *laterospinosa*; mesonotum chiefly blackened, prothorax reddish yellow; rostrum reddish; halteres dusky, the knobs yellow; wings subhyaline on proximal half, very weakly infuscated beyond the cord; stigma dark brown, the cord narrowly seamed; apical lobe of basistyle of male hypopygium tumid, terminating in a straight spine; outer dististyle unequally bispinous at apex; surface of ædeagus with about 15 strong setæ.

MALE.—Length about 4.5–5 mm.; wing 4.8–5.5 mm.

Rostrum reddish; palpi brown. Antennæ with the scape and pedicel obscure yellow, flagellum brownish black; basal flagellar segments subglobular, the outer ones passing into oval; proximal segments abruptly narrowed into very short apical necks, producing a moniliform effect. Head reddish.

Prothorax reddish yellow. Mesonotum chiefly black, the humeral region of praescutum, suture, scutellum, and, in cases, about the cephalic fourth of the mediotergite reddish to yellow; pleurotergite black. Pleura reddish yellow, the ventral sternopleurite more infuscated; posterior pleurites somewhat brighter and more or less pruinose. Halteres dusky, knobs yellow. Legs with the coxæ and trochanters yellow; fore femora chiefly black, the basal fifth yellow; tibiæ dark brown, the tips and the tarsi black; middle and hind femora yellow; tibæ and basitarsi obscure yellow, the outer tarsal segments black; posterior tibiæ at near five-sixth the length with a slightly swollen glandular area. Wings subhyaline on proximal half, very weakly to scarcely infuscated beyond the cord; stigma short-oval, dark brown, sending a much narrower seam back over the cord; cell *Sc* above the arculus restrictedly darkened; veins brown. Venation: *Sc* short, Sc_1 ending just beyond origin of *Rs*, Sc_2 some distance before this origin; R_2 at or just beyond the fork of *Rs*; branches of *Rs* parallel to one another on about the basal half, R_5 thence bent strongly caudad to the wing tip, cell R_4 very wide at margin, greater than cell R_2; cell *1st* M_2 closed; *m–cu* at or close to the fork of *M*.

Abdominal tergites and the hypopygium black; sternites weakly bicolored, black, the narrow apices yellow, the amount of pale color decreasing on the outer segments. Sternal pocket of segment five comprised of a transverse semicircular row of relatively short setæ; sternite six without a well-defined pocket. Male hypopygium with the apical lobe of basistyle a tumid structure that terminates abruptly in a straight spine; mesal flange of basistyle blackened but smooth. Outer dististyle a strong darkened club, gradually widened beyond the base, the apex truncate, the outer angle thence produced into a strong spine that is about one-half the length of the base, the inner apical angle with a much smaller spine; inner margin of basal part of style with a series of strong serrations or spines. Inner dististyle with the apex unequally bifid, the lower arm or flange with marginal microscopic serrulations; a strong basal lobe bearing three very long setæ. Ædeagus conspicuously compressed into an obtuse blade, the apical part a low darkened knob; surface of ædeagus with about 15 strong setæ.

Habitat.—Peru.

Holotype, ♂, Chanchamayo, Junin, altitude 1300 meters, February 10, 1941 (Schunke). Paratopotypes, 5 ♂♂, August 15, 1941–February 10, 1942 (Schunke).

The most similar species include *Teucholabis* (*Teucholabis*) *laterospinosa* Alexander and *T.* (*T.*) *tullochi* Alexander, which differ in the details of coloration and structure of the male hypopygium.

Genus *Gnophomyia* Osten Sacken

Gnophomyia (Eugnophomyia) glabripennis, new species.

Size large (wing, male, over 8 mm.); general coloration of body, antennæ, halteres and legs black; wings with a strong blackish ground, the centers of most of the cells more whitened to produce a streaked appearance; cells of wings glabrous; male hypopygium with the dististyle elongate, its tip narrowly obtuse, the lower surface with abundant very long black setæ; on outer face of style at base with a small obtuse lobe; ædeagus strongly recurved at midlength.

Male.—Length about 7.5 mm.; wing 8.3 mm.

Rostrum and palpi black. Antennæ black throughout; flagellar segments subcylindrical; terminal segment much larger than the penultimate. Head dull black.

Thorax uniformly dull black. Halteres and legs black. Wings with a strong blackish ground, the centers of most of the cells beyond wing base whitened to produce a streaked appearance; veins brownish black. Cells of wing without macrotrichia. Venation: Sc_1 ending a short distance before level of fork of Rs, Sc_1 alone longer than $r\text{–}m$; Rs long; vein R_2 oblique, its cephalic end entire to subatrophied and lying more basad than the posterior portion; cell *1st* M_2 a little shorter than vein M_4; $m\text{–}cu$ at near one-third the length of cell *1st* M_2 or about one-half its length beyond the fork of M; vein *2nd A* sinuous.

Abdomen, including hypopygium, black. Male hypopygium generally as in the subgenus; apex of basistyle produced beyond the point of insertion of the dististyle into an elongate conical point, the tip subacute. Dististyle a little longer and larger than the apex of the basistyle, its tip narrowly obtuse; lower surface with abundant very long black setæ; on outer face at base with a small obtuse lobe. Ædeagus strongly recurved at midlength, the basal part more expanded.

Habitat.—Peru.

Holotype, ♂, Chanchamayo, Junin, altitude 1350 meters, March 10, 1941 (Schunke).

Gnophomyia (*Eugnophomyia*) *glabripennis* is readily told from all other regional species by the glabrous wings. All other species have numerous macrotrichia in the outer cells. In general appearance, the present fly is most like *Gnophomyia* (*Eugnophomyia*) *funerea* Alexander, from which it is further distinguished by the streaked wings and the structure of the male hypopygium.

Genus *Gonomyia* Meigen

Gonomyia (Gonomyia) subunicolor, new species.

Allied to *unicolor*; general coloration of mesonotal præscutum and scutum dark brown, the posterior sclerites of the notum more yellowed; antennæ black, the proximal half of scape yellow; legs blackened; wings with a weak brownish tinge; Sc_1 ending a short distance beyond origin of Rs; R_{2+3+4} long; cell *1st* M_2 closed; male hypopygium having much the structure of *unicolor* but the gonapophyses very reduced, appearing as small flattened black blades.

MALE.—Length about 4 mm.; wing 4.5 mm.

Rostrum narrowly yellow basally, the palpi and mouthparts black. Antennæ with the proximal half of scape yellow, the remainder of organ black; flagellar segments long-oval, with elongate verticils. Head dark gray.

Pronotum yellowish brown. Mesonotal præsutum and scutum chiefly dark brown, the sides paler; scutellum and postnotum more yellowed. Pleura yellow, the propleura and mesepisternum more infuscated. Halteres brownish black. Legs with the coxæ yellow, the fore pair slightly more darkened; trochanters infuscated; remainder of legs blackened. Wings with a weak brownish tinge, the long-oval stigma slightly darker brown; veins dark brown. Venation: Sc_1 ending a short distance beyond origin of Rs, Sc_2 opposite this origin; Rs in direct alignment with R_5, the usual basal deflection of the latter lacking; R_{2+3+4} long, nearly twice vein R_3; cell *1st* M_2 rectangular with *m–cu* at near one-third the length.

Abdomen with tergites brown, the sternites more yellowed; hypopygium brownish yellow. Male hypopygium with the styli much as in *unicolor* and with the phallosome much as in this species but differing in an important regard, the length and shape of the gonapophyses; in the present fly these appear as small flattened black blades that extend caudad only to the level of the apices of the lateral plates of the phallosome; in *unicolor* the apophyses appear as long blackened rods, much exceeding the ædeagus in length, the tips acutely pointed. The outer portion of the phallosome, presumed to be the ædeagus, shows two narrow blackened lines or sclerotized strips.

Habitat.—Panama.

Holotype, ♂, Cerro Pena, near El Valle, November 1946 (Noël L. H. Krauss).

The present fly is undoubtedly close to *Gonomyia* (*Gonomyia*) *unicolor* Alexander (Mexico, Salvador, Guatemala) but differs in the important genitalic character discussed above.

Gonomyia (Lipophleps) spiniterga, new species.

Size large (wing, male, over 5 mm.); mesonotum dark brown, the posterior border of scutellum broadly yellow; pleura with a whitish stripe; legs dark brown; wings with a strong dusky tinge; *Sc* short, Sc_1 ending some distance before origin of Rs; male hypopygium with the tergite provided with conspicuous blackened spinous setæ; dististyle single, terminal in position, bilobed.

MALE.—Length about 5 mm.; wing 5.2 mm.

Rostrum orange; palpi black. Antennæ relatively long, blackened; flagellar segments elongate, especially the outer ones; verticils of the more proximal segments very long. Head above chiefly dark colored.

Pronotum and pretergites light yellow. Mesonotum dark brown, the surface pruinose, more heavily so behind; scutellum with posterior border broadly yellow. Pleura black, heavily pruinose, with a broad more whitish longitudinal stripe extending from behind the fore coxæ to the base of abdomen, slightly widened behind. Halteres with stem pale, knob dusky. Legs with the coxæ yellow, more or less darkened basally, the surface pruinose; trochanters dusky; remainder of legs dark brown. Wings with a strong dusky tinge, the prearcular and costal fields more whitened; stigma very slightly darker, very diffuse; veins brown, paler in the brightened portions. Venation: Sc short, Sc_1 ending a distance before origin of Rs only a little less than the length of the latter; anterior branch of Rs curved strongly cephalad, nearly parallel to R_{1+2}; cell *1st* M_2 closed.

Abdominal tergites brown; sternites obscure yellow. Male hypopygium with the tergite conspicuously armed with blackened spinous setæ, including a marginal row of six or seven on either side, the more basal ones larger and stouter. Basistyle elongate, slender. Dististyle single, terminal in position, bilobed, the outer lobe a sinuous rod that terminates in a blackened spine, the inner lobe fleshy, tipped with a single very strong fasciculate bristle; a few other setæ on this lobe. Phallosome consisting essentially of a single long straight spine, the tip blackened and acute; at base of spine more dilated and with two smaller pale acute points.

Habitat.—Southeastern Brazil.

Holotype, ♂, Boracea, São Paulo, altitude 800 meters, August 1947 (John Lane).

In the strongly developed spinous armature of the tergite of the male hypopygium, the present fly agrees most closely with *Gonomyia* (*Lipophleps*) *ctenophora* Alexander and *G.* (*L.*) *juquiana* Alexander, differing in the large size and in all details of structure of the male hypopygium.

ADDITIONS AND CORRECTIONS TO THE LIST OF NEARCTIC SPECIES OF DIANTHIDIUM (HYMENOPTERA, APOIDEA)[1]

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Two new species of *Dianthidium* which have come to my attention since my paper on this genus was published, in 1943 (see JOURNAL NEW YORK ENTOMOLOGICAL SOCIETY, Vol. 51, pp. 71–109), both run to couplet 9 in the key to the females (pp. 72–74). This couplet may be revised as follows:

9 . Punctures of mesoscutum all of one size, except that they may become finer and denser on anterior middle 9a

Mesoscutum with close, minute punctures that become denser on anterior middle, and with scattered coarse punctures; punctures of frons very coarse, those of clypeus and mesopleura hardly smaller; clypeus, frons, and sixth tergite immaculate black; yellow band on tergites 1 to 4 interrupted on each side, that on 2 to 4 interrupted also in middle; tergite 5 with two submedian yellow marks .... *discors* n. sp.

9a. Punctures of frons close and at most only slightly coarser than those of mesoscutum 9b

Punctures of frons coarse and well separated, those of mesoscutum being much finer and becoming very fine and dense on anterior middle; base of abdomen more or less red; color and maculations otherwise much as in *discors*, except for a small additional spot on each side of tergite 5 .... *implicatum* n. sp.

9b. Large, more coarsely punctured species, resembling *sayi*, with the legs mainly red .... *subrufulum* Timb.

Smaller species, with punctures of frons and mesoscutum fine and close, and those of mesopleura rather coarse .... *pudicum* (Cresson)

Dianthidium discors new species.

Easily distinguished from all our other species of *Dianthidium* by the coarsely punctured frons and by the dually punctured mesoscutum.

FEMALE.—Black, with pale-yellow markings as follows: sides of face, including area between clypeus and eye and extending narrowly to level of anterior ocellus; short line behind upper part of eye; pair of small quadrate

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[1] Paper No. 580, University of California Citrus Experiment Station, Riverside, California.

spots on anterior margin of mesoscutum; small spot on tubercles and on axillæ; apical margin of scutellum; band on tergites 1 to 5, interrupted on each side on 1 to 4 and also in middle on 2 to 5, the band on 5 being restricted to two submedian marks; streak on outer inferior margin of anterior and middle femora, and spot at base of all the tibiæ. Tegulæ and wing bases bright ferruginous. Extreme apices of femora and tibiæ, the apical joints of tarsi, spur of hind coxæ, and apex of first ventrite ferruginous. Apical third of mandible reddened. Flagellum a little reddened beneath. Wings subfuliginous, darker in marginal cell. Nervures piceous. Cutting edge of mandible a little concavely oblique, with the preapical notch very small. Face shining, the punctures of frons coarse and well separated, those of remainder of face a little finer and closer, and those of cheeks much finer. Mesopleura shining, with coarse, close punctures a little finer than those of frons. Mesoscutum polished and shining between very fine, close punctures which become dense on the anterior middle. Interspersed on mesoscutum are also large, scattered punctures, not quite so coarse as those of clypeus. Scutellum similarly sculptured, but with some gradation between the coarse and fine punctures. Tegulæ finely punctured. Tergites coarsely punctured, the punctures about like those of mesopleura and becoming coarser on middle of the first tergite. Pubescence white, densest as usual on sides of thorax. Hair of mesoscutum fine, short and appressed, and imparting a whitish bloom. Ventral scopa pale ochreous. Length, 8 mm.; anterior wing, 6.5 mm.

Holotype, female, Sierra Blanca, Texas, 4,500 feet, June 24, 1942 (H. A. Scullen), in the collection of the California Academy of Sciences.

Dianthidium implicatum new species

This species resembles *D. pudicum* (Cresson) in structure of mandibles, but is easily distinguished by the coarse, well-separated punctures of the frons.

FEMALE.—Color and markings nearly as in *discors*, but base of abdomen more or less red (tergite 1 and part of tergite 2 red in holotype; tergites 1 and 2, most of 3, and part of tergite 4 red in paratype). Yellow spots on anterior margin of mesoscutum and on tubercles larger than in *discors*. A yellow mark also present on tegulæ; yellow marks on axillæ and on apical margin of scutellum form a continuous band. Markings of abdomen as in *discors*, except that a small yellow spot is present on each side of tergite 5. Apex of middle and hind femora with a pale-yellow spot above, the markings of legs otherwise as in *discors*. Wings slightly tinged with fuliginous, becoming darker in marginal cell. Cutting edge of mandible almost straight, the preapical notch very small. Face polished, with coarse, well-separated punctures on the frons, and close, somewhat finer punctures below antennæ. Mesoscutum tessellate and dull between the fine, close punctures, which become minute and very dense on anterior middle. Scutellum and mesopleura shining with coarse, close punctures about like those of clypeus. Punctures of abdomen a little smaller and more separated than those of scutellum. Pubescence of mesoscutum short and subappressed, but considerably sparser than in *discors*. Ventral scopa pale ochreous. Length, 6.5–7 mm.; anterior wing, 5.5 mm.

Holotype, female, Morongo Valley, San Bernardino Co., California, on *Gutierrezia lucida*, Sept. 27, 1941 (P. F. Timberlake), in collection of the Citrus Experiment Station. Paratype, female, 15 miles north of El Paso, Texas, June 23, 1942 (H. A. Scullen).

CHANGES IN NOMENCLATURE

In the writer's recent article on *Dianthidium* there are two serious errors in identification, which now need to be corrected, and which involve changes in the nomenclature of three species.

In 1940 Mr. Schwarz described *D. heterulkei* from Elk Lake, Deschutes National Forest, Oregon. In my paper I failed to recognize this species, as I relied too much on the figure of the male pygidium, which shows the median process too short and blunt. Since then I have seen the types of *heterulkei*, and my *D. fraternum hirtulum* proves to be identical (new synonymy). The names involved need correction as follows:

Dianthidium heterulkei heterulkei Schwarz.

D. heterulkei Schwarz, 1940, Amer. Mus. Novitates, 1058, p. 6.

D. fraternum hirtulum Timberlake, 1943, JOUR. N. Y. ENT. Soc., 51, pp. 92, 94.

Dianthidium heterulkei fraternum Timberlake.

D. fraternum fraternum Timberlake, 1943, *l.c.*, p. 92.

The other error involves the use of the name *Dianthidium consimile* (Ashmead). In 1928 Mr. Schwarz reported that he considered *D. provancheri* Titus a synonym of *D. consimile*. In my paper I considered that Ashmead had described the southern California form of *D. dubium* Schwarz, because of the mention of two yellow spots on the sixth tergite of the female. The material that I identified as *provancheri* had the sixth tergite of the female immaculate. I now have a series of 6 females reared from a nest collected on Piute Butte, Los Angeles Co., of which 3 have the sixth tergite immaculate and 3 have the same segment marked with two yellow spots. I have also examined Ashmead's type in the National Museum and can thus reaffirm the synonymy first proposed by Schwarz. The change in use of the name *consimile* involves two species, *D. pudicum,* and *D. dubium,* as follows:

Dianthidium pudicum consimile (Ashmead).
Anthidium consimile Ashmead, 1896, Ent. News, 7, p. 25.
Dianthidium provancheri Titus, 1906, Proc. Ent. Soc. Washington, 7, p. 165.
D. pudicum provancheri Timberlake, 1943, Jour. N. Y. Ent. Soc., 57, pp. 99, 102.

Dianthidium dubium dubium Schwarz.
D. dubium Schwarz, 1928, Jour. N. Y. Ent. Soc., 36, p. 404.
D. consimile dubium Timberlake, 1943, *l.c.,* p. 103.

Dianthidium dubium mccrackenae Timberlake.
D. consimile mccrackenae Timberlake, 1943, *l.c.,* p. 104.

Dianthidium dubium dilectum new subspecies.

D. consimile consimile Timberlake, 1943, *l.c.,* p. 103 (*nec* Ashmead).

Distinguished specifically by the characters given in my table on p. 98 (*l.c.*) under *consimile* (*nec* Ashmead), and subspecifically from the other races of *dubium* by the much fuller and brighter yellow maculations.

Female.—Black, with bright-yellow maculations as follows: clypeus, small supranclypeal spot, sides of face almost to summit of eyes, oval spot on middle of frons; transverse band on vertex, sometimes interrupted medially, and broad line behind eyes; two large spots on anterior margin of mesoscutum, large spot on tubercles, comma-shaped mark on tegulæ; axillæ and broad apical margin of scutellum; very large mark on mesopleura, small spot on metapleura, and small prespiracular spot on sides of propodeum; broad band on tergites 1 to 6, usually interrupted medially on 2 to 5, notched medially in front on 6, notched on each side behind on 1 to 3 and on 6, and usually with enclosed black spot on each side behind on 4 and 5; apex of femora and broad stripe beneath on front and middle pair; all tibiæ except beneath, and all basitarsi. Mesoscutum dull, finely and densely punctured. Punctures of frons finer and closer than in *pudicum.* Punctures of mesopleura a little separated. Pubescence of the usual density on head and sides of thorax, that on the mesoscutum very short and inconspicuous. Ventral scopa ochreous. Length, 6.5–8 mm.; anterior wing, 5.5–6 mm.

Male.—Markings as in the female, except supraclypeal and frontal spots small (the latter often absent), the band behind ocelli absent, mark on mesopleura smaller, marks on metapleura and sides of propodeum absent, abdominal bands with a broad posterior emargination on each side, and band on tergites 3 to 6 strongly notched anteriorly in middle or interrupted. Markings same color as in female, except that those of face and anterior marks of mesoscutum are whitish. Male differs from that of typical *dubium* in having the tergites not reddened and testaceous at apex, the yellow bands of abdomen brighter, those on tergites 1 and 2 usually entire (divided into three or even four spots in *dubium*), and outer side of all tibiæ usually entirely yellow. Punctures of mesopleura close (usually more separated in typical *dubium*). Length, 7–9.5 mm.; anterior wing, 6–7.25 mm.

Holotype, female, and allotype, from Camp Baldy, San Gabriel Mts., California, at flowers of *Stephanomeria cichoriacea,* Aug. 21, 1929 (Timberlake), in collection of the Citrus Experiment Station. Paratypes as follows: 4 males, 4 females, Camp Baldy, on *Stephanomeria* and on *Verbena prostrata,* Aug. 18 and 21, 1929; 1 female, Camp Baldy, on *Eriogonum fasciculatum,* Aug. 22, 1920; 1 female, Sheep Creek, San Gabriel Mts., on *Eriodictyon trichocalyx,* June 3, 1928; 2 males Mt. Lowe, reared from nest collected in fall of 1912 (issued July 26, 1914); 2 males, Lone Pine Canyon, San Gabriel Mts., on *Eriodictyon trichocalyx,* July 4, 1933; and 3 males, Mountain Home Creek, San Bernardino Mts., about 4,300 feet, on *Phacelia ramosissima* and *Corethrogyne filaginifolia,* Aug. 14, 1934, and on *Eriogonum fasciculatum,* Aug. 24, 1944 (all Timberlake).

A male collected at Andreas Canyon, near Palm Springs, on *Lotus scoparius,* April 14, 1946, is a form of *D. dubium,* near *dilectum,* but will perhaps deserve a name when more material is available. It has the supraclypeal and frontal spots and band on vertex absent, the stripe behind the eye very short; anterior marks on mesoscutum very small; band on ergite 1 divided into three marks, that on four following segments narrowly interrupted medially, while that on tergite 6 is represented by a small spot on each far side; a dark spot on outer side of hind tibiæ at the middle, and the front and middle tibiæ black behind on outer side.

"USELESS AND ILL-ADVISED"

"We note the formation of the 'Entomological Society of America,' having been formed at the Philadelphia meeting of the Entomological Club of the American Association for the Advancement of Science. This appears to be a new society, not a new name for the Entomological Club. We fail to see any necessity for this organization, or any special purpose in its formation. No place of meeting is mentioned, and it must either meet in some later selected place, in which case it will only uselessly compete with the local society there, or meet with the American Association for the Advancement of Science, to uselessly compete with the Entomological Club. No mention of a publication appears with the prospectus, and we heartily hope none will be attempted. None of the present entomological societies are able to pay for their publications out of their subscriptions, except 'Entomological News,' so that a reduction in the number of publishing societies would seem to be in order, rather than an increase. The American entomologist is a rather rare species, and the number of journals he has to purchase, to keep up to date, is already too great. Unless the Entomological Society of America can absorb one or more of the existing societies, we think its formation not only useless, but ill-advised."

The above was written 42 years ago by Dr. H. G. Dyar and published in the JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, vol. 14, No. 4, p. 231–232, Dec., 1906. Although there may have been some justification for that opinion in 1906, the statement is an example of the danger of being dogmatic, especially in print.—H. B. W.

NOTES ON A COLONY OF POLISTES FUSCATUS HUNTERI BEQUAERT

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The genus Polistes consists of a cosmopolitan group of social vespid wasps. Various observers have described the founding and maintenance of the polistine colonies. As information about the divers species accumulates, it is obvious that, while all the species follow the same broad basic pattern, there are many behavioral differences between species and perhaps between various populations of the same species. This is not surprising, especially when one considers the number of species and the vast geographical range of the genus. Just how diverse the pattern of activities of the genus will eventually prove to be can not be determined until many more observations have been made both on previously studied species and on those species which have not as yet been critically observed. So far as could be ascertained no records of the activities of *Polistes fuscatus hunteri* Bequaert have previously been made known. The following observations on this sub-species, although in no sense complete, are based on the data collected from a colony of *P. hunteri* Beq. during the summer of 1945 while the author was at Tyndall Field, Florida.

The nest under observation was located on the ceiling of the open porch of a small, single story house in Port Saint Joe, Florida. The porch faced south and the nest was placed in the northwest corner with the holdfast attached to the upper inner edge of a wooden, cavetto style molding. The house was approximately fifteen months old and had been occupied continuously since its completion. There seems to be adequate evidence that this was the first nest that *P. hunteri* had constructed on this porch. Another nest was found about fifty feet away in the shrubbery on the south side of a house of the same type and age on the adjoining lot. This shrubbery had been planted during the fall of 1944 so that the nest in it also seems to represent new colonization for the species. When the author moved into the house on 1 March, 1945, the nest on the porch was noted as a tiny comb but no observations were made until July 30. Once observations were started, they were continued daily (with the exception of five days from September 10 to 14) until October 7 and were made during the early morning and evening hours and on occasional off-duty days.

Although the nest was protected from the elements by the porch, it was easily accessible for observation. *Polistes fuscatus hunteri* Beq., is a gentle wasp and the constant presence and activity of human beings on the porch seemed to condition this particular colony to the presence of large animals. At any rate, the wasps seemed less excited by my presence than were those of the nest located in the shrubbery. The method of observation was to stand on a stool within close proximity to the comb. A thin metal mirror attached to a stick and slipped between the ceiling and the comb showed the top of the comb. By using a flashlight and the mirror, it was possible to count the number of individuals that slept on the comb. A porch light enabled one one to make general observations at various times after darkness had fallen.

COLONY POPULATION

From July 30 to August 15, seven individuals worked and slept on the comb. All these were females and one, by virtue of her activity as well as her more worn appearance, was considered to be the foundress of the colony. During this time, no new individuals emerged. On August 15 two individuals emerged and that night nine specimens were counted. One female emerged on the 16th and another on the 18th, so that on the night of August 18 eleven wasps slept on the comb. During this period (July 30 to August 18) apparently there was no mortality among the adults. From then on, however, disparity constantly existed between the number that was expected and the actual number counted sleeping on the comb. It is true that apparently an occasional individual spent the night away from the comb, but the disparity was too great to be accounted for by this cause alone. From August 19 to September 6, at least thirteen individuals emerged, making a total of twenty-four wasps that were expected in the population. On the night of September 6, fifteen individuals slept on the comb, thus leaving nine unaccounted for. During the next few days a number of individuals emerged. It was impossible to determine the exact number, but on September 9 twenty females slept on the comb and one on a morning glory vine nearby. From then on it was not possible to take an accurate census, due mainly to the appearance of males in the nest. It would seem that either mortality or desertion from the colony occurs as the season goes along. Considering the hazards that the wasps must face when foraging abroad for food and building materials, it is not surprising that some individuals should fail to return to the nest. The fact that seven individuals should have suffered no fatalities during the period from July 30 to August 18, inclusive, indicates that an adult Polistes is well able to care for herself in a hostile world.

As indicated above, no observations were made from September 10 to 14 inclusive (at which time I was on temporary duty at another Army post). During this period males appeared in the colony and became steadily more numerous from then on. Due to the hostility of the females toward the males, the latter were usually found on the top of the comb. At night they, plus some workers, slept on the top, packed so densely that it was impossible to count the exact number. It is certain, however, that the adult population at any one time never reached more than thirty and probably was less than twenty-five.

The ''shrubbery nest'' (as we shall designate the previously mentioned nest located in the neighbors' shrubs fifty feet away) underwent a parallel development except that it was ''younger'' than the porch nest. At all times it was smaller and males did not appear until September 28. Unfortunately this nest was destroyed before it had completed its cycle.

THE COMB AND ITS CONSTRUCTION

On March 1 the comb consisted of several cells, probably not more than six. By August 3 there were forty-three cells and when the colony broke up on October 29 there were 146 cells. The final nest shape was asymmetrical, probably due to the location of the nest in the corner of the porch. The shrubbery nest was symmetrical in construction. The porch nest was attached to the upper edge of the inner face of a concave cavetto style molding that ran around the porch ceiling with the holdfast itself adhered to the wooden molding and extended on up to the ceiling. By August the nest had grown to such a size that it filled the corner and thus new cells could be added on only two sides, viz., the east and south sides. The holdfast was strengthened and enlarged from time to time, and on August 26 it was observed that a secondary attachment had been made to the molding on the north side of the porch.

From time to time individuals were observed returning to the nest with a pellet of wood pulp of from 1 to 2 millimeters in diameter. This pellet, unlike the food balls, was carried and handled almost exclusively by the mouth parts, although once an individual was seen to use her fore legs while manipulating the wood pulp. Upon arrival at the nest, the wasp might either divide or give the entire pellet to other wasps or might retain the whole pellet herself. It was not possible to learn what determined which procedure was to be followed, but in any case the wood pulp pellet was ready for immediate use when brought into the nest. Without further ado, the wasp would run over the surface of the comb until she found a cell that suited her for further construction. She would then align her longitudinal axis with the wall of the cell and, moving backwards, spread the wood pulp over the edge of the cell. In doing this, the pulp was actually spread by the mandibles while the other mouth parts, except for the labrum, were used to support the pellet. At the same time the antennæ rapidly and continuously tapped the wall of the cell, one on either side. The antennæ always tapped that part of the cell that had been previously constructed. At first the pulp was rapidly and thickly spread over the edge of the cell wall, and then the wasp went over it again and again until it was thinned and smoothed to her satisfaction. Invariably she moved backwards as she worked with the wood pulp, but she might move either clockwise or counterclockwise and often changed her direction several times during the addition of a pellet.

To the queen apparently belonged the task of initiating the construction of new cells. Since she apparently did not leave the comb during the period of observation, she always had to solicit the wood pulp necessary to build the new cells. A single pellet of pulp would furnish enough material to build a tiny shallow cell. While it was still damp, she would at once (or, very rarely, shortly thereafter) oviposit in this new cell. On August 29 the queen was observed to build a new cell, oviposit in it and then, after having very briefly cleaned herself and visited two larvæ, she approached a worker who was building on an older cell and not only demanded and received what was left of the pellet but also she re-collected what had been spread out. The queen then proceeded to select a site and start a new cell. It took her seven minutes to select the site for the new cell and six minutes to construct it. Having finished the cell she did not immediately oviposit. This, however, was the only time that she was not observed to oviposit immediately after completing the construction of a new cell.

The new cells were always added to the edge of the comb and were directed not downward but laterally. As the larvæ grew and the cells were enlarged, then the additions were so made that the opening of the mature cell faced downward. During the last two months of the colony's existence, the new cells were piled up on the edge of the comb so that the dorsal surface of the comb actually became concave. This shallow concavity was a favorite resting spot for the sentinels and males and at night was filled with sleeping individuals.

No more wood pulp was added to a new cell until the egg had hatched and the larva started growing. Then the workers kept constantly adding to the walls of the cell so that by the time the larva had reached maturity, the cell was large enough to accommodate the pupa. Not all cells were of exactly the same length and thus the stimuli that effected the construction of the cells seemed to be derived from the larva rather than from the surrounding cell walls. Different stimuli, however, affected the larva and if when it was ready to pupate its cell was shorter than were the surrounding ones, then it would add silken material until it brought the walls to the approximate level of the surrounding cells. Having done this, it would then spin a rounded pupal cell cap. If the cell was as long as, or longer than, the surrounding cells, then the pupal cell cap was spun on the ends of the wood pulp walls and was flat rather than rounded.

When the adult emerged it perforated the pupal case by cutting a circular flap from the end of the pupal cell. This flap attached at one side hung downwards while the cut edges of the cell were always rough and ragged. The older workers would immediately refurbish the cell by scraping out the interior, removing the flap and leveling the ragged edges so that the cell wall was even with that of the surrounding cells. Quite different stimuli were obviously involved in refurbishing the cells from those involved in the original construction.

The materials collected during the refurbishing of the cells were not discarded but were chewed up into pulp and used for the construction of other cells. Thus the final comb although principally made up of wood pulp also contained material derived from the larval silk.

FOOD AND FLUID

The solid food utilized by the colony consisted of chunks of caterpillars. Apparently this did not include any part of the caterpillar digestive system but seemed to be made up of the body wall. These pieces varied considerably in size, an average piece being 3 × 3 × 3 mm. Sometimes the pieces were very small, although occasionally they were so large that the individual was unable to make a proper landing on the nest. One such overloaded worker calmly flew across the porch, landed on a flat surface and clipped off a protruding piece from the chunk she had been carrying. Having done this, she was then able to land on the comb. At no time was an entire caterpillar brought to the comb; rather the food always consisted of pieces that had been cut from individuals. When flying the wasp carried the food by means of the mouth parts and the fore legs. When such an individual landed she supported herself by the meso- and metathoracic legs.

Invariably when the food bearer alighted on the nest, she was accosted by one of the householders and then one of three things would happen: (1) The bearer might insist on retaining the food. If she insisted, she usually would succeed although she might have to refuse several applicants. (2) The entire food mass would be turned over to the applicant. (3) The food mass would be divided with another individual. The third procedure was most common and the division was accomplished by means of the mandibles and usually resulted in a rather equitable distribution of the food. Sometimes in the case of a large mass the applicant would receive the larger part and then this in turn might be divided with another nest-mate.

Once this division had been accomplished then the wasps would proceed to masticate each chunk and reduce it finally to a spherical bolus. Having started the process of mastication an individual would only rarely be molested by a nest-mate. Mastication was accomplished by the mouth parts aided by the antennæ and the fore legs. Only the tips of the fore tibia and the basal segments of the tarsi—not the tarsal claws or distal segment—came into contact with the food. Mastication did not appreciably decrease the size of the food mass and an adult was never observed to eat any of the food. After formation of the bolus, the wasp would then walk across the comb and finally select a larva which would then be offered the food. This was done by means of the mouth parts alone and the bolus, plus most of the head of the adult, was inserted into the larval cell. The larva would be allowed to feed for five to ten seconds and then the adult would retract her head and a large cavity could be seen on the side of the bolus where the larva had eaten away the food. The bolus would then be reformed, after which the adult might return to the same larva that she had been feeding or she might go on to another cell. Sometimes she would feed as many as three larvæ with one bolus. Exception to the normal procedure might occur with older larvæ to whom a small bolus of food might merely be given and then the adult would immediately remove her head and allow the larva to handle the food without aid. No reasons could be determined for the selection of the larvæ that received food. Sometimes an adult would visit many cells before she selected a larva to feed. Obviously there must have been some stimulus involved but it was not apparent to the observer. Neither could any reason be determined why some larvæ might receive an entire bolus while another one would be given only a part of the available food.

Often individuals would return to the nest without any visible cargo. They would be accosted immediately by a nest-mate who would usually nudge the returnee, and then there would ensue a brisk tete-a-tete between the two individuals involving rapid mouth movements which probably accompanied the transfer of materials from the returnee to the applicant. Apparently the returnee had a supply of nectar or other substance that was sought by the applicant. If the tete-a-tete lasted for some time then the applicant, after having finished with the returnee, would hold a tete-a-tete with another householder. Now and then a wasp would return and refuse to cooperate with its messmates. Such individuals were often roughly handled by the householders. In such instances, if nudging and shoving did not produce results, the usual treatment was for the householder to seize with her jaws the dorsum of the returnee's abdomen in the region of the petiole. Then she would chew vigorously and with rare exceptions such treatment would quickly cause the returnees to acquiesce to the demands made upon them. All individuals that returned to the nests were accosted, but it seemed that those that carried no material externally, *i.e.*, meat or wood pulp, were sought most eagerly. When males appeared in the colony they would rush to accost those returnees that might be carrying nectar but strictly avoided those carrying meat or wood pulp. These activities between the adults seem to be best classed as examples of trophallaxis.

On two occasions when the humidity was obviously low (in each case a meteorological front had passed through the area just a few hours before), clear fluid was seen in all cells, *i.e.*, not only those that contained larvæ but also those in which eggs were present. This was placed on the walls of the cells in small droplets. Other than on these two occasions there was no sign of fluid per such being distributed to the developing individuals.

OTHER ACTIVITIES OF THE COLONY

One of the most characteristic features of the colony was the behavioral pattern followed by the individuals on the comb.

This consisted of periods of rest followed by surges of physical activity. If an individual returned from afield, she was invariably accosted by one or more nest mates. This activity would in turn stimulate all other individuals on the comb to activity and almost immediately all of them would be visiting larvæ, tete-a-teting with the returnee, moving about on the comb, or cleaning themselves. One by one, if no other stimulating incidents occurred, the individuals would relapse into a state of quiescence until all the individuals would be resting. Before the colony returned to a state of rest, every individual would have cleaned herself and have visited one or more, usually more, larvæ.

These periods of rest were of much longer duration than the periods of activity. While on the comb, the individual wasp unquestionably spent most of the time resting. After a trip afield an individual apparently always indulged in a prolonged rest before again returning to the field. A resting wasp assumed a characteristic posture with drooping antennæ, and with its body in contact with the comb.

Next to resting, the individual wasp spent most of her time cleaning herself. After activity of any sort, the individual invariably cleaned itself. The front legs were used to clean the face and associated structures such as the mouth parts and antennæ. The hind legs, assisted by abdominal movements, were used to clean the middle legs, abdomen and distal three-quarters of the wings. The top and rear of the head, the thorax and basal fourth of the wings were cleaned by the fore legs. Most often just the face and associated structures were cleaned, and least often the thorax and top of the head. The latter apparently was a gymnastic feat of some difficulty.

When an individual returned from afield, the surge of activity she created would continue until all materials, regardless of the type, that she had brought back had been disposed of. During periods of the day when the wasps were busily returning to the nest with food and wood pulp, then the colony was in an almost constant ferment of activity. At such times the population on the comb was small, but never was it deserted and usually five or more individuals were somewhere about. One or more of these that remained on the nest was always on the top of the comb and seemed to serve as a sentinel; these individuals on the top invariably rested with their faces directed outward. If a strange being or object approached the nest they were the first to become alert. Their antennæ would be lifted, straightened, and directed forward, slightly upward and divercated at about 45 degrees. Their bodies would be raised from the comb and, if really alerted, they would also raise their wings in preparation for attack. Individuals on the under side of the comb might also assume the alert position but apparently those on the dorsal surface were the first and most easily stimulated.

If the colony had been quiet for a time and no intrusion from foreign objects or returnees had stimulated the individuals to activity, then suddenly one of the resting individuals would become active, either to clean itself, to move about preparatory to leaving the comb or most usually to visit the larvæ. Such activity would then stimulate the rest of the colony to activity. Thus either internal or external stimuli might start a cycle of activity. It is to be noted that if an individual had been afield, or had been working with wood pulp or meat, then she always cleaned herself both before and after visiting the larvæ. If she had been merely resting then she might visit the larvæ without cleaning herself. After the visit she would clean herself. The rule seemed to be that an individual cleaned herself after every phase of activity.

As stated above, during the surges of activity the wasps visited the larvæ. In such cases the wasp would move over the ventral surface of the comb, pausing momentarily at the various cells, select a cell in which a larva was present, insert her head and antennæ deeply (much further than when the wasps profferred food to the larvæ) and spend twenty to forty seconds with the larva. During this time the antennæ could be seen to vibrate gently. The wasp would visit from one to twenty larvæ in succession, but in doing so she might inspect many more without actually sticking her head into the cell. This activity was most characteristic and common and was interpreted as trophallaxis. No counts were made as to cumulative numbers of times that a single larva was visited during a day, but it certainly must have been many hundreds of times.

When the larvæ were ready to pupate they were ignored by the wasps and were neither fed nor visited for trophallactic exchange. Likewise the eggs and young larvæ were ignored. One of the unobserved features about the colony was how the very young larvæ were cared for. Apparently, until they were about one-fifth grown, the wasps completely ignored them with the exception of those rare instances when fluid was deposited in the cells. At that time all cells regardless of the presence or non-presence of an occupant received a portion. At no time (even though special attention was paid to this question) was a wasp observed to deal with any of those cells that contained eggs or young larvæ.

On those days when the ambient temperature was high, individual wasps were observed to raise their bodies from the comb and rapidly and vigorously beat the air with their wings. It was not possible to determine the significance of this activity. There seemed no relationship between the position of the wasp on the comb and the activity.

In cleaning herself, visiting the larvæ, resting, etc., the queen acted like all the wasps except that (1) she seemed to prefer the central area of the ventral surface of the comb as her resting and sleeping locale; (2) she quickly and easily drove all other wasps from this area, and (3) often she would violently shake herself much in the fashion that a dog shakes the water from its body after having been immersed. The queen was the only individual that indulged in this peculiar activity and no significance could be attached thereto.

OVIPOSITION

Oviposition was observed numerous times. In all cases observed, whether in a new cell or an old one that had been vacated by its previous inhabitant, the queen was the individual that produced the eggs. In the case of new cells she would, as shown above, build the cells from a single pellet of wood pulp and then oviposit in the cell while the walls were still damp. The ovipositing sequence was as follows: (1) As soon as she had finished a cell or discovered an empty one she would inspect it carefully, touching the inner surfaces with her antennæ; (2) she would then turn about, insert her abdomen for a few seconds; (3) then remove her abdomen, change her position on the comb and re-insert the abdomen into the cell and proceed to oviposit.

During the actual period of oviposition the abdomen was arched slightly and for the first sixty seconds or so might be seen to move about and then become quiet. About four to five minutes were necessary for oviposition and the termination could be anticipated by the fact that the queen's antennæ began to vibrate for several seconds before she removed her abdomen from the cell. Having placed the egg in the cell she turned quickly and inspected it carefully with the tips of her antennæ. She then cleaned herself and visited some of the larvæ.

Oviposition took place at various times during the day and there seemed no definite time or rhythm involved, although it seemed restricted to the hours of daylight.

PUPATION AND EMERGENCE OF THE ADULT INDIVIDUALS

Mature larvæ pupated at all hours of the day and night. The spinning of the pupal cap took several hours. A larva would spin a small sector by wagging its head back and forth with a sidewise motion, then suddenly it would retract into the cell, rotate its body about one-fifth to one-third of a turn while retracted, extend itself and proceed to work on a new sector which invariably overlapped that area it had just completed.

When the adults of the shrubbery nest were destroyed, the comb itself was secured and the larvæ and pupæ removed for study. The full fed larvæ that had just spun their cocoons but had not shed the last larval exuviæ were located in the cocoons with their heads directed downwards, but individuals that had just shed this larval exuviæ (just transformed into exarate pupæ and were still unpigmented) had their heads directed upwards in the cells. Those individuals that were fully pigmented and ready to emerge had their heads directed downwards. Thus the individuals change direction at least twice after the cocoon has been spun. Probably the full fed larva, after it has finished the cocoon and when ready to pupate, is located so that its head is directed toward the top of the comb. The pupa therefore is similarly oriented. When the pharate stage of the adult is attained, however, then the individual reverses its position in the cell and with its head directed downwards is ready to emerge.

Emergence of adults took place at all hours of the day and night. One individual was observed to emerge at 6.20 in the evening. She cut her way out, crawled out of the cell and onto the comb, cleaned her antennæ, visited the nearest larva, tete-a-teted with an adult, visited two other larvæ, cleaned her wings and hind legs, explored the comb, and then became quiescent. In the meantime an adult had discovered the empty cell and became much excited. She cleared away the flap-like cap and the ragged edges, forming a ball of pulp from the material. Then she entered the cell and apparently scraped the inner walls with her mouth parts. She moved around on the comb but kept constantly returning to the empty cell and scraping the inside. This continued for at least fifteen minutes. The pellet of pulp which was derived from the cap and the scrapings was eventually built into a cell.

THE MALES

Sometime during the break in the daily observations that occurred between September 10 to 14, the males appeared in the colony. Because of their color and the shape of their antennæ, they could be readily identified. The females constantly drove the males from the ventral surface of the comb and perforce they spent most of their time on the top of the comb. They would, however, come down onto the ventral surface to visit the larvæ and to tete-a-tete with those females that returned to the colony without any visible cargo. They never approached a female that was bearing meat or wood pulp. They did, however, forage for themselves among the flowers in the neighborhood where they could be caught in considerable numbers.

During the remainder of the life of the colony the males became more and more abundant. Gradually the workers were less and less able to keep the males from almost monopolizing the ventral surface of the comb.

As stated above only the queen was observed actually to lay eggs. Since, however, these observations covered only a fraction of all the eggs actually laid, it is impossible to say that the males were the offspring of the queen although circumstantial evidence indicates that such was the case in this colony.

BREAK-UP OF THE COLONY

On September 23 it was observed that several cells were empty and that apparently this was due to larval mortality since the larvæ that had occupied these cells had not been full-grown and certainly had not pupated. Except for continuing mortality of this type, the colony seemed to proceed normally from then until September 27. On that date it was observed that the workers were no longer cleaning up the cells from which adults were emerging. The new adults were apparently all males. On the morning of September 28, most of the larval cells were devoid of inhabitants. At 7.00 P.M., on the same day, all the larvæ as well as the eggs were gone from the nest and now only pupæ (29), males and females, remained. The day was overcast and showers had fallen. Just as darkness fell, a rain squall accompanied with considerable wind struck the area. At 8.30 P.M., after the storm had abated, the comb was inspected and found to be completely deserted by the wasps. Inspection of the porch showed numerous individuals, both males and females, resting on the wooden surfaces and on the morning glory vines that were supported by trellises.

From September 28 to October 7, wasps were occasionally seen on the comb but never more than two individuals at any given time. A few of the twenty-nine pupæ emerged, but once the nest was deserted by the adults, ants invaded it immediately (they had done so in great numbers by 8.30 P.M., on the night of September 28) and cut their way through the pupal cases and ate and killed the pupæ.

On October 7 the comb was removed except for the basal part of the holdfast. From then until November 1, an occasional wasp would spend the night sleeping on the holdfast.

ENEMIES

The chief enemies of these wasps appeared to be various species of ants. Constantly the wasps drove the ants away and as long as an adult was about the comb, the ants were never able to gain access to the colony. An attempt was made to transfer to another corner of the porch a colony of *Polistes fuscatus bellicosus* Cresson[1] which had to be destroyed from its original site. The adults of this colony, although transferred with the comb, immediately left the comb and returned to the old site. Ants invaded this comb within fifteen minutes of the time it was deserted.

Parasites also attacked the colony, although the actual invasion was never observed. As stated above, observations were not made from September 10 to 14 and when observations were resumed on September 15 it was noted that many of the cells in the central region of the comb had a silken, sheet-like structure running obliquely from the mouth of the cell into the interior. It was not possible to determine just what parasite was responsible for this condition. This sheet was not removed from the cell and, even though the volume of the cell was greatly reduced by its presence, nonetheless eggs were laid in these cells, presumably by the queen.

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[1] It is obviously erroneous to consider *bellicosus* Cresson and *hunteri* Beq. as subspecies of *fuscatus*. They were both living in the same area and clearly not interbreeding. They are quite distinct in many ways and by all known criteria belong to different species. Despite this, since I am not familiar with the taxonomy of Polistes, I am following the present but incorrect nomenclature.

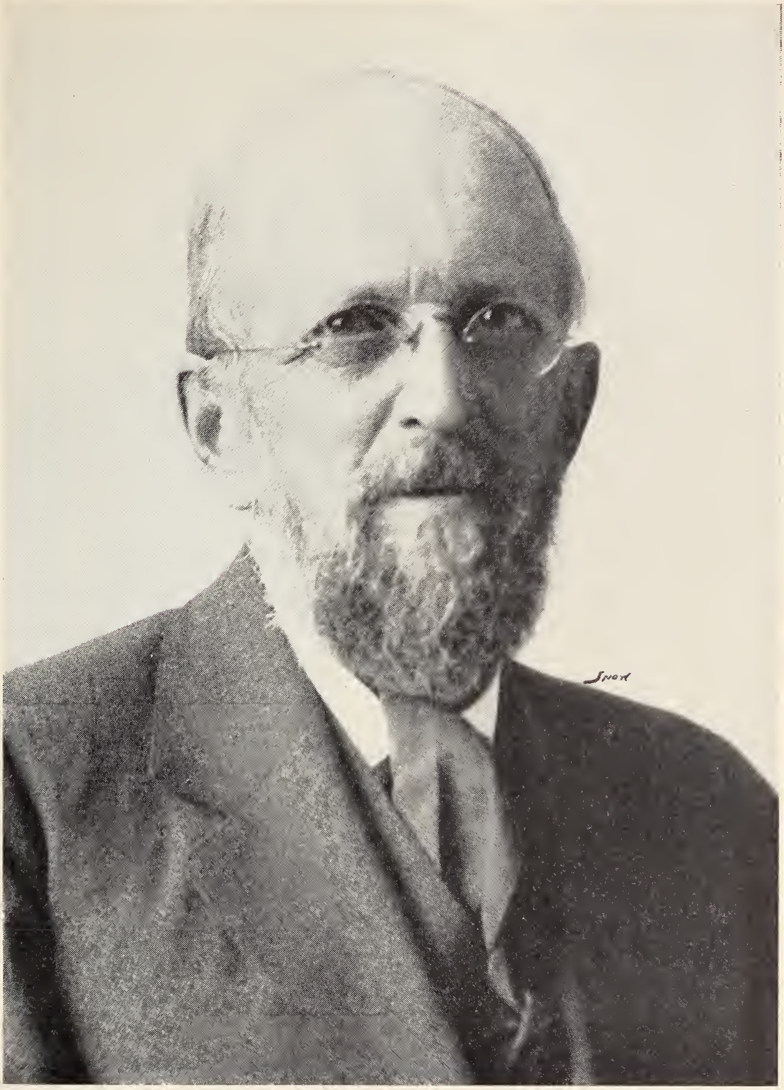
INSECTS AND SLANG

Slang is usually humorous and satirical and its use is world-wide. It frequently expresses in a few words something that would ordinarily take many more. Often, but not always, it is characterized as coarse or vulgar. All sorts of callings, professional and otherwise have their own peculiar slang, and it abounds in schools, factories, offices, etc. There is military slang, stage slang, legal slang, etc., etc., etc.

One would not expect any but the most common insects, usually those associated with man, to be used in slang expressions. And this is borne out by the following examples which have been hastily gathered from "The Slang Dictionary", London, 1894 and "Slang and Its Analogues" by John S. Farmer, London, 1890, 6 vols.

Beeswax, poor soft cheese.
Beeswaxers, thick boots used for playing football.
Beeswing, a film in port wines, the result of age.
Beetle-crusher, a large foot.
Beetle-sticker, an entomologist.
Bug, (thieves') a breast pin.
Bug blinding, (military) whitewashing operations.
Bug hunter, a thief who robs drunken men.
Bug juice, ginger ale, bad whiskey, etc.
Bug walk, a bed.
Butterfly, (nautical) a river barge.
Flea bite, a trifle.
Flea, a miser, skin flint.
Flea-bag, a bed.
Flies, nonsense, trickery, deceit, lies.
Louse ladder, a ladder in a stocking.
Louse trap, a small-tooth comb.
Louse walk, a back hair parting.
Maggoty, fanciful, fidgety.

A further search might result in the finding of additional slang terms involving insects and perhaps uncover "entomological slang", although at the moment, I am unable to think of a single word or expression that belongs to the latter category.—H. B. W.



T. D. A. Cockerell

T. D. A. COCKERELL

In the death in San Diego, California, on January 26, 1948, of Theodore Dru Alison Cockerell, we have lost one of our very well known entomologists and zoologists. The loss will be felt by all who knew him, for his quiet wit, charming whimsicality, kindliness, and his personal interest in fellow biologists endeared him to all. Although for many years especially interested in the taxonomy of wild bees, he was interested in and wrote about so many other fields that there is scarcely a taxonomic biologist who has not examined some of his papers. He wrote extensively on scale insects, land snails, slugs, fossil insects, fish scales, sunflower taxonomy and genetics, and paleobotany. Although he regarded himself as amateur in botany, he described 32 new plants from New Mexico, in addition to others from other areas.

To compile a list of his publications would be a herculean task, and in addition to thousands of short papers, they include a general zoology book, a book entitled, "The Zoology of Colorado," numerous poems, and pamphlets on public affairs and politics.

Cockerell was born in Norwood, England, on August 22, 1866. Although he has written that his interest in natural history began as early as he can remember, he debated whether to go into the arts or into science. As a child he was interested in every phase of natural history, and this broad interest and enthusiasm continued until his death. He was a frail child and because of this he received little formal education but had time for many walks in the meadows and woods, where he acquired first hand information on natural history.

Because of an illness he left England in 1887 to live in Wet Mountain Valley, Colorado. There he began a catalogue of the biota of Colorado. In his work there he specialized in the Macrolepidoptera, molluscs, and flowering plants. Being ostensibly cured in 1890, he returned to England, and after about a year working in the British Museum was appointed Curator of the Public Museum, Kingston, Jamaica, where he went in

1891. Although continuing his previous studies, he acquired in Jamaica a special interest in the Coccidæ or scale insects, and described many new species.

In 1893, because of new signs of tuberculosis, he determined to return to the Rocky Mountain area and was able to exchange positions with C. H. Tyler Townsend, the well known dipterist. By this arrangeemnt Cockerell went to teach at the New Mexico College of Agriculture near Las Cruces. From this time on he lived in this country, and became a United States citizen.

Cockerell's interest in wild bees began in New Mexico, where they abound, and his first paper on them was published in 1894. From that year to this not a year passed without the publication of numerous papers under his name on these insects. A few still await publication. One of his most extensive and best bee papers was a revision of the genus *Perdita,* published in 1896, only three years after his arrival in New Mexico.

It was in New Mexico that Cockerell met Wilmatte Porter, with whom he collaborated in various bee papers both before and after their marriage. After brief stays at other schools in New Mexico and Colorado, the Cockerells moved in 1904 to Boulder, Colorado, where he became a member of the faculty of the University of Colorado.

The Cockerells maintained their home in Boulder for 44 years. During this time they were able to make expeditions, principally for collecting bees and fossil insects, to many parts of the world —Argentina, Peru, Madeira, Morocco, the Belgian Congo, South Africa, Australia, New Caledonia, Siam, Lake Baikal, and the maritime provinces of Siberia and Japan. After his retirement from the University of Colorado in 1934, he maintained an office there but spent part of each year elsewhere, usually in California. While there he made a special effort to stimulate interest in the coastal islands off Southern California and made several trips to them. The Cockerells spent considerable time in 1946 and 1947 at the Escuela Agricola Panamericana in Honduras. Here, as always, they collected bees, and I have a letter written only five days before his death, discussing the progress he was making in working up the bees obtained there. Prior to the work in Honduras, the Cockerells' previous major expedition was to South Africa, where shortly after his retirement, they obtained, with the aid of others, the largest bee collection ever brought out of Africa.

Cockerell had a remarkable ability to accurately express himself, both verbally and in writing. He was always an interesting, quiet speaker, but this ability is best exemplified by his manner of writing papers. Examining bees with a hand lens, resorting to a binocular microscope only for occasional elusive details, he would write out the descriptions and discussions on separate small sheets of paper. When a sufficient number of these had accumulated, and the paper was completed, he would rearrange them if necessary, reread them, but without changing more than a few words the paper was ready for publication. This seems little short of miraculous to those of us who have to cross out, rewrite, and rearrange the greater part of what we write before submitting it for publication. More remarkable, his papers were consistently accepted in longhand by dozens of editors, for Cockerell never used a typewriter and apparently never was provided with a secretary.

Another remarkable feature of his working methods was his dependence, fully justified, upon his memory. Only rarely was it necessary for him to consult the Zoological Record or other source of reference to learn where a given description was published. Ordinarily when he wished to see the description of a certain bee, he could go directly to his reprint collection and take out the correct reprint. To a large extent it was memory also which made it possible for him to almost completely avoid making homonyms, a remarkable feat considering the thousands of species which he named.

Unlike many men who describe great numbers of new animals, Cockerell never attempted to maintain a monopoly in any of the groups in which he was interested. Indeed his greatest desire was to start others working in the same lines, so that additional work could be done in the fields in which he was so interested. For example, after hearing that I was interested in bees, the Cockerells took special pains to arrange a meeting and later invited me to spend a summer with them in Boulder, living in their home. Each day Professor Cockerell and I walked to the University, he always carrying an insect bottle in a pocket so that we could collect any interesting specimen we might see in the vacant lots we passed. In his office he always gave freely of his vast store of knowledge about bees.

Cockerell has written, "We build on foundations often poorly established, and no matter how clever or industrious we may be, posterity will have to revise and correct much of what we have done." Speaking of his naming of so many bees and the need for proper revisional studies, he has said to me, "I have gathered the wood, now it is up to you to build the house." Thus we see one of his most admirable characteristics. Although his own work as largely purely descriptive, he never found fault when others, with more material available and after more thorough study, placed his names in synonymy; indeed he treated many of his own names in this way himself. Moreover, he fully appreciated the importance of extensive revisional and experimental studies and constantly urged individuals and groups to undertake such projects because of the light they would shed on evolutionary and distributional problems, matters in which he was vitally interested and highly conversant, although he wrote relatively little about them.

No account of Professor Cockerell would be complete without further mention of Mrs. Cockerell, his constant companion both in Boulder and in the field. The Cockerells had a very serious interest in conservation and through the years assembled a library of motion picture films on various natural history subjects. These they showed at every opportunity, wherever they might be. Indeed they made numerous long and difficult trips for the sole purpose of showing these films and talking about conservation, particularly to groups of children.—Charles D. Michener,[1] American Museum of Natural History.

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[1] It should be mentioned that Cockerell wrote a series of autobiographical notes, from which some of the above information was obtained. These were published in Bios, 1935–1939, 6: 372–385; 7: 149–155, 205–211; 8: 12–18, 51–56, 122–127; 9: 21–25, 66–70, 117–124; 10: 35–41, 99–106.

NOTES ON THE DISTRIBUTION, HABITS, AND HABITATS OF SOME PANAMA CULICINES (DIPTERA: CULICIDÆ)

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(Continued from Vol. 55, p. 200)

In the first part of this paper I discussed the distribution, habits and habitats of some Panama Anophelines. In this part I am continuing with the Panama Culicines, *Uranotænia* thru *Deinocerites.*

PART II

Uranotæniini

Uranotænia Lynch Arribalzaga

Uranotænia calosomata Dyar & Knab

Uranotænia calosomata Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 200, 1907 (Type Loc.: Tabernilla, C. Z.).

Distribution:—Tabernilla (Busck); Culebra (Army Medical Museum); Paja (Shropshire); La Chorrera (Author).

Habits and Halitats:—The larvæ breed in shady, swift flowing streams, associated with *Chagasia bathanus.* This is a rare species collected only in March. (Bred from larvæ in prints of horse's feet containing water—Busck. Ground pools and often in cattle tracks—Dyar).

Uranotænia contzacoalcos Dyar & Knab

Uranotænia coatzacoalcos Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 186, 1906.

Uranotænia typhlosomata Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 200, 1907. (Type Loc.: Tabago Island, R. de P.) (Var. *coatzacoalcos* D. & K., *vide* Dyar & Shannon, Ins. Ins. Mens., 12: 191, 1924.) (Syn. *coatzacoalcos* D. & K., *vide,* Dyar, Ins. Ins. Mens., 13: 185, 1925.)

Distribution:—Pedro Miguel (Jennings); Gatun (Zetek); Barro Colorado Island (Shannon); Caldera Island, Tabago Island

(Jennings); Gamboa, National Forest, La Chorrera, El Valle de Anton (Author).

Habits and Habitats:—Larvæ breed in rock pools, streams and once collected in water in a fallen log. This species is a shade breeder, without vegetation, but debris may be present. It is not collected in flowing water.

This species breeds throughout the year associated with *Anopheles eiseni, A. punctimacula* and *A. apicimacula.*

Adults have been captured flying in the jungle near the breeding pool.

Uranotænia geometrica Lutz

Uranotænia geometrica Lutz (in Theobald), Mon. Cul., 2: 247, 1901.

Distribution:—Empire, Gatun, Culebra (Busck); Cartagenita, La Boca, Ancon, Pedro Miguel, Corozal, Gorgona, Gatun, Tabernilla (Jennings); Caño (Zetek); Paraiso (Dunn); Toro Point, Gold Hill, Summit, Margarita, Mindi, Monte Lirio, Miraflores, Las Cascades, Partilla, Mount Hope, Majagual, La Pita, Comacho, Cativa, Mandinga (Shropshire); Caño Saddle (Dyar & Shannon); Panama (Zetek); Tabago Island (Jennings); Empire, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in hoofprints, seepage areas, small streams, swamps, rock pools and in floating river vegetation, always in the sun and with various types of vegetation. It is associated with *Anopheles* larvae of several species.

This is the common *Uranotænia* of La Chorrera. The adults have not been taken in the field.

Uranotænia lowii Theobald

Uranotænia lowii Theobald, Mon. Cul., 2: 339, 1901.

Distribution:—Las Cascades (Busck); La Boca, Culebra, Miraflores, Ancon (Jennings); Corozal (Zetek); Frijoles, Caño Saddle (Dyar & Shannon); Arenal River (Shropshire); Miraflores, La Chorrera, Rio Abajo, Old Panama (Author).

Habits and Habitats:—The larvæ breed in streams, swamps, pasture marshes, sand flats, seepage areas, ponds, pools and rock pools. They breed in sunny places with vegetation; water stagment, clear or foul. It is associated with several species of *Anopheles* larvæ.

The adults were not taken in the field. (Not known to bite—Dyar.)

This species breeds throughout the year. It is less common than *U. geometrica* but more generally distributed.

Uranotœnia pulcherrima Lynch Arribalzaga

Uranotœnia pulcherrima Lynch Arribalzaga, Rov. Mus. La Plata, 2: 165, 1891.

Distribution:—Panama (Dyar); Empire, Gamboa (Author).

Habits and Habitats:—The larvæ breed in floating river vegetation, in *Najas* and *Pistia*. It is associated with *A. albimanus* and *triannulatus*.

The adults have not been taken in the field.

These four species of *Uranotœnia* are all of the genus that are known from Panama with the exception of *Uranotœnia hystera* Dyar & Knab, which is reported as a very rare species known only from a few females, and is unknown to the author.

Megarhinini

Megarhinus Robineau-Desvoidy

Megarhinus hypoptes Knab

Megarhinus hypoptes Knab, Can. Ent., 29: 50, 1907.

Megarhinus trinidadensis Busck (nec D. & K.) Smith Misc. Coll., 53: 60, 1908. (Syn. *hypoptes* Knab, *vide*, Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 4: 956, 1917.)

Distribution:—Tabernilla (Busck); Mount Hope, Ancon, Comacho (Shropshire); Caño Saddle, France Field (Dyar & Shannon); Porto Bello (Busck); Chiva Chiva, Gamboa, La Chorrera, Old Panama (Author).

Habits and Habitats:—The larvæ are tree hole breeders. They are predaceous.

Adults have been collected on leaves in the jungle. The eggs are laid singly on the edge of tree holes.

The pupæ are distinctive from the other mosquitoes by the large size.

(Larvæ breed in bamboo—Dyar.)

Megarhinus moctezuma Dyar & Knab

Megarhinus moctezuma Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 48: 251, 1906.

Distribution:—La Boca (Busck); Ancon, Miraflores (Jennings); Panama (Zetck); Old Panama (Author).

Habits and Habitats:—The larvæ breed in tree holes. (Gord husks—Dyar). They are predaceous.

Adults were not seen in the field.

Megarhinus superbus Dyar & Knab

Megarhinus superbus Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 48: 255, 1906.

Distribution:—Tabernilla (Busck); Majagual, Porto Grande (Shorpshire); Caño Saddle (Dyar & Shannon); Fort Randolph (Baker); Piña (Author).

Habits and Habitats:—The larvæ breed in leaf bracts of wild pineapple and are predaceous. (Bromeliads—Dyar.)

The adults may be recognized in the field by the bright red abdominal hair tufts.

These three species are the only *Megarhinus* so far recorded from Panama.

Culicini

Culex Linnæus

There are no really satisfactory keys to the species of *Culex* found in Panama. The keys, descriptions and figures in Dyar's *Mosquitoes of the Americas* are not altogether trustworthy (Komp, 1935), and of course there are many new descriptions since Dyar's work, making it necessary to refer to the original papers. These papers are widely scattered throughout the literature. Until all the types are studied and new accurate drawings are made, this genus will remain relatively unknown even though some of its members are very well known. It is the largest genus represented in Panama in both species and probably in individuals, with the exception of some of the major pest mosquitoes such as *Mansonia* spp. and *Aedes tæniorhynchus* or *Anopheles* spp.

Culex, subgenus *Culex* sens. str.

Culex chidesteri Dyar

Culex chidesteri Dyar, Ins. Ins. Mens., 9: 117, 1921. (Type Loc.: Colon, R. de P.)

Distribution:—Colon (Chidester); La Chorrera (Author).

Habits and Habitats:—The larvæ breed in open sunny swamps, in deeply shaded pools and in slow flowing streams with floating debris. It apparently has rather diversified breeding habits. It appears to be uncommon, but it is difficult to identify, and may prove to be quite common.

No adults were identified in any material collected.

Culex corniger Theobald

Culex corniger Theobald, Mon. Cul., 3: 173, 1903.

Culex lactator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 206. (Syn. *corniger* Theobald, *vide,* Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 240, 1951.)

Culex lactator loquaculus Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 254, 1908. (Type Loc.: Canal Zone.) (Syn. *corniger* Theobald, *vide,* Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 240, 1915.)

Distribution:—Tabernilla, Las Cascades, Pedro Miguel, Lion Hill, Gatun (Busck); Culebra, Empire, Ancon (Jennings); Fort Sherman, Frijoles, Corozal (Zetek); Mindi, Gold Hill, Golden Green, Mount Hope, Monte Lirio, Coco Solo, Cativa, Majagual, La Pita, Cerro Gordo, Paja, Fort Randolph, Toro Point, Bella Vista, Margarita, Flemenco Island, Lirio Mill (Shropshire); Fort Davis, Fort Amador (Baker); Caldera Island (Jennings); Panama (Zetek); Chiriqui (Dunn); Chiva Chiva, Fort Clayton, La Chorrera, Rio Abajo, Jaun Diez, Old Panama, Lagarto (Author).

Habits and Habitats:—The larvæ breed in pools, hoofprints, pasture marshes, coconut shells, bamboo joints, rock holes, stump holes and root holes. (Barrels, tin cans, rotten banana trunk, water tub, hollow tree stump—Busck.) Usually found in shady places but it will breed in the sun. It was never found in flowing water and seldom in water in which vegetation is present. The body of water in which it breeds is always small and of a temporary nature. It breeds throughout the year and is very common.

The eggs are laid in typical "culex" egg rafts.

The adults were never taken in trap collections.

Culex coronator Dyar & Knab

Culex coronator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 215, 1906. *Culex ousqua* Dyar, Ins. Ins. Mens., 6: 99, 1918. (Type Loc.: Panama.) (Var. *coronator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 10: 18, 1922; listed as syn. *coronator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 172, 1923.) *Culex usquatissimus* Dyar, Ins. Ins. Mens., 10: 19, 1922. (Described as a form of *coronator;* listed as syn. *coronator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 175, 1923.)

Distribution:—Pedro Miguel, Culebra, Bohio, Tabernilla, Las Cascades, Alejuela (Busck); Corozal, Gatun, La Boca, Ancon (Jennings); Paraiso, Mount Hope (Zetek); Sabanas, Coco Solo, Mindi, Gold Hill, Mandingo, Piatella, Majagual, Torro Point, Empire, Cativa, Paja, Comacho (Shropshire); Culebra (Dunn); Panama, Chagres River, Tabago Island (Busck); Porto Bello, Caldera Island (Jennings); Chiriqui (Dunn); Pedro Miguel, Gamboa, Chiva Chiva, Fort Clayton, La Chorrera, Rio Abajo, Old Panama, Piña, Lagarto (Author).

Habits and Habitats:—The larvæ of this species breeds in rock pools, hoofprints, swampy pastures, pools, seepage areas, potholes, streams (sluggish), marshes, road ruts, cement drains, coconut shells, rowboats, occasionally in tree holes and artificial containers. (Stagnant foul pool, rain barrel, hoofprints, streams, still shady pool, tank, rain pool, and old boat—Busck.)

This is probably the most common *Culex* in Panama. It breeds in many different situations and the breeding site may be sunny or shady. They seem to show little preference. It is seldom found in flowing water, but may be found in either fresh or foul water with or without vegetation. It is common throughout the year.

Adults are taken in horse traps, but there are no records of it biting man.

Culex declarator Dyar & Knab

Culex declarator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 211, 1906.

Culex inquisitor Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 211, 1906. (Syn. *declarator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 6: 97, 1918.)

Culex jubilator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 211, 1906. (Type Loc.: Panama). (Syn. *declarator* Dyar & Knab, *vide,* Dyar Ins. Ins. Mens., 6: 97, 1918).

Culex proclamitor Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 211, 1906. (Var. *declarator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 6: 97, 1918.) (Syn. *declarator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 9: 196, 1921.)

Culex revelator Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 202, 1907. (Type Loc.: Tabago Island, R. de P.) (Syn. *declarator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 6: 97, 1918.)

Distribution:—Pedro Miguel, Gatun, Rio Chagres (Busck); Paraiso, Las Cascadas (Jennings); Ancon (Dunn); Bas Obispo (Zetek); Toro Point, Mindi, Monte Lirio, Miraflores, Cativa, Gold Hill, Las Cascades, Golden Green, Sweetwater, Cerro Gordo, Mandingo, Cardenas River, Paja, Gold Hill, Bella Vista Margarita, Culebra, Empire, Comacho (Shropshire); Fort Randolph (Baker); Cascajal River, Tabago Island (Jennings); Chiriqui (Dunn); Gamboa, Pedro Miguel, Chiva Chiva, Fort Clayton, National Forest, La Chorrera, Rio Abajo, Jaun Diez, Old Panama, Lagarto (Author).

Habits and Habitats:—The larvæ breed in swamps, rock pools, foul pools, cement drains, pasture marshes, stump holes, tree holes, coconut shells, palm spathes. This species breeds in a variety of places, either sunny or shady, usually without vegetation and often in foul water. "Tree hole" breeding is as common as terrestrial breeding. The species is fairly common, but no adults were taken. Egg rafts were collected in stump holes. It breeds mainly during the rainy season. (Does not bite—Dyar.)

Culex quinquefasciatus Say

Culex quinquefasciatus Say, Jour. Ac. Nat. Sc. Phila., 3: 10, 1823.

Culex fatigans Wiedemann, Aussereurop. Zweifl. Ins., 1: 10, 1828. (Syn. *quinquefasciatus* Say, *vide,* Dyar & Knab, Proc. Ent. Soc. Wash., 11: 34, 1909.)

Distribution:—Ancon, Tabernilla, Las Cascadas (Busck; Corazal (Jennings); Miraflores, Pedro Miguel, Gatun, Balboa (Zetek); Empire, Margarita (Shropshire); Fort Davis (Baker); Cocoli Camp (Jennings); David (Zetek); Jaun Diez, La Chorrera (Author).

Habits and Habitats:—The larvae breed in foul sunny pools with floating debris. (Largely in artificial containers—Dyar.)

Adults were collected in native houses at the seashore.

This species seems to be uncommon on the Isthmus of Panama.

Culex inflectus Theobald

Culex inflectus Theobald, Mon. Cul., 2: 115, 1901.

Culex extricator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 211, 1906. (Probably syn. *inflectus* Theobald, *vide,* Bonne-Wepster & Bonne, Ins. Ins. Mens., 9: 18, 1921; syn. *inflectus* Theobald, *vide,* Dyar, Ins. Ins. Mens., 9: 30, 1921.)

Distribution:—Corozal, Ancon (Jennings); Paraiso (Zetek); Fort Sherman (Dunn); Torro Point, Majagual, Cativa, Gold Hill, Margarita, Balboa, Empire, (Shropshire); Fort Randolph (Dyar & Shannon); Fort Davis (Baker); Colon (Busck & Chidester); Caldera Island (Jennings); Piña (Army Medical Museum); Chiriqui (Dunn); Piña (Author).

Habits and Habitats:—The larvæ breed in crab holes. Rarely in dirty receptacles (Dyar). Breeding may take place in old tin cans and in hollow logs. It is associated with *Trichoprosopon digitatum* in tin cans and with *Hæmagogus lucifer* in logs (Dunn).

(The adults do not bite—Dyar.)

This appears to be one of the rarest *Culex,* subgenus *Culex* of those found in Panama.

Culex interrogator Dyar & Knab

Culex interrogator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 209, 1906. *Culex reflector* Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 256, 1908. (Type Loc.: Ancon, C. Z.) (Syn. *interrogator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 176, 1923.)

Distribution:—Paraiso, Ancon (Jennings); Empire, La Boca, Tabernilla (Busck); Tabago Island (Busck); Old Panama, La Chorrera, Juan Diez (Author).

Habits and Habitats:—The larvæ breed in foul pools and wheel ruts. They are always in foul water, sunny, stagnant and with little or no vegetation. (Clear ground pools and tree holes—Dyar; Old boat, rain barrel, stagnant pools—Busck.)

Adults were not taken in trap collections.

This species is collected during the rainy season; uncomon.

Culex mollis Dyar & Knab

Culex mollis Dyar & Knab, Proc. Biol. Soc. Wash., 19: 171, 1906. (First treated as a sp., *vide,* Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 267, 1915.)

Culex carmodyiæ Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 210, 1906. (Distinct from *mollis* Dyar & Knab, *vide,* Dyar & Knab, Proc. Biol. Soc. Wash., 19: 171, 1906; syn. *nigripalpus* Theobald, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Culex equivocator Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 203, 1907. (Syn. *mollis* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Culex elocutilis Dyar & Knab, Smith. Misc., Colls., Quar. Iss., 52: 255, 1908. (Type Loc.: Porto Bello Bay, Panama.) (Syn. *mollis* Dyar & Knab, *vide,* Dyar. Ins. Ins. Mens., 9: 28, 1921.)

Culex delys Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 317, 1915. (Type Loc.: Tabernilla, C. Z.) (Syn. *mollis* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Culex lepostenis Dyar, Ins. Ins. Mens., 11: 70, 1923. (Syn. *mollis* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 10, 1935.)

Distribution:—Tabernilla, Ahorca Lagarto, Lion Hill (Busck); San Pablo (Jennings); Paraiso (Zetek); Comacho, Sweetwater, Miraflores, La Pita, Majagual, Toro Point, Paja, Fort Randolph, Margarita (Shropshire); Barro Colorado Island (Dyar & Shannon); Caldera Island, Cascajal River (Jennings); Colon (Busck); Caño (Zetek); Bruja, Army Medical Museum); Empire, Gamboa, National Forest, Chiva Chiva, Fort Clayton, La Joya, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in tree holes, jungle streams, drains, swamps, pools, rock holes, fallen logs, small ponds (Bromeliads—Jennings). Found in a variety of places, this species is most abundant in rock holes, in shade, but also in the sun. Water is usually clear and wanting vegetation. (Bamboo trunk, water foul—Busck.)

The adults were not collected in traps.

Culex nigripalpus Theobald

Culex nigripalpus Theobald, Mon. Cul., 2: 322, 1901.

Culex factor Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 212, 1906. (Syn. *nigripalpus* Theobald, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Culex regulator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 213, 1906. (Syn. *nigripalpus* Theobald, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Culex carmodyiae Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 210, 1906. (Syn. *nigripalpus* Theobald, *vide,* Dyar, Ins. Ins. Mens., 9: 28, 1921.)

Distribution:—Ancon, Paraiso, La Boca (Jennings); Pedro Miguel (Zetek); Balboa, Corozal, Gatun, Culebra, Rio Grande, Monte Lirio, La Pita, Sweetwater, Toro Point, Margarita, Flemenco Island, Empire, Coco Solo (Shropshire); Colon, (Zetek); Tabago Island (Jennings); Rio Chagres (Busck); Chiva Chiva, Fort Clayton, Old Panama, Rio Abajo, Juan Diez (Author).

Habits and Habitats:—The larvæ breed in wheel ruts, pools, drains, pasture marshes and axils of palm fronds. Usually it breeds in foul water, either sunny or shady. Terrestrial, it is rarely in axils of leaves. Vegetation may be present or absent in the habitat. (Old boat and tub—Jennings; clear swamps and coral pools—Dyar; Bromeliads—Busck.)

Adults were not taken in trap collecting, but they will bite humans.

Uncommon.

Subgenus *Melanoconion* Theobald

Melanoconion Theobald, Mon. Cul., 3: 238, 1903. (Type: *Culex atratus* Theobald.)

Culex aikenii Aiken

Gnophodeomyia aikenii Aiken, Brit. Guiana Med. Ann., 60, 1906.
Culex panacossa Dyar, Ins. Ins. Mens., 11: 120, 1923. (Syn. *aikenii* Aiken, *vide*, Dyar, Ins. Ins. Mens., 13: 21, 1925.

Distribution:—Bas Obispo (Shropshire); Empire (Author).

Habits and Habitats:—The larvæ breed in floating vegetation in the Rio Mandinga. It is collected from June to September. (Roots of *Pistia*—Dyar).

Rare.

Culex bastigarius Dyar & Knab

Culex bastigarius Dyar & Knab, Proc. Biol. Soc. Wash., 19: 170, 1906.
Culex cuclyx Dyar & Shannon, Ins. Ins. Mens., 12: 48, 1924. (Type Loc.: Fort Clayton, C. Z.) (Syn. *bastigarius* Dyar & Knab, *vide,* Komp. Proc. Ent. Soc. Wash., 37: 7, 1935.)
Culex xivilis Dyar, Ins. Ins. Mens., 9: 78, 1920. (Syn. *bastigarius* Dyar & Knab, *vide*, Komp, Proc. Ent. Soc. Wash., 37: 7, 1935.)

Distribution:—Fort Clayton (Shannon); La Chorrera (Author).

Habits and Habitats:—The larvæ are found only in slow flowing streams, with vegetation, sunny. It is collected in October. (Edge of streams—Dyar.)

Culex chrysonotum Dyar & Knab

Culex chrysonotum Dyar & Knab, Proc. U. S. Nat. Mus., 35: 57, 1908. (Type Loc.: Canal Zone.)
Melanoconion theobaldi Lutz (*in* Bour. Nom. Nud.) Mos.

Bras., 39, 1904. (Syn. *chrysonotum* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 7, 1935.)

Distribution:—Cartagenita, Ancon, Tabernilla, Miraflores (Jennings); Balboa, Gatun (Zetek); Empire, Gold Hill, Monte Lirio, Margarita, Mindi (Shropshire); Fort Clayton, Culebra (Baker); La Chorrera, Old Panama (Author).

Habits and Habitats:—The larvæ breed in pools, streams, seepage areas, potholes, pasture marshes and ponds. It breeds in sunny places usually in grassy vegetation, water flowing, sluggish or stagnant, but usually clear. Sometimes it will breed in foul water.

The eggs of this species are laid on grass or sedge in double rows about fifty to a row, about one inch above the surface of the water.

The adults are collected on screens in the evening. They may be recognized in the field by the golden pronotum. There are no records of it biting man. It is collected throughout the year, common.

Culex conspirator Dyar & Knab

Culex conspirator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 217, 1906.

Culex dymathes Dyar & Ludlow, Ins. Ins. Mens., 9: 47, 1921. (Type Loc.: Cativa, C. Z.) (Syn. *conspirator* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 4, 1935 and Dyar, Ins. Ins. Mens., 11: 69, 1923.)

Culex fatuator Dyar & Shannon, Ins. Ins. Mens., 12: 47, 1924. (Syn. *conspirator* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 5, 1935.)

Distribution:—Las Cascades (Jennings); Sweetwater, Cativa (Shropshire); Fort Clayton, Caño Saddle (Shannon); Barro Colorado Island (Dyar & Shannon); France Field (Baker); Pedro Miguel (Busck); Tabago Island, Rio Chagres (Busck); Gamboa, Empire, La Chorrera (Author).

Habits and Habitat:—The larvæ breed in shady rock pools. It is collected during the rainy season. (Ground pools and in root base pools, slow stream in grass—Dyar.)

Adults not collected in traps.

Uncommon.

Culex dunni Dyar

Culex dunni Dyar, Ins. Ins. Mens., 6: 123, 1918. (Type Loc.: Rio Mandinga, C. Z.)

Culex ruffinis Dyar & Shannon, Ins. Ins. Mens., 12: 143, 1924. (Type Loc.: Barro Colorado Is., C. Z.) (Syn. *dunni* Dyar, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 8, 1935.)

Distribution:—Mandinga River (Dunn); Darian, Frijoles (Dyar & Shannon); Barro Colorado Island (Shannon); Far Fan (Curry); La Chorrera (Author).

Habits and Habitats:—The larvæ breed in sunny swamps and ponds having grass or sedge. (Bred from larvæ associated with *Pistia*—Dunn).

(Adults are not known to bite—Dyar.) Collected from June to December.

Uncommon.

Culex eastor Dyar

Culex eastor Dyar, Ins. Ins. Mens., 8: 71, 1920.

Distribution:—Gatun (Author). (Previously collected in this locality by W. H. W. Komp, but not published.)

Habits and Habitats:—The larvæ breed in ground pools. (Collected in a pool at the base of a fallen tree—Komp, *in litt.*)

Adults not taken in trap collections.

Collected in May. It is apparently rare.

Culex educator Dyar & Knab

Culex educator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 217, 1906.

Culex apateticus Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 331, 1915. (Type Loc.: Canal Zone.) (Syn. *pro parte educator* Dyar & Knab, *vide* Ins. Ins. Mens., 6: 106, 1918.)

Culex aneles Dyar & Ludlow, The Mil. Surg., 49: 63, 1922. (Type Loc.: Fort Clayton, C. Z.) (Syn. *educator* Dyar & Knab, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 326, 1928.)

Distribution:—Cardenas, Majagual (Army Medical Museum); Gatun, Mindi (Shropshire); Pedro Miguel (Busck); Miraflores, Rio Grande, Tabernilla (Jennings); Gatun, Caño, Fort Sherman, Quarry Heights, Fort Amador (Zetek); Fort Clayton, Barro Colorado Island (Shannon); Fort Randolph (Baker); Upper Pequini River (Jennings); Tabago Island (Zetek); La Chorrera (Author).

Habits and Habitats:—The larvæ breed in grassy pools and streams in the sun. It is collected from July to October.

No adults taken in trap collections.

Uncommon.

Culex egcymon Dyar

Culex egcymon Dyar, Ins. Ins. Mens., 11: 67, 1923. (Type Loc.: Tabernilla, C. Z.)

Distribution:—Tabernilla (Busck); Darien (Dyar & Shannon; Empire, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in jungle streams, shady, devoid of vegetation. (Slowly running spring full of larvæ and small fish—Dyar; slow streams, in roots of *Pistia*—Dyar & Shannon.) Collected from May to September.

Adults were taken on screens in the evening.

Uncommon.

Culex elevator Dyar & Knab

Culex elevator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 217, 1906.

Culex apateticus Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 321, 1915. (Type Loc.: Canal Zone.) (Syn. *pro parte elevator* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 6: 106, 1918.)

Culex curryi Dyar. Ins. Ins. Mens., 14: 112, 1926. (Type Loc.: Mojinga Swamp, C. Z.) (Syn. *elevator* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 7, 1935.)

Culex dornarum Dyar & Shannon, Ins. Ins. Mens., 12: 46, 1924. (Type Loc.: Fort Sherman, C. Z.) (Syn. *elevator* Dyar & Knab, *vide,* Komp, Proc. Ent. Soc. Wash., 37: 5, 1935.)

Distribution:—Fort Clayton (Shannon); Barro Colorado Island (Dyar & Shannon); Fort Sherman (Shannon and Shropshire); Mojinga Swamp (Curry); Tabernilla (Busck); Caldera Island, Porto Bello (Jennings); Chagres River (Busck); Gamboa, Empire, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in rock pools, rock holes, jungle streams, and one record of it in water in a fallen log. It breeds in the shade, usually in flowing water. It is common during the rainy season. (Ground pools, slow streams with leaves—Dyar.)

No adults taken in trap collections.

Culex erraticus Dyar & Knab

Mochlostyrax erraticus Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 224, 1906.

Culex leprincei Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 202, 1907. (Type Loc.: Canal Zone.) (Syn. *erraticus* Dyar & Knab, *vide,* King & Bradley, An. Ent. Soc. Am., 30: 345, 1937.)

Culex trachycampa Dyar & Knab, Can. Ent., 41: 101, 1909. (Syn. *leprincei* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 119, 1923.)

Distribution:—Pedro Miguel, Tabernilla, Bas Obispo, Las Cascades, Empire, Culebra, (Busck); Balboa (Zetek); Gold Hill (Shropshire); Fort Clayton, Caño Saddle (Shannon); Fort San Lorenzo, Gamboa, Monte Lirio (Dyar & Shannon); Cardanas River (Baker); Panama (Zetek); Gamboa, Empire, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in floating river vegetation or in pond vegetation, in the sun. Found in water lettuce and *Najas* beds, it is most abundant in *Najas* associated with *Anopheles albimanus* and *Aedeomyia squamipennis.* It is common throughout the year.

No adults taken in trap collections.

Subgenus *Isostomyia* Coquillett

Isostomyia Coquillett, U. S. Dept. of Agr., Bur. Ent., Tech. Ser., 11: 16, 1906. (Type: *Culex conservator* Dyar & Knab.)

Culex conservator Dyar & Knab

Culex conservator Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 221, 1906.

Culex bifoliatus Dyar, Ins. Ins. Mens., 10: 92, 1922. (Syn.

conservator Dyar & Knab, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 345, 1928.)

Distribution:—Miraflores, Mandinga (Shropshire); Gatun (Curry); Empire, Barro Colorado Island, La Chorrera, Old Panama (Author).

Habits and Habitats:—The larvæ breed in tree holes. It is common during the rainy season.

No adults were taken in trap collections.

Subgenus *Mochlostyrax* Dyar & Knab

Mochlostyrax Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 228, 1906 (Type: *caudelli* Dyar & Knab.)

Culex hesitator Dyar & Knab

Culex hesitator Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 205, 1907. (Type Loc.: Las Cascadas, C. Z.)

Distribution:—Las Cascadas (Busck); Matachin (Zetek); La Chorrera (Author).

Habits and Habitats:—The larvæ are collected in sunny ponds in thick grass. (Small sunny streams—Dyar; Swampy stream—Busck.)

Culex pilosus Dyar & Knab

Culex pilosus Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 224, 1906.

Mochlostyrax cubensis Dyar & Knab (nec Bigot), Jour. N. Y. Ent. Soc., 14: 223, 1906. (nom. nud. *agitator* Dyar & Knab, *vide,* Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 100, 1907.)

Culex agitator Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 100, 1907. (Syn. *floridanus* Dyar & Knab, *vide,* Dyar & Knab, Ins. Ins. Mens., 5: 180, 1917.)

Culex floridanus Dyar & Knab, Proc. Biol. Soc. Wash., 19: 171, 1906. (Listed as a syn. *pilosus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 12: 186, 1924.)

Distribution:—Matachin, Gatun (Zetek and Shannon); France Field (Dyar & Shannon); Las Cascadas (Busck); Tabago Island (Busck); Cristobal, Juan Diez, La Chorrera, Old Panama (Author).

Habits and Habitats:—The larvæ breed in salt or fresh water in permanent bodies of water or streams. They will breed in the sun or in shade, in foul or in clear water. The breeding place is usually grassy. (Temporary surface pools with *Aedes* and *Psorophora*. In jungle pools—Dyar. In temporary rain pools and not in permanent water—Komp. Old boat and foul water in old machinery—Busck.)

Common during the rainy season.

No adults taken. (Adults do not bite—Dyar.)

Subgenus *Lutzia* Theobald

Lutzia Theobald, Mon. Cul., 3: 155, 1903. (Type: *Culex bigoti* Bellardi.)

Culex allostigma Howard, Dyar & Knab

Culex allostigma Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 471, 1916. (Type Loc.: Panama.)

Distribution:—Ancon, San Pablo, Gatun, Tabernilla, Las Cascades (Busck); Corozal, Pedro Miguel (Jennings); Fort Sherman (Zetek); Empire, Golden Green, Cerro Gordo, Majagual (Shropshire); Barro Colorado Island, France Field, Gamboa (Dyar & Shannon); Culebra, Fort Davis (Baker); Boca del Toro (Osterhout); Panama, Caldera Island (Jennings); Gamboa, Chiva Chiva, National Forest, La Chorrera (Author).

Habits and Habitats:—The larvæ breed in rock holes, drains, and small ponds. They may be found in the sun or in shade, without vegetation, water clear, but usually with fallen leaves and debris. (Artificial containers—Dyar.)

The eggs are laid in rafts. The pupæ are large, distinctive and very active. The larvæ when disturbed lie on the bottom of the shallow pool in mud and debris for long periods of time. The larvæ are predaceous on other mosquito larvæ and are found with *Culex mollis, Anopheles eiseni, A. punctimacula* and *A. apicimacula.*

There are many more species of *Culex* recorded in the literature as occurring in Panama, but these are unknown to the author. There are also species known from Panama, some of which are apparently quite common, which have never been recorded. The following list are those species recorded in the literature, some of which are undoubtly misidentifications: *Culex distinguendus* Dyar, *elaphas* Komp, *inhibitator* Dyar & Knab = *erraticus* Dyar?, *flabellifer* Komp, *iolambdis* Dyar, *jubifer* Komp, *latisquama* Coquillett, *limacifer* Komp, *menytes* Dyar, *mutator* Dyar & Knab, *opisthopus* Komp, *paracrybda* Komp, *phlogistus* Dyar, *plectoporpe* Root, *psatharus* Dyar, *quadrifoliatus* Komp, *rooti* Roseboom, *serratimargo* Root, *spissipes* Theobald, *taeniopus* Dyar & Knab, *tecmarsis* Dyar, *vexillifer* Komp, *vomerifer* Komp, *zeteci* Dyar, *browni* Komp, *corrigani* Dyar & Knab, *alogistus* Dyar, *daumastocampa* Dyar & Knab, *imitator* Theobald, *jenningsi* Dyar & Knab, *bonnei* Dyar, *secunda* Bonne-Wepster & Bonne, *bigoti* Bellardi.

Deinocerites Theobald

Deinocerites Theobald, Mon. Cul., 2: 215, 1901. (Type: *cancer* Theobald.)

Deinocerites cancer Theobald

Deinocerites cancer Theobald, Mon. Cul., 2: 215, 1901.

Deinocerites melanophylum Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 200, 1907. (Type Loc.: Colon, R. de P.) (Listed as syn. *cancer* Theobald, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 1928.)

Deinocerites monospathus Dyar, Ins. Ins. Mens., 13: 155, 1923. (Type Loc.: Fort Sherman, C. Z.) (Listed as ?aber. *cancer* Theobald, *vide,* Edwards, Genera Insectorum, fasc. 194, 222, 1932.)

Distribution:—La Boca (Busck); Fort Davis (Baker); Fort Randolph, France Field, Fort Sherman (Baker and Zetek); Margarita, Majagual, Toro Point (Shropshire); Boca del Toro (Rosenau); Colon (Busck); Caldera Island (Jennings); Fort Randolph (Author).

Habits and Habitats:—The larvæ breed in crab holes. (Adults do not bite humans—Dyar.)

Deinocerites pseudes Dyar & Knab

Deinocerites pseudes Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 260, 1909. (Type Loc.: Ancon, C. Z.)

Distribution:—Corozal, Miraflores, Ancon (Jennings); Monte Lirio (Army Medical Museum); Fort Sherman (Zetek); Toro Point, Cativa, Margarita (Shropshire); Panama (Dunn); La Chorrera, Rio Abajo, Old Panama (Author).

Habits and Habitats:—The larvæ breed in crab holes on the beach.

Adults are collected in horse traps and in houses. (Adults do not bite humans—Dyar.)

Common throughout the year.

There are two more species of *Deinocerites* recorded in the literature as occurring in Panama, but these are unknown to the author. They are: *D. epitedeus* Knab and *D. spanius* Dyar & Knab.

(*To be continued*)

BOOK NOTICE

Spiders of Connecticut. By Benjamin Julian Kaston, Ph.D. State Geological and Natural History Survey Bulletin No. 70, Hartford, Conn., 1948. $9 \times 5\frac{3}{4}$ inches. 874 p. 142 pl.

This impressive monograph is more than its title implies. Its geographical scope extends beyond Connecticut and includes Massachusetts, Rhode Island and that portion of New York east of the Hudson River and south of the westward extension of the northern boundary of Massachusetts. From this region, 597 species (in 224 genera) are treated. Of this number 462 species (in 184 genera) were collected in Connecticut.

Approximately the first fifty pages are devoted to a general, informative account of the biology of spiders including their external and internal anatomy, life history, habits, parasites, economic importance, and the collection and preservation of specimens. The balance of the work is taxonomic and includes keys to families, genera and species, as well as diagnostic characters of genera and species, distribution data, notes on habits, life histories, etc. This portion is accompanied by 142 plates with over 2,100 figures illustrating various species, anatomical details, webs, egg sacs, etc. A glossary and bibliography add to its completeness.

This work is another example of the outstanding contributions to natural science that originate in Connecticut. It is the result of many years of research and study, and Dr. Kaston's authorship of it is a sufficient guarantee of its excellence and scholarship. It is gratifying to know that in some places, funds are still available for the publication of extensive biological studies.—H. B. W.

HONEY-BEE PREDATORS

By S. W. Bromley
Bartlett Tree Research Laboratories
Stamford, Conn.

It has always been a source of wonder that certain insects are able to overcome so powerfully defended an animal as the domestic bee equipped as she is with a venomous sting which would soon kill any other insect if it could be successfully brought to bear. The writer has always been interested in apiculture but has never been able to work around bees because of the violent effects of their stings. Of the common insects able to sting, the ordinary honey-bee is by far the worst in my personal experience. This is probably due in part to their habit of stinging without provocation and also to the fact that the poison sac is left, with the sting, in the wound thus enabling a greater amount of toxin to enter the system than with wasps which withdraw the sting after each stab. Just one sting is likely to have a serious systemic effect and my only recourse has been to keep off my feet several hours after being stung and to apply cold compresses to the injury. For many years I have made observations at Stamford, Connecticut, on the Arthropods which kill bees and these are herewith presented. These prey records cover the years 1929 to 1947. In no case was the bee predation sufficient to cause economic losses to bee-keepers. The role of predators in bee-killing is a very minor one these days compared with the losses of bees poisoned by arsenicals, DDT and other insecticidal sprays and dusts, or dying from such diseases as American foul brood. It seems quite probable, moreover, that in New England at least, bee-predators never did cause economic losses to apiarists.

Of the records here submitted; 260 pertain to insect predators, 243 to spiders. Honey-bee predators in the Stamford area are (1) ambush bugs, (2) robber flies, (3) mantids, (4) dragon flies, (5) hornets or wasps, and (6) soldier bugs among the insects; and certain flower spiders, orbweavers, grass spiders and house spiders among the Arachnida.

I. INSECTS

1. AMBUSH BUGS. Certain years the common ambush bug, *Phymata pennsylvanica* Handl., may be very abundant on certain flowers during mid and late summer feeding on flower-frequenting insects. They are especially fond of the honey-bee which they are able to overcome after a struggle. Sometimes 2 or 3 other ambush bugs will feed on a kill, often simultaneously. I have 147 Stamford records of their preying on honey-bees. Most of these were on hydrangea, spirea, helenium and asters in flower gardens or on goldenrod or sumac blossoms in the wild.

2. ROBBER FLIES. Certain robber flies have long been known as enemies of the honey-bee. I have the following Stamford records.

Nebraska bee-killer, *Promachus fitchii* O. S.	22
Bumblebee robber fly, *Bombomima thoracica* Fabr.	18
Brown robber fly, *Proctacanthus philadelphicus* Macq.	10
Discolored robber fly, *Diogmites discolor* Loew	10
False Nebraska bee-killer, *Promachus bastardii* Macq.	3
Japanese beetle-killer, *Bombomima grossa* Fabr.	2
Small bumblebee robber fly, *Bombomima flavicollis* Say	1
Fly-hawk, *Erax aestuans* L.	1

Of these 8 species, the bumble bee mimic, *B. thoracica* (*alias Dasyllis* or *Laphria thoracica!*) is the only one I have seen killing bees close to the hives; most of the others take bees around flowers. During the past 12 years, *Proctacanthus philadelphicus, Promachus fitchii, P. bastardii* and *Diogmites* (formerly *Deromyia*) *discolor,* all once common, have become increasingly rare in this area, due no doubt to the growing scarcity of the white grub, *Phyllophaga fusca,* which was apparently the principal food of the larvæ of these flies. This decrease of the native white grub seems to have coincided with the advent of the Japanese beetle, *Popillia japonica,* which has successfully invaded New England from the adjacent areas to the southwest.

Of the above records; *P. fitchii* captured honey-bees in hay fields and lawns near white clover blossoms; *B. thoracica* in apiaries, or among *Deutzia* or white clover blossoms; *P. philadelphicus* in old fields or pastures near goldenrod or buckwheat blossoms; *D. discolor* around goldenrod, asters, flower gardens and buckwheat fields; *P. bastardii* at sumac blossoms in what had been an open oak grove, clean cut and lumbered out a year or two before; *B. grossa* in a tasseling corn field and at edge of a sumac clump; *B. flavicollis* on a log in the sunlight in a cut-over woodlot; and *E. æstuans* (a large female) on a plantain blossom within 100 yards of an apiary.

3. MANTIDS. Twenty-eight honey-bee prey records were taken from the Chinese mantis, *Tenodera sinensis* Sauss. These were obtained either on goldenrod blossoms or in flower gardens.

4. DRAGON FLIES. Many dragon flies have been seen to dart at honey-bees in flight, but only 5 actual captures where feeding took place have been noted. Three records of the green darning-needle fly, *Anax junius* Drury, have been taken: one near a bee-hive, two others over goldenrod. The giant dragon fly *Epiaeschna heros* Fabr., was in one instance seen to seize a honey-bee around Chinese beauty-bush (*Kolkowitzia*) blossoms. Amid a profusion of meadow spirea and early sumac at the edge of a woods, a wood flying-adder, *Cordulegaster diastatops* Selys., was taken feeding on a honey-bee worker.

5. HORNETS OR WASPS. Worker European hornets, *Vespa crabro* L., were seen on 5 different occasions killing honey-bees in goldenrod fields. One instance each of the English wasp, *Vespa vulgaris* L., and of the native ground nesting yellow-jacket, *Vespa maculifrons* Buy., were noted by Stamford bee-keepers. The last 2 vespids belong to the subgenus *Vespula.* While hornets are of little importance as bee-predators in New England, they are dangerous enemies of bees in certain parts of the World. In China, the great *Vespa mandarina* is one of the most serious of bee-predators, as the following extract from a letter written by Dr. E. R. Tinkham dated October 13, 1947 testifies.

''You may be interested to know that I was on the Lingnan University staff from 1933–1936 and full time Ass't Curator of the Lingnan Natural History Survey and Museum from 1934–1936. A great number of my 38 publications are on the Orthoptera of China and a few on Lepidoptera and Odonata. Perhaps you would be interested in some remarks on 'bee-killers.' In 1933–34 at Lingnan there was an American operating an apiary and he and I used to have many dinner table chats on his problems. The two biggest seemed to be the giant wasps and the Deaths-head Hawk Moths. The latter stole much honey during the night and apparently intimidated the bees by their squeak. Their depredations, however, were controlled by placing coarse wire screen over the entrance to the hives. A much more troublesome and unsolved problem was the control of the huge wasps *Vespa mandarina* that perched on the supers and slaughtered great numbers of bees daily. The numbers seem to stick in my mind—30–40 bees daily for each wasp. As far as I can recall I do not think Asilids entered into the situation for on the whole they are rare. I have collected rather extensively in south China, west to Yunnan and in Formosa but the Asilids collected were very few and probably all deposited in the Lingnan Museum.''

6. SOLDIER BUGS. Four instances of the pale soldierbug, *Podisus placidus* Uhl., feeding on honey-bees after impaling them on sumac blossoms have been obtained. Two records of nymphs of the spined soldier bug, *Podisus maculiventris* Say, were also secured.

II. SPIDERS

Spiders catch many honey-bees either in their webs or on flowers.

1. FLOWER SPIDERS. Forty-eight records of the yellow crab spider, *Misumena aleatoria* Hentz,[1] have been obtained, mostly on goldenrod blossoms, among which the spiders nestle and, secure in their protective coloration, seize the unwary bee before she is cognizant of danger. One is reminded of the old proverb by Ben Johnson:

> ''The bee and the spider
> By some diverse power
> Suck honey and poison
> From the self-same flower''

except that in this case the bee gets the poison and the spider the honey, second hand!

2. ORBWEAVERS. Certain orbweaving spiders become abundant in late summer. Their wheel-like webs occur in goldenrod, aster, hydrangeas and the blossoms of many garden flowers. The

largest and most striking spider of this group is the black and yellow garden or blackberry spider, *Argiope aurantia* Lucas. Seventy-nine records of honey-bees captured in the webs of this spider, mostly in goldenrod have been secured. Twenty-two honey-bees have been noted in the webs of the smaller Silvery garden spider, *Argiope trifasciata* Forskal. In among hydrangea, goldenrod and asters, the webs of the large white orbweaver, *Epeira obesa* Hentz, have claimed 46 honey-bee victims, while 38 have been noted in the webs of the red and yellow orbweaver, *Epeira raji* Scopoli.[2] One was noted in a web of the dusky orbweaver, *Epeira domiciliorum* Hentz.

3. GRASS SPIDERS. In the webs of the grass funnel spider, *Agelena nævia* Walck., 4 honey-bees have been seen near a shed adjacent to an apiary.

4. HOUSE SPIDERS. Five honey-bees have been noted trapped in the webs of the common house spider, *Theridion tepidariorum* C. Koch., located outside a shed near the bee hives.

[1,2] Specifically identified through the kindness of Dr. W. J. Gertsch of the American Museum of Natural History, New York City.

BOOK NOTICE

Days Without Time, Adventures of a Naturalist, Illustrated with 144 Photographs by the Author. By Edwin Way Teale. Dodd, Mead & Company, New York, 1948. 10 × 7 inches, xiv + 283 pages, $6.00.

I do not know anyone who writes so entertainingly and accurately on such a multiplicity of natural history subjects as Mr. Teale. His latest book is full of his "adventures" among animals that fly, crawl, cling, run and swim and that may be watched by most of us, close to our homes. To be exact Mr. Teale's book contains 29 natural history vignettes, all perfect delineations of the behavior of insects, toads, dogs, wolves, rabbits, rats, spiders, snakes, swimming cats, birds, turtles, etc., as well as of the fauna of ditchwater, of the heat generated by the skunk cabbage, and of the author's bird observations at night on the top of the Empire State Building, to mention only a few. Mr. Teale is always interesting whether he is writing about the curl in a pig's tail or the foam tracks on a beach, and after reading his books one is always painlessly and quietly enriched from his boundless supply of facts.

Sometimes I wonder if there are sordid sides to the author's adventures, involving mosquito bites, scratches from brambles, stepping into water-holes, or other discomforts. If such occur there is no mention of them to mar the smoothness of his narratives. Anyhow his readers are quite willing for him to suffer if it results in such skillful and eloquent writing supplemented by his own extraordinary photographs which are just as full of interest as his texts.

If you are not a naturalist *Days Without Time* will open up new worlds for you. If you are a naturalist you will get infinite pleasure from reading about animals outside your own specialty. —H. B. WEISS.

A NEW MEMBER OF THE GENUS CADDO (PHALANGIDA)

BY CLARENCE J. AND MARIE L. GOODNIGHT

The genus *Caddo,* a member of the subfamily Oligolophinæ, (Palpatores: Phalangiidæ), is characterized by a prominent eye tubercle. The species within the genus are separated mainly on the basis of the spination of the palpus.

With this present description there are now four described species in this genus. Of these, three are modern. The two previously described modern species, *Caddo boopis* Banks and *Caddo agilis* Crosby and Bishop are known from the northeastern portion of the United States and the southeastern portion of Canada. They are small forms found in leaf mould.

The third described species, *Caddo dentipalpus* (Koch and Berendt) is known only from the Tertiary Baltic amber. It differs markedly from the modern species by possessing a group of stiff hairs at the apical median portion of the femur of the palpus.

This new species was found at San Cristobal de las Casas, Chiapas, at an altitude of about 5000 feet. Due to prevailing winds and moisture, this region is very cold, has a dense forest of oaks and pines covering the mountains. The habitat thus bears a very close climatic relationship to that occupied by both *boopis* and *agilis.* From this meager evidence, one can conclude that this genus at one time was widely distributed; but is restricted at present to widely separated localities.

Suborder Palpatores Thorell
Phalangiidæ Simon
Tribe Eupnoi Hansen and Sœrensen
Oligolophinæ Banks
Caddo chomulæ, new species
(Figs. 1 and 2)

Holotype.—Total length of body, 0.9 mm. Cephalothorax, 0.5 mm. Width of body at widest portion, 0.5 mm. Length of femora; I, 0.4 mm.; II, 0.5 mm.; III, 0.4 mm.; IV, 0.4 mm.

Entire dorsum smooth, eye tubercle characteristically enlarged. Supracheliceral lamella smooth, barely visible. Eye tubercle somewhat elliptical in shape, rounded toward the front, more or less egg-shaped toward the rear. Free sternites smooth, coxæ smooth except for a few scattered black hairs.

Legs: Trochanters small and unarmed. Each femur with a basal false articulation. All segments of legs without armature, but with a few scattered hairs on the tarsi. Metatarsi with false articulations: 1–2–1–2. Tarsal segments: 5–6–6–7.

Palpus: Trochanter, 0.3 mm. long; femur, 1.1.; patella, 0.4; tibia, 0.4; and tarsus, 0.3. Total length, 2.5 mm. Palpus armed retrolaterally as in figure. Prolaterally the femur with several small black spines at the apical porrion. Patella, tibia and tarsus unarmed prolaterally. Ventral portion of tibia with black hairs; tarsus thickly clothed with black hairs. Tarsal claw extremely small.

Chelicera small, normal, unarmed, without a dorsal elevation on the proximal segment.

Entire body reddish brown with a few lighter streaks between the segments, enlarged area surrounding the eyes characteristically black. Trochanter, femur, and patella of palpus white. Tibia and tarsus light brown. Legs dusty brown, chelicera yellowish, claws of chelicerae darker.

Type locality: Holotype from Ciudad de las Casas, Chiapas, July 22, 1947 (C. and M. Goodnight).

This new species differs from the formerly described species in the shape of the eye tubercle and the armature of the palpus.

Holotype in the collection of the American Museum of Natural History.

REFERENCES

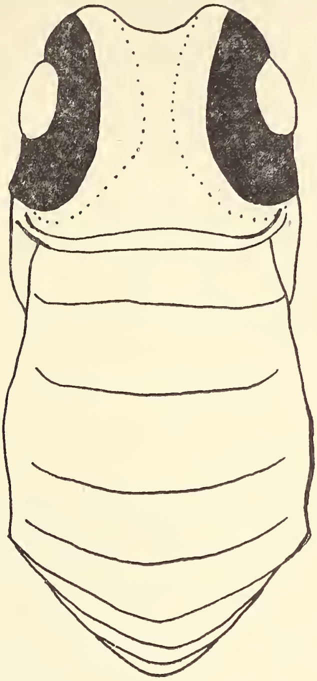
Bishop, Sherman C. and C. R. Crosby. 1924. A Fossil Species of *Caddo* (Opiliones) from the Baltic Amber and Its living Relatives. New York State Museum Bulletin No. 253, 19th report of the director.

Koch, C. L. and G. C. Berendt. 1854. Die im Bernstein befindlichen Crustaceen, Myriapoden, Arachniden und Apteren der Vorwelt, in Berendt, Die im Bernstein befindlichen Organischen Reste der Vorwelt. Berlin, 1854, 1(2): 1–124, pl. I–XVIII.

PLATE VI

Figure 1. *Caddo chomulæ*, new species, dorsal view of holotoype.
Figure 2. *Idem*, lateral view of holotype.

(Jour. N. Y. Ent. Soc.), Vol. LVI (Plate VI)



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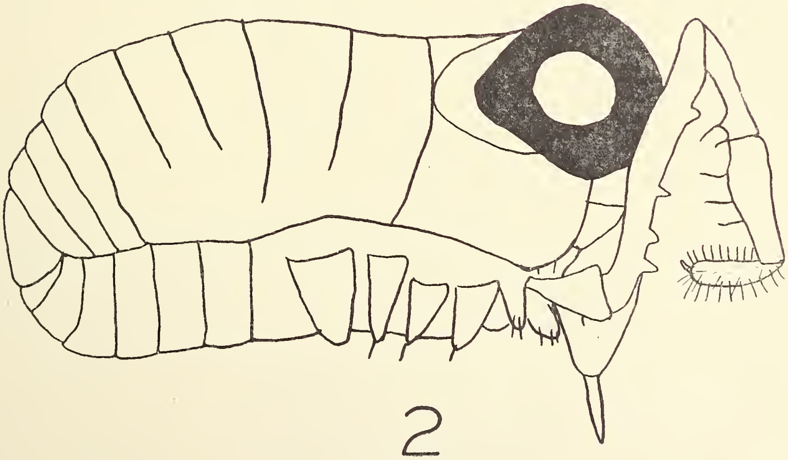

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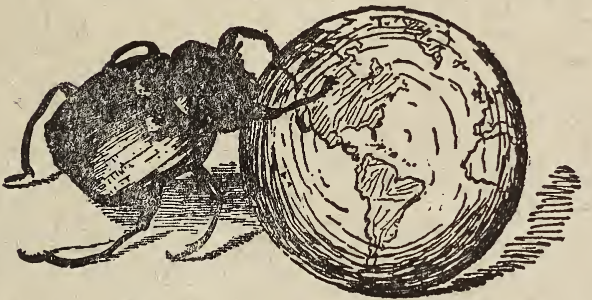
Caddo chomulæ

Vol. LVI No. 4

DECEMBER, 1948

Journal
of the
New York Entomological Society

Devoted to Entomology in General



Edited by HARRY B. WEISS

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Subscription $4.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1948

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NOTICE: Volume LVI, Number 3 of the Journal of The New York Entomological Society was published on October 7, 1948.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

Vol. LVI December, 1948 No. 4

A NEW GENUS AND SPECIES OF ANT FROM INDIA (HYMENOPTERA: FORMICIDAE)

By Marion R. Smith

Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture

The specimens representing the species upon which this article is based were intercepted at Honolulu, Hawaii, in an orchid shipment originating in India. In Emery's keys to the genera of the subfamily Myrmicinae (1921), *in* Wytsman, Genera Insectorum, Fascicule 174a, pp. 1–94, and in Wheeler's ''Keys to the Genera and Subgenera of Ants'' (1922), Bul. Amer. Mus. Nat. Hist., 45: 631–710, the specimens key out to a position near *Lophomyrmex,* a genus peculiar to continental and insular India. They definitely do not belong to that genus, however, as they differ in many characters, including the following: Clypeus not perpendicular and ending in the middle of its anterior border as an obtuse projection; frontal area lacking; promesonotal suture obsolescent; petiole non-pedunculate; epinotal spines not long and acute; short legs with greatly enlarged femora and tibiae; shorter and stouter body, and presence on the petiolar node of a sharp, transverse carina. Both Horace Donisthorpe and Wm. L. Brown, Jr., have confirmed the author's opinion that the specimens belong to a new genus.

Although the species clearly belongs to the subfamily Myrmicinæ, its tribal position is questionable. Many, if not all, of the tribes, are largely determined by male and female characters and in this case only workers are present. Furthermore, the number of workers at hand is so small that it is impossible to be sure whether the species has monomorphic, dimorphic, or polymorphic workers.

Recently the author has seen specimens belonging to this new genus from Szechwan Province, China, with the following additional data: 5 miles north Hsin Ching, 1700 ft., 6–24–44, from trunk and roots of *Ficus* sp.; Schwangliu, 6–21–44, from a moist, moss-covered bank deeply shaded by bamboo. These specimens were collected by Wm. L. Brown, Jr., who is of the opinion that the ants may nest in the soil. He noted that those from the first-mentioned locality were timid and stuck tenaciously to the bark when an attempt was made to collect them. Those from the other locality, however, were rather quick in their pace. In view of the small number of workers from each locality, no attempt has been made to place them specifically.

The name proposed for the new genus is *Acalama,* which means ''without a stalk or stem,'' this reference being to the non-pedunculate petiole. The genotype bears the specific name *donisthorpei* in honor of the eminent formicologist, Horace Donisthorpe, of the British Museum.

Acalama, new genus.

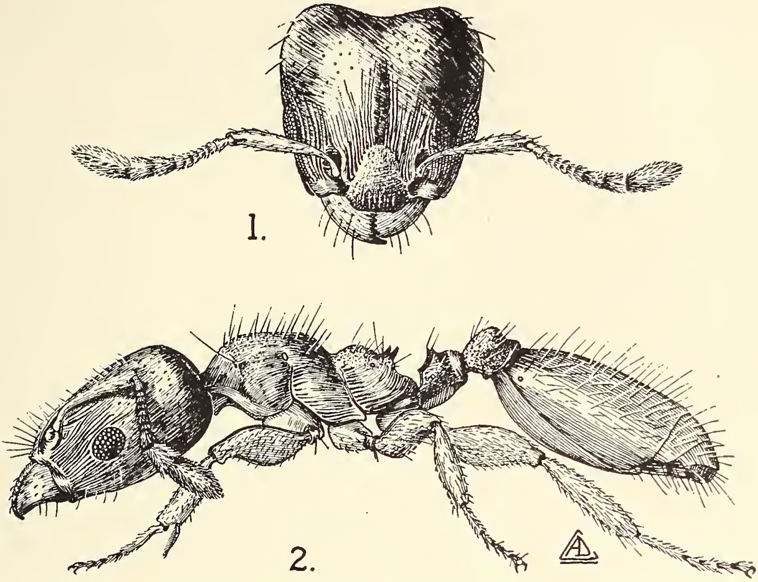
WORKER.—Small, apparently monomorphic. Head (including mandibles) subcordate, with rounded posterior corners and not very deep, but distinctly emarginate posterior border. Antenna 11-segmented, with a prominent 3-segmented club, the latter much longer than the remainder of the funiculus; scape short, curved basally, enlarged apically, failing by one-fourth to one-third its length from reaching the posterior border of the head. Frontal carinæ short, well-separated, indistinctly or not lobed, concealing antennal insertions. Frontal area indistinct or absent. Clypeus, in profile, flattened, median region extended as a short lobe, the anterior border of which is straight or indistinctly emarginate. Eye well-developed, placed nearer the anterior than the posterior border of the head, with at least 7–9 ommatidia in its greatest length. Mandible of ordinary shape, the masticatory border with 2 large apical and 3 or 4 smaller basal teeth.

Thorax, in profile, flattened or weakly convex. Pronotum with a distinct humeral tooth. Promesonotal suture obsolescent. Mesoepinotum with a remarkably deep constriction. Epinotal spines unusually short, upwardly directed. Legs rather short, with greatly enlarged femora and tibiæ; tibial spur of anterior leg well-developed, those of the middle and posterior legs vestigial or lacking. Petiole non-pedunculate; anterior and posterior faces of the node declivous, the two surfaces meeting to form a sharp, transverse carina which is distinctly emarginate; ventral surface of petiole with a tooth. Post-petiole slightly broader than long, also broader than the petiole. Gaster truncate basally, with distinct humeral angles.

Genotype.—Acalama donisthorpei, new species.

Acalama donisthorpei, new species

(Figs. 1, 2.)



Worker of *Acalama donisthorpei,* new species. Fig. 1, frontal view of head. Fig. 2, body in profile. (Illustrations by Arthur D. Cushman.)

WORKER.—Length 2.2 mm. (holotype).

Mandibles with rather coarse, scattered, piligerous punctures. Clypeus with a few, fine, longitudinal rugulae interspersed with minute punctulations. Cheeks and much of the front of the head with numerous, fine, longitudinal rugulæ, which in some lights, at least, give these regions a subopaque appearance. Posterior part of head with scattered but distinct punctures. Dorsal surface of epinotum punctulate, also with very fine, indistinct, longitudinal rugulæ. Posterior part of head, legs, and gaster more shining than the remainder of body.

Hairs yellowish or grayish according to the light, simple, moderately abundant, variable in length, apparently longest and most abundant on gaster.

Body brown, gaster darker.

Type locality.—Sikkim, Province of Assam, India.

Described from the holotype and 21 paratype workers collected at Honolulu, Hawaii, April 14, 1947 by T. F. Chong, of the Division of Foreign Plant Quarantines, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture. The ants were found ''in or on'' an orchid plant, *Dendrobium moschatum* Wall, the shipment of which originated at the locality mentioned above. The holotype and paratype specimens, which bear U. S. National Museum No. 58660, have been placed in the United States National Museum.

One paratype is slightly smaller than the holotype, measuring 2 mm. in length.

STUDIES ON THE COTTON JASSID (EMPOASCA DEVASTANS DISTANT) IN THE WESTERN PUNJAB. XIII. METHOD OF COTTON BREEDING FOR JASSID RESISTANCE

By Muhammad Afzal and M. A. Ghani
Cotton Research Laboratory, Lyallpur (Pakistan)

INTRODUCTION

Almost all the workers on the cotton jassid in the world are of the opinion that hairiness and jassid resistance are closely linked together. Macdonald, Ruston and King (1943), summarizing all the previous work done in South Africa, have stated that there exists a very close relationship between hairiness and jassid resistance. The other literature bearing on this point has been fully reviewed in a previous paper (Afzal and Abbas, 1943) and will not be repeated here. It was also pointed out that all previous work suffered from the serious flaw that linkage of the two characters had been sought from the study on pure breeding varieties. Genetic linkage can, however, be only fully appreciated from a study of hybrid progenies. A few results of this study have already been reported (Afzal and Abbas, 1943) and it has been shown that the two characters were closely linked. In these studies the plants were classified simply by eye observation into resistant and susceptible groups. These studies were, thus, of a qualitative nature. It was, however, realized that it would be much better to study these characters quantitatively by actually counting the number of eggs laid on the plants with varying degree of hairiness as it is now known that resistance to jassid is really resistance to oviposition only and the eggs once laid even in the leaf-veins of immune varieties of *arboreum* cotton have no difficulty in hatching out and developing into adults (Verma and Afzal, 1940). The correlation of various plant characters should, therefore, be worked out with resistance to oviposition. Investigations in this direction were carried out at Lyallpur during 1943 and the results of these observations are reported here.

MATERIAL AND METHOD

For these observations the following two 4th generation hybrid progenies, which were split for hairiness were selected:

(1) Progeny No. 204 of (920 Cambodia × 58 F) 289F/43.
(2) Progeny No. 226 of (920 Cambodia × 58 F) 124F.

There were 38 plants in Progeny No. 204 and 37 in Progeny No. 226 available for these observations. As the progenies were split for hairiness, plants of all shades of hairiness from sparsely to profusely hairy, were represented within these progenies.

The actual counting of the eggs laid in the leaf-veins could be carried out only by dissecting the leaf-veins which necessitated the plucking of the leaves. This method was, therefore, not employed. On the contrary, the oviposition was studied indirectly by counting the freshly hatched nymphs on all leaves of all the plants on alternate days. All the nymphs were killed and removed from the leaves by means of a camels-hair brush. These observations were continued throughout the period of severe jassid infestation *i.e.*, from the 10th August to the end of September.

The extent of hairiness was determined by counting, under a binocular, the total number of hairs on one centimeter length of each of the three prominent leaf-veins from the pulvinus spot of the leaf. These observations were taken from the fully formed primary leaves of the 20th, 25th, 30th and 35th nodes from each plant.

The toughness of leaf-veins was studied by means of a special apparatus designed for the purpose (Ahmad, Afzal and Ghani, in press). The toughness was measured in the c.c. of water required to be displaced by puncturing a particular vein by means of a needle. As in the case of hairiness, the toughness was also determined from all the primary leaves available on the main stem of each plant from the 20th to the 45th nodes. It was recorded from the mid-rib of each leaf at a distance of one centimeter from the pulvinus spot.

DATA AND RESULTS

The total nymphal population, mean hairiness and toughness of leaf veins of all the plants of the two progenies under observation are given in Table I.

Table I

Nymphal population and mean hairiness and toughness in hybrid progenies

Plant No.	Progeny 204			Progeny 226		
	Population	Hairiness	Toughness	Population	Hairiness	Toughness
1	256.83	9.67	56.00	77.83	36.25	67.10
2	133.46	116.58	85.08	77.25	183.75	71.39
3	139.21	156.83	80.71	155.04	21.92	66.33
4	115.66	87.33	79.19	110.88	49.67	69.56
5	237.41	24.75	48.92	119.67	27.75	64.36
6	136.62	52.58	80.72	115.08	34.17	63.80
7	202.66	30.33	59.29	68.04	232.67	65.90
8	266.08	11.92	55.44	67.92	45.83	61.15
9	118.96	96.25	73.72	81.17	61.50	57.58
10	62.08	107.25	66.89	59.54	160.42	67.92
11	123.00	70.00	76.19	110.67	21.75	60.15
12	57.67	82.92	72.75	108.38	20.58	60.50
13	62.25	130.75	67.25	69.54	44.00	48.72
14	302.62	5.08	55.60	94.58	36.50	58.14
15	174.33	6.92	51.50	45.13	195.42	66.94
16	118.37	129.58	77.89	114.67	38.00	53.73
17	184.33	151.17	67.06	121.88	15.33	61.85
18	214.66	104.00	70.75	49.54	190.08	62.00
19	171.16	12.67	56.63	97.54	35.50	74.29
20	50.29	148.00	62.00	105.33	33.50	66.13
21	135.21	109.33	72.50	62.54	122.58	67.00
22	112.00	112.83	74.50	62.33	161.33	69.00
23	94.12	79.50	67.69	58.13	182.50	64.13
24	58.29	103.50	68.70	43.42	180.92	70.55
25	127.33	105.92	68.75	77.54	24.33	61.00
26	158.83	98.33	59.00	103.92	34.67	52.29
27	60.62	84.25	70.36	54.67	142.75	61.61
28	88.83	86.00	81.25	82.42	50.67	60.67
29	79.08	114.75	63.70	113.46	37.33	65.42
30	46.25	117.83	62.50	116.04	37.00	69.25
31	79.75	79.75	78.96	45.21	208.25	65.61
32	65.67	191.92	76.10	41.33	199.92	68.00
33	94.96	97.83	72.33	107.67	30.42	58.83
34	84.25	106.33	71.67	59.83	224.75	70.79
35	70.54	123.25	79.00	84.92	47.00	70.40
36	205.83	7.17	56.86	75.42	75.33	63.45
37	68.71	109.58	65.00	42.04	194.50	66.58
38	103.50	128.42	82.81			

From the figures given in Table I, an attempt was made to find out the correlations of the three factors, namely, oviposition, hairiness and toughness. These correlations are discussed below:

(i) *Hairiness and toughness*

Progeny 204 r = + 0.6050 Significant at 1%.
Progeny 226 r = + 0.4022 Significant at 5%.

These correlations were positive and significant in both the progenies, showing thereby that the more the number of hairs on a leaf-vein, the tougher its veins were likely to be or in other words hairiness and toughness went together.

(ii) *Toughness and jassid population*

Progeny 204 r = – 0.5295 Significant at 1%.
Progeny 226 r = – 0.1899 Non-significant.

This correlation was significant only in the case of one progeny and its validity should, therefore, be considered somewhat doubtful. The negative nature of this correlation in both the progenies, however, indicated that the population had a tendency to decrease as the toughness increased.

(iii) *Hairiness and jassid population*

Progeny 204 r = – 0.6873 Significant at 1%.
Progeny 226 r = – 0.8108 Significant at 1%.

This correlation in both the progenies was negative and highly significant. This shows that the more hairy plants had definitely a smaller population than the less hairy ones.

In order, however, to find out the inter-relationship of these three characters—population, toughness and hairiness partial regressions were worked out, as it is only by this method that the actual relationship can be determined.

(iv) *Partial regressions of toughness and population by keeping the hairiness as constant*

Progeny 204 r = – 0.1966 Non-significant.
Progeny 226 r = + 0.2542 Non-significant.

Thus it appears from the above that toughness alone played a very insignificant part in determining the jassid population on a plant. Moreover, it has to be conceded that delicate measurements of toughness will not prove of much benefit to the cotton breeder unless such measurements can be made very rapidly.

Table II

Hairiness and Jassid population in hybrid progenies

Hairiness (Class intervals)	Population (Class intervals)								
	0–30	30.1–60	60.1–90	90.1–120	120.1–150	150.1–180	180.1–210	210.1–240	240.1 & above
0– 20					1*	2	1		3
20.1– 40			1*	13*		1*	1	1	
40.1– 60			5*	1*	1				
60.1– 80			1 2*	1	1				
80.1–100		1	2	2	1	1			
100.1–120		1	4	1	3			1	
120.1–140		1	2 1*	2					
140.1–160		1 1*			1		1		
160.1–180			1*						
180.1–200		6*	1 1*						
200.1–220		1*							
220.1–240		1*	1*						

Note:—The figures starred indicate the number of plants of Progeny 226, while others that of Progeny 204.

The breeder has to deal with literally thousands of plants in a short space of time and it is necessary that some easily recognizable morphological character of the plant associated with jassid resistance should be found.

Painter (1943) is of the opinion that hardness of tissue as a cause of resistance is open to question, but that differences in plant structure may be found to be genetically linked with resistance and may hence prove to be useful marks in the search for resistance. The toughness of the cuticle of the leaf-vein of cotton is, perhaps, a character which is not the primary cause of resistance but only an indication of it.

(v) *Partial regressions of hairiness and population by keeping the toughness as constant*

Progeny 204 $r = -0.5434$ Significant at 1%.
Progeny 226 $r = -0.8171$ Significant at 1%.

Both these regressions were negative and highly significant showing thereby that as the hairiness increased the jassid population decreased.

The behavior of different plants in the two progenies, as regards hairiness and population can be more clearly studied from Table II.

It will be observed from Table II that, on the whole, progeny 204 was more hairy than 226, though the plants with the largest number of hairs were met with in progeny 226. The population showed a definite decrease with the increase in hairiness. The most important point to be noted from this table, however, is that in both the progenies, with the exception of two plants in Progeny 204, almost all the plants with more than 120 hairs per centimeter length of the leaf-vein, had very small jassid populations and hence may be considered as resistant. It may now, however, be stated that if a cotton breeder selects plants with more than 120 hairs per centimeter length of the leaf-vein, an overwhelming majority of these will be resistant to the attack of jassids. Thus hairiness has proved to be a most important and easily recognizable morphological character associated with jassid resistance on which a breeder can rely for the selection of resistant varieties with a fair amount of certainty.

EFFECT OF ARTIFICIAL REMOVAL OF HAIR ON JASSID OVIPOSITION

Although hairiness has been shown to be highly correlated with resistance, there is still some doubt regarding the nature of this interdependence. If hairiness as a physical character of the plant, was inhibiting oviposition and was thus directly linked with resistance when the artificial removal of hair from the leaf-vein should render the plant susceptible. That this is not so has been shown by the following experiment.

The experiment was carried out for the first time in 1943 when the jassid population in the fields was fairly high. Four plants of 199 F, a hairy and resistant variety were encaged in removable muslin cages ($2\frac{1}{2}' \times 2\frac{1}{2}' \times 4'$). After 5–6 days the cages were removed and all the nymphs present on the leaves were killed and removed. This was done to allow sufficient time for the eggs, if any were laid before the commencement of

Table III

No. of nymph hatching on shaved and unshaved leaves, 1943

Date of observation	Shaved leaves		Unshaved leaves	
	No. of leaves	No. of nymphs	No. of leaves	No. of nymphs
30.VIII	39	25	43	26
2.IX	30	26	40	14
4.IX	30	10	40	6
6.IX	27	34	41	55
8.IX	27	25	37	16
10.IX	25	5	35	7
14.IX	94	69	90	48
16.IX	99	90	93	69
18.IX	97	38	88	35
20.IX	95	4	91	8
22.IX	89	15	79	21
24.IX	88	11	82	24
27.IX	82	8	80	13
29.IX	80	16	75	22
Total .	902	376	914	364
Average No. of nymphs per leaf.		0.417		0.398

the experiment, to hatch out. The hairs from the prominent veins of the alternate leaves of the each plant were removed by means of safety razor blades, taking care not to injure the cuticle. The shaved leaves were tagged to distinguish these from the unshaved ones. The cages were then removed to allow free access to the jassids. The oviposition on the shaved and unshaved leaves was then studied as already described. The data obtained are presented in Table III.

The experiment was repeated in 1944 and the data are given in Table IV.

Table IV

No. of nymphs hatching on shaved and unshaved leaves, 1944

Date of observation	Shaved leaves		Unshaved leaves	
	No. of leaves	No. of nymphs	No. of leaves	No. of nymphs
9.VIII	88	23	92	20
11.VIII	82	44	84	45
13.VIII	87	62	88	57
15.VIII	72	53	76	63
18.VIII	80	76	74	56
20.VIII	52	47	51	56
22.VIII	41	36	46	45
24.VIII	46	36	42	41
Total	548	377	553	383
Average No. of nymphs per leaf.		0.688		0.693

From Tables III and IV it is abundantly clear that the removal of hairs made no difference in jassid oviposition. It may, therefore, he stated that the physical presence of hair on the leaf-vein does not induce resistance. It, therefore, appears highly likely that, as hairiness is closely associated with toughness, the combined effect of these two characters renders a plant resistant. It is also within the limits of possibility that some other character (moisture contents of the leaf-vein for example) may also be associated with these two characters. From the plant breeders point of view, however, it is enough to know that hairy plants are resistant to the attack of jassids and the present work has been useful in settling all the previous doubts (Afzal, Husain and Lal, 1940), regarding the utility of this character, at rest. It is, therefore, now suggested that in areas where jassids are a serious menace, the plant breeder should select plants with more than 120 hair per centimeter length of the leaf-vein. It cannot, however, be expected of the breeder to actually count the number of hairs on the leaf-veins of all the plants he is dealing with, and an easier method has, therefore, to be prescribed. Hutchinson, Ramiah, *et al.* (1938) have published grades of hairiness of the stem-tip. It is now known that the stem-tip hairiness is closely associated with hairiness of the leaf. It is, therefore, proposed that the breeder should select, by visual observation only, plants of grades 1 and 2. If this is done a vast majority of the plants will be resistant to jassids.

SUMMARY

Jassid oviposition, hairiness and toughness were studied at Lyallpur during 1943, in all the plants of two hybrid progenies which were split for hairiness.

From the data obtained simple correlations between jassid oviposition, hairiness and toughness were worked out. The correlation between hairiness and toughness was positive and significant in both the progenies, showing thereby that hairy plants had tougher veins. The correlation between toughness and jassid population was significant only in the case of one progeny, therefore, its validity is rather doubtful. But it was negative in both the cases which shows that the jassid population had a tendency to decrease as the toughness increased. The correlation between hairiness and jassid population was negative and significant in both the progenies. This indicated that hairy plants had smaller populations and vice-versa.

The partial regressions were worked out from these three factors—jassid population, toughness and hairiness. The partial regression of hairiness and population, keeping the toughness as constant, was only significant and was a negative one. This showed, that out of these two plant characters, hairiness

played the major role in determining the extent of jassid infestation.

Jassid oviposition was also studied on shaved and unshaved leaves. It was seen that artificial removal of hair made no difference to jassid oviposition. It is, thus, evident that the physical presence of hairs does not induce resistance, though hairiness is closely associated with it.

It was further observed that plants having more than 120 hair per c.m. length of the leaf-vein had very little jassid population and hence may be considered as resistant. It is therefore recommended that the plant breeder should select plants having more than 120 hair per c.m. length of the leaf-vein. But as he is to deal with a very large number of plants in a limited space of time, it is not possible for him to actually count the number of hair. It is, therefore, proposed that the breeder should select plants, by visual observation, of grades I and II as described by Hutchinson, Ramiah *et al.*, (1938).

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RESULTS OF THE PENNSYLVANIA MOSQUITO SURVEY FOR 1947*

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The Pennsylvania Mosquito Survey was begun in February 1947 and became a part of the Pennsylvania Ecological Insect Survey under the direction of Dr. S. W. Frost. The Insect Survey is a function of the Department of Entomology of the Pennsylvania State College. The Mosquito Survey owes its inception mainly to Dr. Frost and to Major Russell W. Gies of the State Department of Health and the Delaware County (Pa.) Mosquito Extermination Commission.

New Jersey Light Traps were obtained from the Communicable Disease Center, U. S. Public Health Service, Atlanta, through the kind offices of Dr. G. H. Bradley. With the placement of the traps throughout the state, transportation difficulties arose that were solved in part through the kindnesses of Major Gies and Dr. Frost, Mr. Leo Sterenberg of the New York Office of the USPHS and others.

The work would have been impossible but for the cooperation of the public-spirited citizens throughout the state who went to the trouble of maintaining and operating their individual traps.

Primary separation was effected by Messrs. Pryor and Kauffman and the Misses Anderson and Pepper under the direction of Dr. Frost. Thanks are due to Dr. E. H. Dusham for administrative aid and direction and to Mrs. Miriam B. Horn for assistance in identification at the New York Office of the USPHS, to the staff of the Delaware County Commission for help of all sorts.

This paper should be used in conjunction with the excellent list of Wilson, Barnes and Fellton (1) and certain papers of Stabler (2 and mss.), to which it is supplementary. Many records of the known mosquitoes of the state are included whether

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* A contribution from the laboratories of the Department of Zoology and Entomology of the Pennsylvania State College.

or not the present survey has captured them. Since the southeastern part of the state is best known, the emphasis of this survey was placed more on the central and other parts of the state which have been studied less carefully. An effort was made not only to obtain a more satisfactory idea of the ranges of the various species, but also to gain some idea of the abundance at the different points.

Although only one species hitherto unrecorded from the state has been found this year by the Survey, we believe that the records given below will prove to be of value in rounding out our knowledge of our state's mosquito population as other states have done before us. Since the paper (1) published in 1946 by Wilson, Barnes and Fellton, three additional species of culicids have been found to occur in the state, namely *Aedes mitchellae, Aedes punctor* (or *implacabilis*) and *Megarhinus septentrionalis.* The first and the last named have been reported (mss.) by Dr. R. M. Stabler from Delaware County. The three species named as of probable occurrence in the 1946 paper have not yet been found. *Aedes aurifer* (Coquillett) will sooner or later turn up in a biting collection from within the state. *Anopheles occidentalis* Dyar and Knab has been taken by Perry of the USPHS on the Allegheny River just across the border from Pennsylvania where the river loops into New York State for a short distance. A diligent search in that district should reveal the species; a hurried search by the author in the area of Kinzua turned up only a few *A. punctipennis* females. *Wyeomyia smithii* (Coquillett) occurs only in pitcher plants of the genus *Sarracenia.* The areas in which these plants occur are usually in out-of-the-way bogs and swamps, and the one or two small colonies searched did not contain the mosquito. Search should be made in more extensive pitcher plant areas in the Poconos, and in Sullivan and Lancaster Counties among other regions. *Wyeomyia* will eventually be found if the search is stubborn enough.

In the list of species following we use the generic alphabetic order as do Wilson, Barnes and Fellton. For records of the commoner species, only counties are given, but for the rarer types, we have included more exact data.

The present list includes thirty-seven species of mosquitoes which have been found in this State to date.

1. *Aedes atropalpus* (Coquillett)

This mosquito, a breeder in rock holes, was first reported by Howard, Dyar and Knab from Shenk's Ferry in Lancaster Co. It probably occurs at many points farther up the Susquehanna and along other rocky rivers and streams in the state. We have found it breeding abundantly along the Youghiogheny River at Ohiopyle, Fayette Co., and have taken a specimen from the trap operated by Mr. Edward J. Pugh, Director of Health, at Wilkes Barre, Luzerne Co., which is on the bank of East Branch of the Susquehanna. At Ohiopyle, the first breeding occurred in 1947 only after the 20th of April. The 1947 records are the first for over thirty years in Pennsylvania.

2. *Aedes canadensis* (Theobald)

This mosquito is far and away the commonest early spring breeder in the state. The author feels that it occurs in every county in the state, breeding in open situations as well as in woodland pools. It begins breeding in Delaware Co., during the first or second week of March, usually a little later elsewhere, and in 1947 was strongly retarded in the cooler parts of the state except, for some unexplained reason, in the northeastern region, where heavy breeding occurred throughout April.

The Survey has taken *canadensis* in the following counties from which it has not been recorded previously: Blair, Center, Clearfield, Crawford, Carbon, Erie, Huntingdon, Luzerne, Mifflin, McKean, Northumberland, Philadelphia, Schuylkill, Westmoreland and Wayne.

3. *Aedes cantator* (Coquillett)

Aedes cantator has so far been reported only from the southeastern part of the state. The Survey has one specimen from the trap at the Philadelphia Navy Yard operated by Lieutenant Holway, as well as scattered specimens from various localities in Delaware Co., collected by the Delaware County Mosquito Extermination Commission.

4. *Aedes cinereus* (Meigen)

This small and inconspicuous mosquito has heretofore been considered rather rare in the state. The author agrees with Stabler that it is not uncommon in several localities in Delaware Co., and he will go further and state that he has found it among the commonest of mosquitoes during spring and early summer in other parts of the state. At Philipsburg in mid-April the larvæ were associated in enormous numbers with those of *A. canadensis* in open swamps and grassy ponds as well as in woodland pools. This association of *canadensis* and *cinereus* seems to replace in Pennsylvania the association of other *Aedes* spring forms found farther north.

In addition to the above localities, breeding of *cinereus* was observed to be common at Ole Bull State Park, Potter Co., again with *canadensis,* and many males were captured during May, June and July in the light trap at that place.

Taken by the Survey in Centre, Clearfield, Erie, Fayette, Philadelphia and Potter counties; by the Delaware Co. Commission in Delaware Co., and Montgomery Co., and by Wilson, Barnes and Fellton in Mercer and Wayne counties.

5. *Aedes dorsalis* (Meigen)

We have not seen any specimens during 1947. Formerly reported only from Philadelphia by Dyar.

6. *Aedes excrucians* (Walker)

This species was fairly abundant in the Philipsburg area (Centre and Clearfield Counties) in the swamps on both sides of Moshannon Creek during May. Both male and females were captured flying low among cattails at dusk during the last week in May; the females made no attempt to bite and fled at the approach of the collector. Mating was in process at the time. Male specimens were captured in June, one in the trap at State College, Centre Co., and two in the trap at Wilkes Barre, Luzerne Co. Male genitalia were checked on specimens from each locality.

7. *Aedes fitchii* (Felt & Young)

This Survey identified no *fitchii* from among the 1947 catches.

Wilson, Barnes and Fellton claim to have captured a few specimens in Bucks County during 1945.

8. *Aedes mitchellae* (Dyar)

Stabler took this species in Delaware Co., (Norwood, Tinicum) during 1946 (mss.) from the light trap catches.

9. *Aedes punctor* (Kirby)

This species is very difficult to separate from *A. implacabilis* (Walk.) in the female sex. We have checked a single specimen taken biting at Philipsburg, Centre Co., against specimens in other collections, and it seems to have more exactly the features of *punctor* than those of its close relative. Neither *punctor* nor *implacabilis* has been previously reported from the state.

The taxonomy of the *punctor-implacabilis* and the *fitchii-stimulans* groups of *Aedes* seems to this writer and to other entomologists engaged in mosquito work to be very dubiously applied. Work on these and other domestic *Aedes* complexes has been virtually stalled, probably due to the appearance of large illustrated works on identification which have given an air of stability to the names presently in use. The occurrence of intergrading forms in the larvæ and both sexes of adults in a large series from New Jersey of the *fitchii-stimulans* group seems suspicious. The matter can be settled only by the rearing of large series from a fair sample of the full ranges of the groups in question.

10. *Aedes sollicitans* (Walker)

This annoying mosquito breeds in Delaware and Philadelphia counties in small numbers except during dry seasons, when, as in late summer 1947, the Delaware River may become slightly brackish, with sea water making itself felt as far up as Chester, Delaware Co., or even farther upstream. The slight brackishness is reflected in an immediate rise in the number of *A. sollicitans* caught in the light traps in Delaware and Philadelphia counties. The adults locally produced are probably augmented by migrating swarms from Delaware and New Jersey when the wind is right.

11. *Aedes sticticus* (Meigen)

This species was taken in large numbers only on Presque Isle, Erie Co., where the adults were troublesome in the woods during the day in July. By early August, they were present in immense swarms on much of the peninsula and would attack in midday, hot sunlight on the open beaches and roads about the woods wherever the stronger breezes could not reach them. A single male was taken at Honesdale, Wayne Co., on July 10, the genitalia verified.

12. *Aedes stimulans* (Walker)

Taken by USPHS group in the northwestern and southeastern portions of the State. Neither this Survey nor the Delaware County Commission has been any clearcut examples of this supposedly common mosquito.

13. *Aedes taeniorhynchus* (Wiedemann)

Known only from Philadelphia and Delaware counties; may occur in Montgomery, Chester and Bucks.

14. *Aedes triseriatus* (Say)

This mosquito was taken fairly abundantly in biting collections during June, July and August at Tiadaghton, Lycoming Co.; Presque Isle State Park, Erie Co.; and near Philipsburg in Centre and Clearfield Counties. Major Gies has taken it at Old Forge State Park in Franklin Co. One specimen was caught in the light trap at Ohiopyle, Fayette Co., during June. The author has observed them to be breeding in large numbers in tree holes in Aldan, Media and Tinicum, all in Delaware Co. In wooded areas in Delaware County, the mosquito is often quite troublesome. In Aldan and Media during July, however, the numbers of *triseriatus* larvæ were considerably reduced by the voracious *Megarhinus* larvæ feeding upon them.

15. *Aedes trivittatus* (Coquillett)

Aedes trivittatus was taken in moderate numbers from most of the light traps throughout the State and was taken abundantly in biting collections along Moshannon Creek near Philipsburg, Centre and Clearfield Counties, up until the time of air-spraying with DDT. Major R. W. Gies has taken them biting at Old Forge State Park, Franklin Co., along with *A. triseriatus*. The trap catches of *trivittatus* were small except at Ohiopyle, Fayette Co., where as many as 100 per night were taken during July. Males were taken in approximately equal proportion to females except in the case of the large Ohiopyle catches, where females were very much in the majority. Trapped in: Blair, Delaware, Erie, Centre, Clearfield, Fayette, Luzerne and Potter Counties. Biting in: Adams, Franklin, Lycoming, Centre, Clearfield, Erie Clinton and Mifflin counties.

16. *Aedes vexans* (Meigen)

This species, along with the *pipiens* group of *Culex,* is the principal pest in Pennsylvania. It was found during the summer in just about every locality visited, and the author does not hesitate to assert his belief that it occurs commonly in every county in the state. It is especially common in the vicinity of inhabited places, though it is also found in wilder districts. Taken in the following counties: Blair, Centre, Clearfield, Delaware, Erie, Clinton, Wayne, Bedford, Adams, Crawford, Montgomery, Berks, Warren, McKean, Potter, Lycoming, Fayette, Mercer, Mifflin, Huntingdon, Luzerne, Philadelphia, Westmoreland, Indiana, Armstrong, Butler, Forest, Elk, Juniata, Cameron, Washington, Venango and Bucks. It exceeded an average of 12 per night for a month or more at the following localities: Tinicum, Delaware Co.; Presque Isle, Erie Co.; Pymatuning, Crawford Co.; Altoona, Blair Co.; Ole Bull Park, Potter Co.; Ohiopyle, Fayette Co.; Philipsburg area, Centre and Clearfield Counties at Moshannon Creek. Ohiopyle, Presque Isle, and Philipsburg were the heaviest catchers (outside Delaware Co.), with catches of one to three hundred per night not uncommon.

A specimen given me by Dr. Stabler, collected in Delaware County and now deposited in the collection of the Pennsylvania State College, differs from the typical *vexans* in having, in addition to the inverted V-shaped white patch at the anterior of each dorsal abdominal segment, a large, central, posterior patch of white scales which is half-oval or subtriangular in shape with the narrowest part directed anteriorly. Mrs. Horn informs me that similar specimens turn up occasionally and that intergrades to the typical *vexans* occur, some specimens having only a few white scales at the posterior edge of each abdominal specimen. Such intergrades would not necessarily preclude the possibility of these aberrant individuals forming an ecological race of *vexans*. More specimens are needed for study.

17. *Anopheles barberi* (Coquillett)

This small tree-hole breeder has previously been taken in Butler and Cumberland Counties. I have seen specimens taken in light traps by Dr. R. M. Stabler of the Delaware County Mosquito Extermination Commission during several of the more recent years. I believe he will mention these records in a forthcoming paper. One additional record is added: Crooked Creek Reservoir, Armstrong Co.—one adult female taken by N.E. Good of the USPHS on Sept. 12, 1945 at an adult resting station. *Barberi* is probably present but difficult to locate throughout most of the State.

18. *Anopheles crucians* Wiedemann

Known from Philadelphia, Delaware and Montgomery Counties.

19. *Anopheles punctipennis* Say

This species is usually regarded as unimportant in the transmission of malaria, though it has been experimentally infected in the laboratory. It differs in distribution from other species of the state in that it is present in nearly every locality examined, but usually not in very large numbers. *Quadrimaculatus* and *walkeri*, on the other hand tend to have a localized distribution in the extreme northwestern and southeastern parts of the state, and quite often are exceedingly abundant where they are found. *Punctipennis*, at least in this state, is certainly not shy about entering houses or biting humans indoors or out. During 1946 in State College, Centre Co., females were seen in houses during October and November, apparently seeking shelter for hibernation, and during August 1947, several cases of *punctipennis* biting were observed here indoors. At Ohiopyle, Fayette Co., where the species was commoner than elsewhere (often 10 to 12 per night in the trap), individuals bit freely on porches and in gardens at dusk and after dark. At this last-named locality, the larvæ were breeding in many of the rock holes along the Youghiogheny River.

Males of this and other species of *Anopheles* were taken only very rarely in the light trap. Specimens from traps and adult resting-places in the following counties: Blair, Centre, Crawford, Delaware, Fayette, Luzerne, Lycoming, McKean, Potter and Warren. Unpublished records of the USPHS are as follows: Conemaugh and Loyalhanna Reservoirs (sites) (Westmoreland Co.), Crooked Creek and Mahoning Dams (Armstrong Co.), Smicksburg (Indiana Co.), Confluence (Somerset Co.); [N.E. Good], Sept. 1945.

20. *Anopheles quadrimaculatus* Say

This well known malaria mosquito has so far been taken in three general regions of the State. It is sometimes fairly commonly seen in Philadelphia and Delaware Counties and is less common in Montgomery County. Gies and Stabler have collected it in Chester County and Gies in Berks County. The present author has found it to occur sparingly in Bucks County. Dr. Mitchell Carroll, head of the Zoology Department at Franklin and Marshall College, [Lancaster Co.], reports fairly heavy numbers of hibernating ''quads'' in some of the college buildings in former years. The MCWA personnel of the USPHS have found it common in mid-summer in scattered localities in Crawford and Mercer Counties. The present survey can add a report of an abundant population on the peninsula at Presque Isle, Erie Co., during the summer of 1947. Major R. W. Gies had already noted its abundance at Presque Isle during the month of October in 1946. On the peninsula, the mosquito is most abundant in natural and artificial resting places, such as hollow logs, bath-houses, privies, etc. It is not well represented, however, in the light trap collections at this locality, where *A. walkeri* was found to be taken so commonly. The one other section of the State in which it has been found is the lower Susquehanna River region, where it has been recorded from West Fairview, Cumberland Co., by Howard, Dyar and Knab. This is one of the few known records from outside the extreme northwestern and southeastern portions of the state. Major R. W. Gies has suggested, and I concur, that *A. quadrimaculatus* population may be large locally in many localities in parts of the State as yet unsurveyed, and that cyclic increases in abundance over a period of years may play a role in distribution. Further surveys will be needed to determine the frequency of such phenomena.

A record from the USPHS files received at the last moment is of interest. Two females were taken in separate resting places near the Mahoning Dam, Armstrong Co., by N. E. Good during September 1945. Two trips to that area by the present writer during 1947 failed to reveal *quadrimaculatus.*

21. *Anopheles walkeri* Theobald

A few specimens of *walkeri* have been taken in the traps of the Delaware County Mosquito Extermination Commission, but the most phenomenal catch seen was that of the Survey's trap on the neck of the peninsula at Presque Isle State Park, Erie Co. This trap was placed about ten feet higher than the regulation six on the limb of a poplar tree. During July it commonly made catches of 50–120 *walkeri,* and on the night of August 8 exceeded 550. A search of resting places such as dark privies and bath-houses was fruitless as far as revealing specimens was concerned, although *A. quadrimaculatus* and a few *A. punctipennis* were found, along with species of other genera. None of the other traps turned up *walkeri* during the season. Thus *walkeri,* like *quadrimaculatus,* seems to find conditions most favorable in the northwestern and southeastern portions of the state.

22. *Culex apicalis* Adams

Previous authors have found this species widely distributed in the State. It is supposed to take its blood from amphibians; data are needed on the adult feeding habits. The Survey has taken a few specimens each from traps in Erie, Luzerne, Fayette and Potter counties. Males were taken in the traps more commonly than females. Adults were reared from larvæ taken in rockholes along the Youghiogheny River at Ohiopyle, Fayette Co., May 8, 1947.

23. *Culex* (*Melanoconion*) sp., probably *erraticus* Dyar and Knab.

Known only from two specimens taken in the Philadelphia area by Dr. R. M. Stabler.

24. *Culex pipiens* Linnaeus

The common house mosquito has been found to be common mainly in the urban areas, and has not been taken as frequently as has *C. restuans* in other areas of the state. Traps at sewage works in Altoona and State College yielded quite different catches, the former giving up nearly all *pipiens* and the latter nearly all *restuans.* The author has no good explanation for this. In general, *pipiens* tended to become slightly more and *restuans* slightly less abundant with the passing of July. In several areas, search for females in resting places during April and May yielded only *restuans.* Thus, it seems that, in Pennsylvania at least, the two species *may* be seasonally different in breeding habits.

New records resulting from the survey in the following counties: Bedford, Centre, Clearfield, Crawford, Erie, Fayette, Luzerne, Mifflin. Records from several counties covered by Wilson, Barnes and Fellton are not included here. The species certainly occurs in every county in the state.

25. *Culex restuans* Theobald

This species requires great care in separation from related species of *Culex.* We have found it more common than *pipiens* in most sections of the state, breeding in all sorts of situations, in clear water and foul, in tin cans, temporary pools and rain barrels. Specimens carefuly reared from such situations nearly always turned out to be typically white-spotted *restuans,* although such places are generally thought to be principally the breeding domain of *pipiens.* Many males and females, the latter predominating, from the light traps in Blair, Centre, Clearfield, Delaware, Erie, Crawford, Bedford, Luzerne, Lycoming, Potter and Wayne counties. Other specimens, both larval and adult, were taken in Carbon, Mercer, Fayette, Huntington, Mifflin, Allegheny, Warren, Clinton, McKean, Chester, Lancaster, Bucks, Lehigh and Schuylkill counties. The species undoubtedly occurs in every county in the state; it is among the commonest mosquitoes in most.

26. *Culex salinarius* Coquillett

The survey found *salinarius* to be much less common than either *pipiens* or *restuans*. It was taken from light traps in the following Counties: Crawford, Erie, Fayette and Wayne. Since the specimens in many cases were too badly damaged to differentiate *salinarius* from the other two common species, the range may be more extensive than our records show. Previous papers seem to bear this out.

27. *Culiseta inornata* (Williston)

Heretofore known only from Delaware and Philadelphia Counties. The Survey took a female specimen from the trap on Presque Isle Penninsula, Erie Co., July 24, 1947.

28. *Culiseta melanura* (Coquillett)

This species is known only from Delaware County.

29. *Culiseta morsitans* (Theobald)

This species was taken in larval dippings in a flooded area of bunch grass together with *Aedes canadensis* and *A. cinereus* at Ole Bull State Park, Potter Co., during May. A male was caught in the same locality in the light trap, July 6, 1947, and a female was taken in the trap at Ohiopyle, Fayette Co., August 13th. Previously recorded from Butler and Monroe counties.

30. *Mansonia perturbans* (Walker)

The larvæ of this mosquito live beneath the surface of the water with their air tubes piercing the roots of aquatic plants for air supply. The species has heretofore been considered common only in southeastern Pennsylvania, but we have taken it in light traps in the following counties outside that area: Blair, Centre, Clearfield, Erie and Potter. The catches have ranged from 1 to 25 individuals per night, with about 4 or 5 as a normal number in all stations but Philipsburg, Centre Co., where the catch was averaging 20 or so two weeks after air-spraying of the area with one gallon of 5 per cent DDT (in kerosene) to the acre. Males are attracted in a proportion of about one to every two or three females, but they occasionally (Ole Bull, Potter Co.) slightly outnumber the females in the New Jersey trap.

31. *Megarhinus septentrionalis* Dyar and Knab

Stabler (mss.) reports a specimen taken in Delaware Co. during 1946. The author can add observations of breeding in treeholes in Aldan, Tinicum and Media, Delaware Co., where the prey seemed in all cases to be *Aedes triseriatus.* Populations of *triseriatus* were greatly reduced and even obliterated during early and mid-July by the feeding of the *Megarhinus.* Several specimens were taken home, put in a jar with many *triseriatus* larvæ, and watched periodically. The first night, July 2, the largest *Megarhinus* larva attacked and ate two *Aedes* during a twelve-hour period. The largest *Megarhinus* survived as a fourth instar larva for 13 days after the last *Ædes* and smaller *septentrionalis* larvæ had disappeared. Presumably the latter were eaten by the large larva, since the empty larval skins were found in halves at the bottom of the jar and seemed in a condition similar to those of the *Aedes* preyed upon. This is the first record of *Megarhinus* actually breeding within the state.

32. *Orthopodomyia signifera* (Coquillett)

This rather rare treehole breeder should be closely scrutinized whenever found, since the closely related *O. alba* Matheson may quite possibly be found in this state. The Survey has taken a single specimen each from the traps in Nanticoke, Luzerne Co., Williamsport, Lycoming Co., and Ohiopyle, Fayette Co. Previous reports are from Philadelphia and Delaware counties. The mosquito is probably rare but present in most of the state.

33. *Psorophora ciliata* (Fabricius)

The Survey has failed to turn up any new records of this mosquito in the state outside of southeastern Pennsylvania, although it may well occur in other parts.

34. *Psorophora confinnis* (Lynch Arribalzaga)

All records of this insect seem to center in the southeastern part of the state; the Survey has nothing to add in the way of distributional data. Previously known from Philadelphia, Delaware and Montgomery counties.

35. *Psorophora ferox* (Humboldt)

The mosquito has been reported from Montgomery and Philadelphia Counties only, but the writer has a few specimens collected by Stabler (1945, 1946) and McGaughey (1947) in Delaware Co.

36. *Psorophora horrida* (Dyar and Knab)

This species has been taken only once in Pennsylvania—by the USPHS group in 1945. We have seen no further specimens from the state.

The collection of the Pennsylvania State College received several fine specimens of this mosquito collected by Mr. Merrill Wood of the Department of Zoology and Entomology during July 1947 near Fremont, Nebraska. Mr. Wood states that this species is a most vicious biter throughout much of that state.

37. *Uranotœnia sapphirina* (Osten Sacken)

This species is probably a feeder upon frogs, since it seems to occur only where the latter amphibians are abundant. A related species, *U. lowii* Theobald has been demonstrated by Remington (4) to be a feeder mainly upon frogs, toads and related amphibians. Captured in light traps in Blair, Delaware, Erie, Luzerne, Lycoming and Potter counties. Five individuals is the maximum catch for one night; males and females come to the traps in approximately equal numbers.

References

For a fuller bibliography on Pennsylvania mosquitoes, see reference (1) below. The following are papers referred to in this paper:

(1). WILSON, C. A., R. C. BARNES AND H. L. FELLTON 1946. A list of the mosquitoes of Pennsylvania with notes on their distribution and abundance. Mosquito News Vol. *6,* No. 2.

(2). STABLER, R. M. 1946. New Jersey light trap versus human bait as a mosquito sampler. Ent. News *56:* 93–99.

(3). ————. mss. (An unpublished paper giving further mosquito records from Delaware County.)

(4). REMINGTON, C. L. 1945. The feeding habits of *Uranotœnia lowii* Theobald. Ent. News *56:* 32–37, 64–68.

THE DESCRIPTION OF A NEW SPECIES OF THE GENUS CEROPALES (HYMENOPTERA: PSAMMOCHARIDÆ) WITH A KEY TO THE SPECIES OF NORTH AMERICA

By R. R. Dreisbach
Midland, Michigan

The following species in the collection of the Museum of Zoology of the University of Michigan is entirely different than any of the types which the writer has recently studied, does not agree with the description of any of the remaining species and is herewith described as new.

Ceropales floridensis new species.

Holotype female: Ground color black; clypeus, mentum, face below the antennæ a basal band on anterior orbits extending half way between base of antennæ and anterior ocellus, large prominence between and just above the base of antennæ, the anterior half of the first two antennal segments, a tiny spot at base on front edge of third antennal segment, a very narrow line along upper edge on posterior orbits, a broad band on posterior border of pronotum, a quadrate spot on postscutellum, the outer posterior corners of propodeum, and a stripe on the upper front edge of posterior coxæ a very light yellow color; mandibles except tip, posterior half of first two antennal segments, most of front, vertex except ocellar enclosure, the posterior orbits except as noted below, all the pronotum except the broad posterior yellow border, the tegulæ, all the propodeum except a broad transverse basal band on dorsal surface which is black, most of the dorsal surface of first abdominal segment, and all the legs, including coxæ, a light red color; the ocellar triangle with the surface surrounding it at sides and front, a large spot on each side behind the head on posterior orbits, the surface just behind the mandibles on posterior orbits, the tips of mandibles, the antennæ except as noted above, black; when seen from in front the ocellar triangle shows up as a very noticeable prominence, with rather prominent golden hairs borne on the whole vertex, the anterior ocellus much less than its diameter from the lateral ocelli, and these in turn separated from each other by about their distance from the eye margins; the ventral surface of thorax as well as the ventral surface of the coxæ very loosely covered with fine, closely appressed, sericeous pubescence, which also covers about the lower half of the sides of thorax; no sericeous hairs on the upper half of dorsum, but these surfaces with light golden hairs much fewer in number, upright and not very long, but the ones on sides of scutellum and postscutellum are rather long; the abdomen with no upright hair but with closely appressed fine hair which becomes slightly longer and more prominent near apex; wings deep black; the extreme bases of second, third and fourth posterior tarsal joints black as well as the aroliæ of all the legs.

Length:—Head and thorax 7.25 mm., abdomen 7.25 mm., fore wing 12.25 mm., rear wing 9.4 mm.

Holotype female; Gainesville, Alachua Co., Fla., May 4, 1923. (Alexander-Walker) Museum of Zoology, Univ. of Mich., Ann Arbor, Mich.

In the key for this genus as given by Fox not all the species known at present are included. The following key is presented in the hope that it will enable a worker to determine all the species of the genus. Four species *C. fumipennis* Cam., *C. chiriquensis* Cam. from Panama, and *C. apicipennis* Cam. and *C. azteca* Cam. from Mexico were not seen but were included from the descriptions and color plates, as given in reference 2

Key to the Species of Genus Ceropales Latreille

1. Females 2
1. Males 19
2. Body entirely black, at the most with a white spot on the postscutellum and the posterior outer angles of propodeum and the anterior orbits with a white line 3
2. Body more or less ornamented with white, red or yellow. 5
3. All the femur black .... *nigripes* Cresson
3. Some of the femur reddish or reddish yellow 4
4. Only the posterior femur reddish .... *bipunctata* Say
4. First two pairs of femur reddish yellow as well as the posterior trochanters and tibiæ .... *bipunctata* v. *tibialis* Banks
5. At least the abdomen with a considerable amount of reddish 6
5. Body ornamented with white or yellow 11
6. Some red on head or thorax, abdomen may have some yellowish markings 9
6. Head and thorax black 7
7. Dorsum strongly punctured; wings hyaline except at apex *agilis* Smith
7. Dorsum and sides of thorax glabrous, impunctate, and highly polished; wings fuliginous with a hyaline spot at apex 8
8. Antennæ entirely black; stigma of fore wings dark brown like rest of wing .... *robinsonii* Cresson
8. Basal half of antennæ reddish or yellowish, only the apical half black; stigma of fore wings clear yellow; marginal and discoidal cells longer than in preceding, and more of the tip of wing hyaline. *robinsonii* v. *stigmatica* Viereck

9. Entirely reddish all over with yellow markings on posterior edge of abdominal segments, posterior edge of prothorax, and on face. *elegans* Cresson

9. Not entirely reddish all over 10

10. Vertex and sides of thorax black; antennæ reaching beyond scutellum .... *cressoni* Fox

10. Vertex, sides and dorsal surface of propodeum reddish; abdomen entirely black except a small amount of ferrugineous on first abdominal segment .... *floridensis* n. sp.

11. First, third, fourth and fifth abdominal segments entirely yellow, the second with one half of its surface black; propodeum with a very short median sulcus .... *stretchi* Fox

11. Abdomen not marked as above 12

12. Abdomen entirely black, except the first segment may be marked with obscure ferrugineous .... *clypeatus* Cresson

12. Abdomen with segments marked with whitish or yellowish in much greater amount than in above 13

13. Propodeum with a very short median sulcus or with none 14

13. Propodeum with a long distinct median furrow 16

14. First abdominal segment with the apical margin pale yellowish; posterior surface of propodeum very much excavated, concave each side of center; third cubital cell dark yellow .... *fulvipes* Cresson

14. First abdominal segment with a large yellow spot or elongate yellowish line on each side; posterior surface of propodeum flat 15

15. The yellow posterior margins of the tergites interrupted medially, and broadly emarginate each side and enlarged at their lateral ends into a large ovate spot; third cubital cell dark yellow; first tergite with a large yellow spot each side; legs ferrugineous .... *longipes* Smith

15. The yellow posterior margins of tergites not interruped medially and of about even width throughout; the first tergite with a rather long narrow yellowish line crosswise of segment slightly before the posterior margin; legs mostly dark .... *fraterna* Smith

16. White lateral marks on abdominal segments, without continuous fasciæ; at least posterior femur, except base, reddish 17

16. Abdominal tergites two to five with continuous fasciæ on posterior edges 18

17. All abdominal segments with a lateral sublunate, white mark on apical margin; a yellow spot on anterior coxæ and the tips of the four posterior coxæ; face, mesopleura, and propodeum silvery; second cubital cell almost quadrate .... *femoralis* Cresson

17. Only the first four abdominal segments with white lateral marks and these not sublunate; no yellow on coxæ; posterior face of propodeum and posterior coxæ with dense silvery pile, which is absent from rest of body .... *foxii* Rohwer

18. First abdominal tergite without an apical fasciæ, but with a spot each side; second tergite with the fasciæ interrupted in the middle; propodeal sulcus extra long .... *cubensis* Cresson
18. First abdominal segment with an apical fasciæ and with an additional mark each side; second cubital cell longer than broad 19
19. Tips of femur, anterior tibiæ in front, base and apex of middle tibiæ, and base of four anterior tibiæ lemon-yellow; apex of propodeum with golden sericeous pile .... *mexicana* Cresson
19. Parts of legs mentioned above reddish; apex of propodeum with silvery pile .... *azteca* Cameron
20. Wings fuliginous, size large for the most part 21
20. Wings hyaline 25
21. Abdomen entirely black, posterior femur reddish 22
21. Abdomen with considerable whitish or yellowish color 23
22. Only the posterior femur reddish .... *bipunctata* Say
22. The posterior tibiæ as well as posterior femur reddish. *bipunctata tibialis* Banks
23. The whole insect yellow; antennæ yellow except the last three joints which are black; sulcus on propodeum long and deep; third cubital cell half as long on marginal vein as on the cubital vein. *quaintencii* Viereck
23. Whole insect not yellowish, mostly black 24
24. Only the last apical segment white; coxæ and femur densely covered with white hair, the tibiæ and tarsi with black hair; the abdomen shining .... *fumipennis* Cameron
24. The three apical segments of abdomen white .... *nigripes* Cresson
25. The abdomen with some reddish color 26
25. Abdomen marked with white or yellow 29
26. Head and thorax black 27
26. Some red color on head and thorax 28
27. Dorsum strongly punctured; apex of wings blackish .... *agilis* Smith
27. Dorsum and sides of thorax glabrous, impunctate, polished, and shining .... *robinsoni* Cresson
28. Entirely reddish all over, with yellow markings on posterior edges of abdominal segments, posterior edge of pronotum, and on face. *elegans* Cresson
28. Not entirely reddish all over .... *cressoni* Fox
29. Abdominal segments with the apical margins with continuous bands, except the first may be interrupted in the middle 30
29. Abdominal segments with the apical bands interrupted in the middle or some of the tergites without maculations 35
30. Antennæ shorter than the head and thorax together; propodeum, except base and extreme sides, rugose; the band on first abdominal segment broadly interrupted .... *fulvipes* Cresson
30. Not with the above assemblage of characters 31

31. Propodeum with a deep sulcus medially; legs, except the coxæ, sometimes reddish 32

31. Propodeum without a deep sulcus medially; femur, except apex, nearly always black 33

32. Front with a rather strong pit in the middle; vertex and propotum impunctate; abdomen glabrous, the first segment with a large spot each side .... *albopicta* Cresson

32. Front with a medial impressed line; vertex and pronotum with sparse strong punctures; first abdominal segment with an irregular mark each side .... *mexicana* Cresson

33. Propodeum granular and posterior face transversely aciculato-granular; third cubital cell twice as long on the cubital vein as the second cubital cell, and but little shorter on the marginal vein than the second; yellow markings not so profuse as in the following.
minima Provancher

33. Propodeum hardly granular and the posterior face with only a faint indication of transverse acicular markings; third cubital cell one and one half times as long as the second cubital cell on the cubital vein and only two thirds as long on the marginal vein as the second; more yellow on the abdomen than the preceding species 34

34. First abdominal segment with the yellow margin interrupted in middle and the second with the yellow spical margin of about even width over the whole length .... *fraterna* Smith

34. First abdominal segment with its yellow margin deeply emarginate above in the middle but not interrupted, the yellow apical band on second segment also deeply emarginate in the middle.
fraterna occidentalis Cockerell

35. Maculations on third and seventh tergites only 36

35. Maculations on other tergites as well as third and seventh 37

36. Two large marks on the third tergite, the apical segment, a line on pronotum behind, and the clypeus, white; head shining and closely punctured; longest spur of hind tibiæ reaches to the fourth tarsal joint from the end of leg; a cloud over the basal veins; marginal cell extending much beyond the third cubital cell ...... *quiriquensis* Cameron

36. A continuous whole band on second tergite, and clypeus white only on the sides; longer spur of hind tibiæ only one half the length of posterior metatarsal joint; no cloud over the basal veins; marginal cell does not extend beyond the end of third cubital cell.
apicipennis Cameron

37. Front with rather a strong pit in the middle; face, clypeus and thorax densely clothed with a silvery pile; head and thorax subopaque.
cubensis Cresson

37. Front with a medial impressed line 38

38. Face and clypeus black, front with distinct, separated punctates; abdominal segments with a lateral pale yellow spot .... *femoralis* Cresson

38. Face and clypeus yellow 39

39. Cross banks of abdominal segments narrowly interrupted in the middle, legs yellow, hind tarsi with each joint narrowly black at base; length about 7 mm. .... *longipes* Smith
39. Crossbands widely separated in the middle, hind tarsi dusky; length about 5 mm. 40
40. Femur rufous .... *foxi* Rohwer
40. Femur black .... *hatoda* Brimley

References

Cameron, Peter. Biol. Centr. Amer., 34, II, 1888–1890, pp. 158–161.
Fox, W. J. Trans. Amer. Ent. Soc., XIX, 1892, pp. 49–63.

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Owing to increased printing costs it is necessary to advance the subscription price of the Journal to non-members from $4.00 to $5.00 beginning with the year 1949. At the same time the price of back numbers will be increased to $1.50 per issue. The Society was faced with the choice of either reducing the number of pages per issue below 60 or continuing at its present level and increasing the subscription price. The latter course was decided upon. Whenever financial conditions permit, the number of pages per issue will be increased automatically.

OBSERVATIONS ON THE MATING BEHAVIOR OF HARVESTER ANTS

By Charles D. Michener
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A variety of observations have been published on the nuptual flights of harvester ants of the genus *Pogonomyrmex.* Winged males and females have been observed leaving the nests, and the establishment of new nests by the deälated and mated females has been recorded. However, observations on the mating behavior, which intervenes between leaving of the parental nests and establishment of new ones, have not been published to my knowledge. Some individuals mate at the parental nest entrance, for Wheeler (1910, ''Ants,'' p. 288) in describing the flight from the nest of *Pogonomyrmex barbatus molefaciens* Buckley, says, ''The amorous males seized many of the females before they could leave the ground.'' The great majority flew before mating, however, and the observations recorded below concerning *Pogonomyrmex barbatus* (Smith) (determined by M. R. Smith) indicate that after the winged individuals fly from their parental nests many of them assemble at the summit of some distant high object (a hill or a tree) and mate there. After mating the females fly again, presumably dispersing and, with good fortune, establishing new nests.

The first and most complete observations were made on a hot sunny afternoon (beginning at 3:00 p.m.) June 23, 1947, near El Paso, Texas. Winged individuals of both sexes were found congregating in an area about fifteen feet square on the top of a high and very steep hill.[2] Although this area was on the summit

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[1] The observations here recorded were made on the David Rockefeller Expedition to northern Mexico in 1947 from the American Museum of Natural History.

[2] On this hill the mating flights of another ant, *Solenopsis* (*Diplorhoptrum*) sp?, a small dark colored species, were observed.
The males swarm in small, rather compact masses, 6–18 inches above the ground, flying about very actively and looking exactly like a swarm of small chironomids. Like chironomid swarms, those of this ant are dispersed some-

of the hill, it included by no means the entire summit. It is evident, therefore, that some factor other than mere altitude must delimit the congregating area. There were thousands of winged ants in this area, buzzing sufficiently to be distinctly noticeable from the sound. Additional individuals approached constantly, flying upwind toward the congregating area as though they were attracted by odor. They flew up the hillside from two to twenty feet above the ground. It was not discovered from what nests these individuals came, but it was evidently from some distance as no nests were found on the hill or in the immediate vicinity. The great number of individuals suggested that they may have come from many nests.

Within the congregating area, individuals tended to alight on the highest points. Almost the only vegetation in the area was a few small *Agave* plants, and their leaves were nearly covered. Many also were in areas shaded by the *Agave* leaves. Great numbers alighted on a person standing in the congregating area.

On alighting the ants, more especially the males, moved about actively as though excited. Individuals were so numerous that within a few seconds after alighting a female was usually found by a male. Recognition seemed to be dependent on contact. Males passing very close to females did not show indications of recognition, but if they touched, recognition was immediate and the male climbed onto the back of the female. When two males met only rarely did one try to climb onto the other, and after a moment they would separate and run about again. The finding of a female by a male seemed dependent on the extremely active running about of the latter.

The mating behavior is very sterotyped. When a male finds a female he quickly mounts her, grasping her body with his legs, his forelegs usually being around her thorax, his mid and hind legs around her abdomen. Her wings are flat over her back, under his body. He also grasps the anterior end of her thorax

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what by a breeze but reform in about the original position when the breeze fails.

The females fly less rapidly than the males and are seen in very much smaller numbers. They fly more or less erratically, not in swarms. Presumably, as with chironomids, the females are pounced upon when they pass through swarms of males. Mating was not observed, however.

with his mandibles. At the same time, he curls the apex of his abdomen downward and the genitalia meet and quickly unite. At this time the bodies of both are approximately straight. Her mandibles are held wide open. This position is maintained for from 10 to 60 seconds (average of 25 matings about 28 seconds).

After this the male, retaining the genitalic union, slides backward, curling his body, often nipping at the female's thorax, petiole, and gaster on the way, but quickly taking up a curled position so that his mandibles can reach the joined genitalia, which he seems to chew. At about the same time the female also turns or curls so that she can reach his body with her mandibles. She may bite his petiole momentarily, but quickly finds his gaster, which she pinches so strongly that it is much compressed. This is done repeatedly, and continues, with the biting of the genitalic region by the male, for as long as this position is maintained, *i.e.*, one to ten minutes (average of 25, 3.1 minutes).

Then the pair separates, the male scurrying about as before and the female walking more slowly, also as before. Often she will work her sting in and out a few times. She may fly away after a short time, flying more or less directly upward. More often, however, she is quickly found by another male. Sometimes a second or even third mating occurs in quick succession without her repulsing the males. More often she will resist for a few seconds by projecting her sting directly upward from the apex of the abdomen each time the male attempts to copulate. This may happen half a dozen times, the male riding on her back, but in every case observed second copulation was finally permitted by the female. It differed in no detail from first copulations. Double or possibly even multiple copulation seemed to be frequent.

Often one or more males will find and cling to copulating pairs, and such individuals often are the ones to mate with the female as soon as the first copulation is completed.

As would be expected from the constant departure of mated females, a very great excess of males develops in the congregating area, all of them, apparently, actively searching for females, even though many of them have already mated one or more times.

Individuals of both sexes were found which were wholly red and which had the head and thorax black. Mating occurred indiscriminately between these two color forms.

Another series of observations by Dr. Herman T. Spieth was made in an area containing numerous nests of the same species at Carta Blanca, sixteen miles west of Matachic, Chihuahua, Mexico, on July 8, 1947.

Winged forms were emerging from the nests.

In the two tallest trees in the area winged forms were assembling, approaching the trees from various directions. Among the upper branches of the trees they were buzzing about in immense numbers. Details of their activity there could not be observed because of the height. Each gust of breeze, however, dislodged a number of small balls of ants, each consisting of a pair in copulation and several males. No doubt the females most overburdened by males were the ones to fall. These females, so far as observed refused to copulate with other males and flew away after a time. As on the hilltop a great preponderance of males was left, partly as a result of the departure of females.

On July 26, 1947, at Catarinas, Chihuahua, Mexico, Dr. Spieth found great numbers of dead males of *Pogonomyrmex barbatus* on a hill top which had evidently been used as a congregating area, and some dead males were found by the author in a similar situation near Encino, Durango, Mexico, on July 27, 1947.

It has been suggested by some workers that the frequency of brother-sister matings resulting from colonial life might be one of the reasons for the great number of closely related but recognizably distinct populations among ants. The observations here recorded suggest, however, that in *Pogonomyrmex barbatus* individuals from numerous colonies assemble and mate in certain areas. This, together with multiple mating of both sexes, insures considerable panmixia. Multiple mating is of regular occurrence in some other ants as well, for example *Prenolepis imparis* Say (see Talbot, 1945, Amer. Midland Nat., 34: 506).

NEW JERSEY RHOPALOCERA—STRYMON CECROPS FABR.

On September 7, 1948 while collecting with Dr. George W. Rawson of Summit, New Jersey near Reed's Beach, on the northwestern part of the Cape May Peninsula, two specimens of *Strymon cecrops* were captured, both badly worn and torn. A third specimen was observed, all almost exactly at the same spot in a small swamp of about an acre in area.

Believing these specimens were not strays but the result of a breeding colony I visited the same locality this year on August 26, 1948 together with L. J. Sanford of New York. The swamp was under 18 inches of water where I had stood the year before. The weather was clear and the temperature over 100° F., in the shade.

On about 35 to 40 occasions *cecrops* was observed in flight on the adjacent higher ground. They were extremely wary. None were seen to feed on the, abundant and variety of, flowers available within and out of the swamp. They were first observed, apparently having been startled from a resting place in the foliage, at a height of about 8 to 12 feet above the ground and at a distance of from 10 to 25 feet from the observer. Their jerky flight was extremely difficult to follow but on many occasions they appeared to alight on a leaf of the tall sumacs, just behind the large flowering heads, and almost invariably with other foliage directly above them. Because of the density of the undergrowth, movement of the collector was slow and because of the location of the insects a free swing of the net was seldom possible. Four specimens were, however, captured after several hours of concentrated effort.

There were so many occasions when no insect could be located where it had apparently come to rest that some peculiar behavior was indicated. This was finally observed. A startled insect coming to rest in a position about eight feet high as described above, remained in view as a cautious approach was being negotiated from about 25 feet distant. It was walking slowly along a sumac leaf and when the collector was about 10 feet distant it suddenly dropped vertically and swiftly to the ground. Fortunately it landed among dead leaves in a small but relatively open patch near the base of the sumac on a spot in view through the undergrowth.

With wings held tightly together it walked very slowly among the leaves while a net was placed carefully over it, an operation requiring considerable disturbance of the underbrush and a half minute of time. It remained motionless under the net until disturbed whereupon it flew upward and was captured. In all, five specimens were taken, mostly fresh but some torn.

How many of the observations in flight involved the same individuals is very hard to estimate. All were confined to an area of less than two acres, though careful search was made beyond. In any event the evidence involving two years would seem to indicate a breeding colony.

In W. P. Comstock's "Butterflies of New Jersey," JOURNAL OF THE NEW YORK ENTOMOLOGICAL SOCIETY, Vol. XLVIII, March 1940, the species is recorded in the "supplemental list," consisting of those which could not be regarded as regular inhabitants. Further observations in the locality may indicate its promotion to regular status in the New Jersey list.—SIDNEY A. HESSEL.

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of October 7, 1947

A regular meeting of the New York Entomological Society was held October 7, 1947 in the American Museum of Natural History. President, Doctor Hagan was in the chair. Fourteen members and four visitors were present.

Miss Joan Pagano of the staff of the American Museum of Natural History was proposed for membership.

Dr. Hagan reported on the picnic of the Society, held June 7, 1947, at the home of Mr. Chris Olsen at West Nyack, N. Y. A rainstorm washed out all plans for collecting, and the site of the picnic was relocated in the Olsen kitchen. Dr. Hagan thanked the Olsens for the fine hospitality extended to the eight members who attended.

The meeting was then opened to general discussions of summer experiences of the group.

Mr. Pallister mentioned a few of his interesting experiences while collecting in Peru. His talk at the October 21 meeting will cover this trip.

Dr. Schneirla spoke of a suspected activity, equivalent of flight, in certain ants. He also spoke of observations on a small ant of the genus Prenolepis, the queen of which is very large. He spoke of the issuance of large numbers of males from some 25 separate but nearby colonies. Only a couple of females issued, and these merely wandered about, while the males congregated in large numbers, flying a distance of only four or five feet, then descending. Dr. Schneirla observed multiple matings and simultaneous multiple matings.

Mr. Teale reported on a mosquito catching cat, which he had observed, and of observations on landing and take-off of dragon-flies at an angle away from the direct beams of the sun. He also reported observing bats attracted to the green light of a neon sign, while ignoring that portion of the same sign, emitting a red glow.

Mr. G. W. Rawson reported he had observed a scarcity of lepidopterous forms over a large part of the eastern states this summer.

Mr. Gual reported an exceptional abundance of Vespinæ, and Dr. Schneirla reported an abundance of ants, throughout the summer months.

Mr. Roman Vishniac reported an abundance of mosquitoes in the cities of Germany, which he visited this summer. They were especially troublesome in Berlin.

F. A. Soraci, *Secretary*

Meeting of October 21, 1947

A regular meeting of the New York Entomological Society was held October 21, 1947, in the American Museum of Natural History. President

Dr. Hagan was in the chair. Twenty-seven members and thirty-one visitors were present.

Joan Pagano was elected a member of the Society.

The speaker of the evening, Mr. John C. Pallister, presented an interesting talk on ''A Naturalist woes to Peru.'' Mr. Pallister told of his experiences while on a nine month's insect collecting trip to Peru and the headwaters of the Amazon. The purpose of the trip was to collect in as many as possible of the river valleys of the eastern slope of the Andes.

Mr. Pallister established two base headquarters. The first was at Tingo Maria, in east central Peru, from which he worked the valleys of the Rio Huallaga, Monzon, and Ucayali.

The second base headquarters was at Cuzco, in southeastern Peru, from which he penetrated into the valleys of the Rio Urabamba, Paucartamba, and the Amazonian jungle of the Rio Madre de Dios.

The lecture was illustrated with Kodachrome slides and colored movies.

LINA SORDILLO, *Asssitant Secretary*

Meeting of November 18, 1947

A regular meeting of the New York Entomological Society was held November 18, 1947, in the American Museum of Natural History. President Dr. Hagan was in the chair. Nine members and eight visitors were present.

In the absence of the Secretary and Assistant Secretary, Dr. Hagan appointed Mr. John C. Pallister, Acting Secretary.

Mrs. John Hastings, American Museum of Natural History was proposed for membership.

The minutes of a trustee's meeting held November 7, 1947, were read to the Society. The President then appointed a committee of Mr. Teale, Mr. Comstock and Dr. King to take under consideration the action of the Trustees.

The speaker of the evening Dr. Daniel Ludwig, presented an interesting talk—''The Effect of DDT on the Metabolism of the Japanese Beetle.''

Dr. Ludwig spoke briefly of the history of DDT from its development in Germany in 1934 to the introduction of the first sample into this country in 1942. He explained that DDT was not a perfect insecticide, but had to be used with caution, because of its effect not only upon other beneficial insects, especially honeybees, but upon animals, birds, fish, and even plants.

Dr. Ludwig found that the eggs and pupa of the Japanese beetle were not effected by DDT except when in the last stages of their development or by unusual contact with the DDT.

The larvæ were poisoned by allowing them to crawl on filter paper wet with 1 percent, 5 percent, and 10 percent solutions of DDT in peanut oil. In all cases there were no recoveries although some survived as long as two weeks. The larvæ shortly after contact with the DDT developed tremors and loss of weight. The greatest loss of weight was in the glycogen contents of the body, the least in the protein.

The adults were very sensitive to DDT.

JOHN C. PALLISTER, *Acting Secretary*

Meeting of December 2, 1947

A regular meeting of the New York Entomological Society was held December 2, 1947, in the American Museum of Natural History. President Doctor Hagan called the meeting to order at 8: 00 P. M. Sixteen members were present.

Mrs. John Hastings was elected to membership.

Mr. Comstock reported for the committee appointed at the November 18, 1947 meeting to consider the action of the trustees at their November 7, 1947 meeting. He reported that the signatures of at least 75 per cent of the membership would be required in order that the society might withdraw funds from its account with the City Bank Farmers Trust Company. These funds would be placed in a savings account. The need for this transfer was explained by Mr. Comstock. Mr. Pallister moved that the necessary resolution be drawn and that the secretary circulate it among the membership. The motion was seconded and approved.

The secretary was instructed to forward congratulations and best wishes for a long and useful life to the Brooklyn Entomological Society on the occasion of their 75th anniversary.

Doctor Herman Spieth then presented his talk on the Museum expedition to North Central Mexico during the summer of 1947. Doctors Cazier, Gertsch, Michener, Spieth and Mr. Schrammell participated in this expedition, the purpose of which was to collect insect, spider, and reptilian specimens. Many beetles, butterflies and spiders were taken, along with a few Drosophila on the trip which carried them from El Paso to Chihuahua, and south to Durango then east and north to Saltillo and Eagle Pass. Their transportation consisted of two jeeps and trailers and one carryall. Many interesting experiences were related and a good sample of the collection was shown.

F. A. SORACI, *Secretary*

Meeting of December 16, 1947

A regular meeting of the New York Entomological Society was held December 16, 1947 at the American Museum of Natural History. President Doctor Hagan called the meeting to order at 8: 00 P. M. Sixteen members and six visitors were present. An invitation to the membership to attend the International Congress of Entomology in Sweden during August 1948 was read. The secretary was instructed to write Mr. Dos Passos asking him to represent this society if he attends the congress.

The following committees were appointed for the annual meeting:

Nominating Committee: Mr. Huntington, Doctor Ruckes, Mr. Pallister.

Auditing Committee: Doctor Spieth, Mr. Becker, Doctor Gertsch.

The speaker of the evening, Dr. E. Gorton Linsley, of the Department of Entomology of the University of California was introduced and he presented a talk on the "Biology of Some Meloid Beetles." His talk was concerned primarily with hypermetamorphosis. He described the development of a meloid from the egg to the first stage larva, called "primary larva", also triungulin (because of the 3 lobed tarsæ consisting of 1 claw with a seta on each side). Upon molting it becomes a ''caraboid'' larva, then molting to the ''first scaraboid'' stage and then molting to ''second scaraboid'' stage. These first four stages are feeding stages. The next molt brings forth a ''co-arctate larva.'' This stage is well protected and extremely resistant. It is immotile and can remain inactive. The next molt produces a motile non feeding stage. This is the final larval stage; the insect now pupates and the adult emerges. Doctor Linsley described this development as apparent degeneration from the primary larva to the non motile stage, then a reversal of the process to maturity.

Similar development was described in the Strepsiptera and in the Syrphidæ and Bombyliidæ of the Diptera. Hypermetamorphosis is also present in the neuropteron, Mantispa. For the primary larvæ of the Meloidæ he reported two main types of food (1) parasites on eggs of grasshoppers (2) parasites in nests of bees and wasps. The habits of the primary larvæ in reaching their hosts are used in distinguishing the subfamilies Meloinæ and Nemognathinæ within the Meloidæ.

Frank A. Soraci, *Secretary*

A NEW RACE OF PSEUDOHAZIS HERA FROM SOUTHERN COLORADO

By J. McDunnough

On a recent visit to New York, the Reverend Bernard Rotger of Capulin, Colorado brought with him for identification a very interesting specimen of a *Pseudohazis* which evidently belonged in the *hera* group but was easily distinguished by its considerably larger size, the dead white ground of the wings and the much heavier black suffusion, especially on the secondaries where the pale areas were limited to the cell around the discal spot and to a series of subterminal rays. On his assurance that he possessed a series of similar specimens, he was advised that a racial name was indicated, and it was suggested that he draw up a description. He has now complied with this request and the description, which should be credited to Rotger as the author, is appended to the present article. Besides the type series it should be noted that there is a similar male specimen in the American Museum collection without data, and another male from the collection of the California Academy of Sciences has been examined which was collected at Taos, New Mexico, August, 1934; both these specimens should be included in the type series. The new race will be illustrated in color in a forthcoming monograph of the Saturniidæ of North and South America which is in course of preparation by various members of the American Museum staff. As it will be some time before this work will be ready for publication, it is thought advisable to secure validity for the new racial name at the present time. The description by Father Rotger follows:

"*Pseudohazis hera* ssps. *magnifica* Rotger

Larger and blacker than *hera*, ground color cream. Fore wings: the triangular markings of limbal area reaching the band; black discal spot united to costal margin. Hind wings: triangular markings of same area, penetrating into the band; the large discal dash with both ends connecting to the band and leaving a more or less triangular white center; base and inner margin till the inner veins, black. Transverse reddish-fulvous bands of abdomen narrow, black bands very wide. Expanse: 80 to 95 mm.

Caught about three miles east of Mesita, Costilla Co., Colorado in the sagebrush country, on August 13, 1943 by the author.

Holotype male, and allotype female in my collection. Eleven topoparatypes, one of which is deposited at the American Museum of Natural History.''

INSECTS AND SLANG AGAIN

Since the publication of the note on insects and slang in the September, 1948 issue of this Journal Dr. Edwin P. Meiners has supplied the starred expressions in the following list.

Beehive, a busy place.

*Bees in your bonnet, eccentric ideas.

*Bug (colloquial and entomological), any insect.

*Bug (medical), any bacterium or micro-organism.

*Bug, a ''nut'', one not in possession of his full senses; one who is an expert in a particular field.

*Bug-eater, a worthless fellow. (See ''Field and Forest'' iii; 132. ''A Colorado Yellow Jacket''.)

Bughouse, an insane asylum.

*Butterfly, a woman intent only upon having a good time.

*Butterflies in stomach, nausea.

Feeler, a proposal.

Flea, a flea in the ear, a rebuff or an irritating hint.

Fleabite, a trifling pain.

Flyspeck, any small dot.

Grub, food.

*Hornet's nest, to stir up a, to cause trouble.

*Louse, a contemptible fellow.

*Lousy, anything contemptible.

—H. B. W.

THE GENUS TRACHYS IN THE UNITED STATES

BY E. GORTON LINSLEY
UNIVERSITY OF CALIFORNIA, BERKELEY

The genus *Trachys,* as currently defined, has not been reported previously in our fauna. However, between June 6 and June 18, 1948, the writer collected a series of *Trachys pygmaea* (Fab.) on hollyhock leaves in Rutherford, New Jersey. This species, indigenous to Europe, Asia Minor, and North Africa (Obenberger, 1937) has apparently been introduced and the indications are that it has become well-established.

The key to related North American genera provided by Nicolay and Weiss (1920: 137) may be modified for the inclusion of *Trachys* as follows:

1. Antennæ, in repose, received in a deep sinus in the prosternum; scutellum always evident 2
   Antennæ free, at most held in a feeble impression in the prosternum; scutellum minute, scarcely visible .... *Trachys*
2. Scutellum small; tibiæ linear 3
   Scutellum large, triangular; tibiæ dilated .... *Pachyschelus*
3. Body ovate; prosternum obtuse behind .... *Brachys*
   Body elongate; prosternum pointed behind .... *Taphrocerus*

In form, *Trachys* resembles *Brachys* but the free antennae and minute scutellum will readily distinguish it. *T. pygmaea* may be easily recognized by the bright green or blue-green elytra and brilliant cupreous head and pronotum. The ventral surface is black with a cupreous lustre.

References

NICOLAY, A. S., AND H. B. WEISS. 1920. The group Traches in North America. Part I. The genera Pachyschelus and Taphrocerus. Jour. N. Y. Ent. Soc., 28: 136–150, pl. 6.

OBENBERGER, J. 1937. In: Junk, Coleopterorum Catalogus, pars 157: 1372–1376.

OLD ENTOMOLOGICAL SIGNBOARDS

Among the hundreds of signboards mentioned in ''The History of Signboards,'' by Jacob Larwood and John Camden Hotten, London c.1866, only a very few were adorned by what might be called entomological devices and these certainly did not indicate the business of the shop for the benefit of customers who could not read. Grasshoppers on London signboards of the seventeenth century were good luck emblems. The shop of Sir Thomas Gresham carried the portrait of a grasshopper and Charles Duncombe and Richard Kent, goldsmiths lived at the Grasshopper on Lombard Street in 1677.

Many shopkeepers of London used the illustration of a beehive, beneath which the following lines indicated the industry of the owners.

''Within this hive, we're all alive,
Good liquor makes us funny:
''If you are dry, step in and try
The flavour of our honey.''

Larwood and Hotten mention an actual hive full of active bees which topped a signpost, at Grantham in Lincolnshire, many years ago. Fifty years ago and less, I recall seeing the beehive on signboards of small shops in Philadelphia and in surrounding towns. In fact some were called The Beehive and used this device in their advertising.

One last example is that a tea-dealer of Oxford Street, Tottenham Court Road, at the end of the eighteenth century, who had the leaf insect of India for his sign.—H. B. W.

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME LVI

Generic names begin with capital letters. New genera, subgenera, species, varieties and new names are printed in italics.

The
New York Entomological Society

Organized June 29, 1892—Incorporated February 25, 1893

Reincorporated February 17, 1943

The meetings of the Society are held on the first and third Tuesday of each month (except June, July, August and September) at 8 P. M., in the American Museum of Natural History, 79th St., & Central Park W., New York 24, N. Y.

Annual dues for Active Members, $3.00; including subscription to the Journal, $5.00.

Members of the Society will please remit their annual dues, payable in January, to the treasurer.

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JOURNAL
of the
NEW YORK ENTOMOLOGICAL SOCIETY

Published quarterly by the Society at N. Queen St., and McGovern Ave., Lancaster, Pa. All communications relating to manuscript for the Journal should be sent to the Editor, Harry B. Weiss, 19 N. 7th Ave., Highland Park, New Jersey; all subscriptions to the Treasurer, Dr. James C. King, American Museum of Natural History, New York 24, N. Y. Orders for back issues should be sent to the Treasurer, Dr. James C. King, American Museum of Natural History, New York 24, N. Y. The society has a complete file of back issues in stock. The Society will not be responsible for lost Journals if not notified immediately of change of address. We do not exchange publications.

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JOURNAL

OF THE

NEW YORK

ENTOMOLOGICAL SOCIETY

Devoted to Entomology in General

VOLUME LVII, 1949

PUBLISHED QUARTERLY BY THE SOCIETY
NORTH QUEEN ST. AND McGOVERN AVE. LANCASTER, PA.
NEW YORK, N. Y.

BUSINESS PRESS, INC.
LANCASTER, PA.

CONTENTS OF VOLUME LVII

Vol. LVII No. 1

MARCH, 1949

Journal
of the
New York Entomological Society

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Edited by HARRY B. WEISS

Publication Committee

HARRY B. WEISS JOHN D. SHERMAN, Jr.
E. W. TEALE

Subscription $5.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1949

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NOTICE: Volume LVI, Number 4, of the Journal of the New York Entomological Society was published on January 26, 1949.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

Vol. LVII March, 1949 No. 1

INSECT COLLECTING IN GUATEMALA 65 YEARS AFTER CHAMPION

By Charles and Patricia Vaurie

A great deal of the material upon which the insect sections of the Biologia Centrali-Americana are based came from Guatemala. Some of this material was collected by Salvin and Godman themselves or later sent to them by native collectors, but most of it was collected by the expert collector, G. C. Champion.

Champion spent four years in Central America and two of these years, from March 16, 1879, to April 7, 1881, were devoted exclusively to Guatemala. Since Champion's day no other extensive systematic collecting was undertaken in Guatemala until the summer of 1947, when the present authors were sent there by Mr. Frank Johnson under the sponsorship of the Department of Insects and Spiders of the American Museum of Natural History.

The purpose of the trip was to collect in and revisit, in so far as time and present day conditions permitted, the same localities or areas visited by Champion.

Changed conditions made exact duplication of localities impossible. In the first place, duplication was not always desirable because some of the places visited by Champion had been so drastically altered that they were no longer suitable collecting grounds and some names had disappeared altogether. Secondly, it was not always possible since the modes of traveling differed. All Champion's travels were on horseback or on foot and thus he could, and did, strike camp at any favorable spot. In the three months at our disposal we could not follow such a method, but, although the modern means of communication we employed did not allow the greater leisure and elasticity of Champion's method, they enabled us to cover an even larger amount of territory. We were able to visit, in addition to the same areas and most of the main localities in which Champion collected, two additional areas, one in the wet Cuchumatanes Mountains, and the other in the dry south east.

Champion's itinerary appeared first in the Entomological News of February, 1907, and later, with additional notes, in the introductory volume (1915, pp. 46–54) of the Biologia. Because of the great changes that have taken place in the land cover since those notes were written, a brief account of all the localities visited by us is given below, with comparisons between past and present conditions at localities common to both of our itineraries.

In order to present a comprehensive picture and to avoid repetition, the specific account is preceded by the following general notes on the physiography, climate, and vegetation of the regions visited.

PHYSIOGRAPHY

Guatemala has for its size (50,000 square miles, or about the area of the state of New York) what is perhaps the most complicated physiography to be found anywhere in the world, and as a result it presents a number of strongly contrasting climatic conditions.

Geologically, the country can be divided into six main regions: 1. the Pacific littoral, 2. the volcanic coastal mountains, 3. the Highlands, 4. the limestone mountains of the interior, 5. the desert or semi arid interior valleys, 6. the Caribbean lowlands and the high plain of the Petén. Some of these regions can be further subdivided: the volcanic mountains into the outer chain of the recent volcanoes, and the inner and older range which forms the Continental Divide; the limestone mountains into the great mass of the Cuchumatanes proper, and the smaller and lower mountains of the Alta Vera Paz. Generalized descriptions of these regions have been given by Popenoe (1926) and Griscom (1932) and a detailed, excellently treated and illustrated cross section of south west Guatemala, from the shores of the Pacific to the foot of the Cuchumatanes, has been given by McBryde (1947). The most important features of these regions may be summarized as follows:

On the Pacific, a plain, varying in width from 30 to 50 miles, extends, flat at first, then gradually sloping inland, to the foot of a nearly straight range of majestic volcanoes. These volcanoes are exceedingly steep and rise with the most striking abruptness from the plain below; the trend of this range runs north west-south east. Inland from this range, and separated from it by a great trough, runs a parallel range of older volcanic mountains which form the Continental Divide. At the northern end the two ranges come together at the great cone of Tajumulco; south of Guatemala City they get gradually lower and more barren as they approach the border of El Salvador. The trough between the two ranges is irregular and is cut by great cross ridges which separate basins which may contain nearly flat plains or lakes, such as Atitlán and Amatitlán.

Inland from the Continental Divide, the plateau of the Highlands (or *Altos*) stretches to the Cuchumatanes. Though spoken of as a "plateau," this region is only a plateau of the most irregular sort. Everywhere the land is dissected by immensely deep and abrupt gorges (the *barrancas*), slopes and ridges abound, and the whole area is extremely broken up.

To the north this region dips into the drainage troughs of the Cuilco and Negro Rivers on the other side of which rises abruptly the enormous mass of the Cuchumatanes. These mountains, unlike the coastal ranges, have a west to east trend, the easterly trend becoming more marked as the mountains continue eastward into the Vera Paz. The Cuchumatanes have a maximum altitude of about 11,000 feet and the mountains in the Alta Vera Paz of about 6,000. Another range of importance is a long range rising a little to the south of the Cuchumatanes. This range, which also runs from west to east, changes its name several times as it proceeds eastwards. On the middle course of the Motagua River, above Zacapa, parts of the range, here called Sierra de las Minas, rise above 7,500 feet.

The west to east course of all these interior mountains determines the trend of the interior valleys, the major ones of which are those of the Río Negro, Salamá and Rabinal, and that of the Motagua River.

To the south of the Motagua, beyond Zacapa, is a region of more or less arid hills and valleys which stretches to the frontiers of Honduras and El Salvador. On the northern side of the Sierra de las Minas are the valleys of the Baja Vera Paz, and on the northern side of the Alta Vera Paz mountains is the high plain of the Petén. These last are drained on the east by the Cahabón and on the south by the Polochic, both of which empty into a vast swamp and from there into Lake Izabal and the Caribbean.

CLIMATE AND VEGETATION

Two seasons prevail over most of Guatemala, a dry and a wet season, the dry lasting generally from early November through April. In addition there is also a more or less marked secondary dry season of variable duration. This secondary dry season, called the "*Veranillo de San Juan*" or "*canícula,*" occurs in mid summer in about half of the country and, where well marked, has an effect on the vegetation. The temperature varies according to the altitude, but at any given level seasonal ranges are slight, and although during the North American winter the average monthly temperature drops somewhat in parts of Guatemala, the drop, except at the highest elevations where frost occasionally occurs, has little effect on the flora and fauna. Climate and seasonal changes, then, are very largely a matter of rainfall and as the distribution of rain in Guatemala is essentially determined by relief and exposure, the climate is very diversified and the changes are apt to be as abrupt as the physiography. (For detailed discussions of climate and weather in Guatemala, see Sapper, 1932, and McBryde, 1942a and 1942b.)

On the Pacific plain and slope, the wet and dry seasons are well marked. The wet season extends from April into November, the rainiest months being June and September, with a drop in between during July and August, the "*Veranillo de San Juan*" mentioned above. The precipitation increases with the altitude, ranging, according to McBryde (1942a), from about 150 centimeters along the shore, to 200 at 300 feet, 300 at 600 feet, until a zone of heavy precipitation is reached at about 2500 feet. In this zone, which extends up to about 4,600 feet, the annual average is about 400 centimeters, going up to 550, or 220 inches, in some localities. The graph of Mocá (3,000 feet) with an annual average of 437 centimeters, or 172 inches, is typical of this zone. (See figure 1). Above this heavy rain belt there is, depending

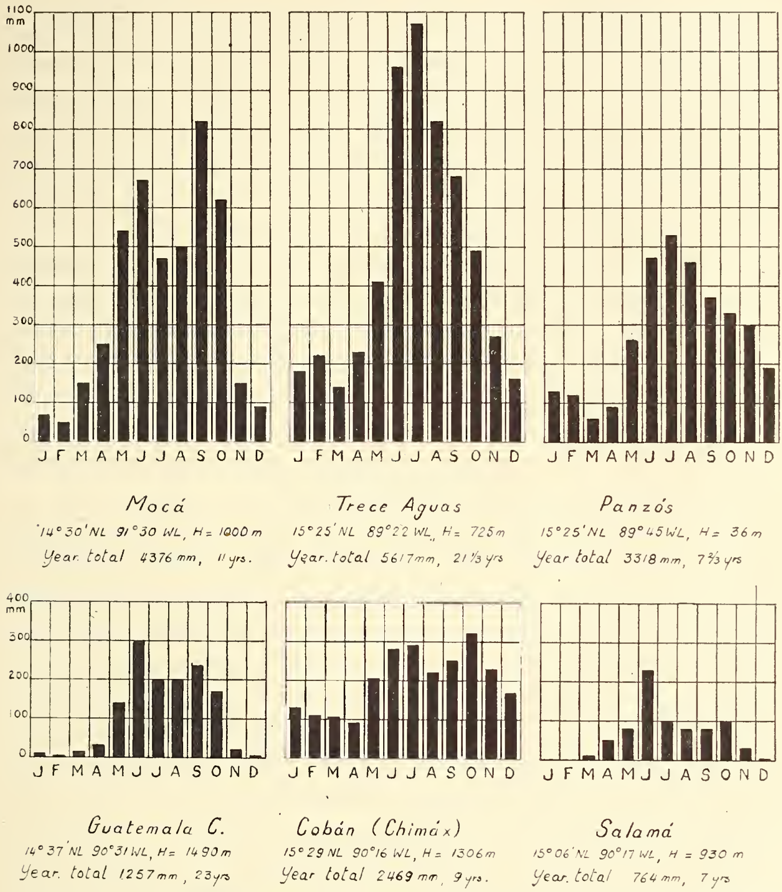

Figure 1. Selected graphs of rainfall in Guatemala; from Sapper (1932) except for Mocá, which is from original data.

on the local mountain condition, a sharp decrease or no further increase in precipitation. Above and below the heavy rain belt, the double maximum (June and September) is not so pronounced. Only a little rain falls from November to March and during this season many of the smaller streams dry up.

The rainy belt of the west slope, which, in terms of the Köppen classification, has a "tropical monsoon" climate, was formerly clothed with a luxuriant rain forest. But today, except along the deeper stream courses, the forest has been cleared or drastically thinned. It has been largely replanted by smaller trees, mostly of the Leguminosæ family, to give shade to the coffee bushes which now everywhere occupy this zone.

On the much drier plain below, the climate is that of a tropical savanna. The vegetation is open and sparse except along the river courses, which are bordered by large trees and dense undergrowth. McBryde applies the term "gallery forest" to these wooded strips, but too often the "forest" has been reduced to but a screen. The plain is largely occupied by extensive cattle ranches, but there are also occasional areas, mostly along the railroad, which go in for diversified crops.

In the mountainous region above the Pacific, as well as throughout the Highlands, the wet and dry seasons are the same as on the Pacific, but the rainfall is much less. Near the Continental Divide, as McBryde states (1942a), the precipitation depends on highly variable factors, chief of which is the exposure to the winds. At Guatemala City, where the mountains are rather open, the annual precipitation (figure 1) averages 125 centimeters, but at Quezaltenango, which is sheltered by mountains both to the east and west, the yearly average is only 67 centimeters. Throughout the Highlands, particularly inland, the rainfall appears to be scanty, and the annual average varies, according to McBryde, from about 70 centimeters to 150. On the Pacific lowlands the temperature is always high, but on the highlands it varies from temperate to decidedly cool.

Except at the higher altitudes where grassy stretches and scattered forests of cypress occur, the whole of this region was probably once covered by an open pine and oak forest. But today, although a few remnants of this forest still persist in the poorer or most inaccessible places, it is fair to say that every acre that could possibly be cultivated has been deforested long ago, and, as Griscom remarks (1932), at least nine tenths of the region under 8,000 feet is now under cultivation or has been cleared.

When the great escarpment of the Cuchumatanes is climbed, one enters into a high and rolling region of a totally different aspect. No weather data was available but as the marine air moves in freely from both coasts the rainfall may be fairly constant throughout the year. Perhaps the precipitation is not regular or great, but the fact that these mountains are so much in the clouds makes this region always cool and very damp. Fog swirls through the branches of great and lofty trees loaded with epiphytes, and mists slowly drift above alpine meadows alive with many flowers. Settlements are few and the region is the least disturbed we saw in Guatemala. We penetrated only a little way beyond Nebaj, or as far as the road went, but we were told that the interior was still covered with many stretches of what must be a nearly primeval forest.

To the east of the Cuchumatanes proper, in the region of the Alta Vera Paz, the weather data is rather extensive and was collected and discussed by Sapper (1932). This area, of which Cobán is the center, is very wet and there are no really dry months. At Cobán (see figure 1) the yearly average (246 centimeters) is considerably less than in the monsoon belt of the Pacific Slope, but a fine rain falls almost daily throughout the year. With the exception of the drier southern part, facing the Baja Vera Paz, the whole of this region was once covered by the luxuriant forests which still existed in Champion's time. But today, due to the great spread of the coffee plantation, combined with lumbering and other destructive practices, the forests have largely disappeared. The eastern slopes of the mountains of the Alta Vera Paz face the Caribbean lowlands and receive some of the highest precipitation anywhere in Guatemala. There the wet season is very marked, but lacks the double maximum of the Pacific Slope region. The rainiest months are June, July, and August, with September not far behind. In this region, contrast the graphs (figure 1) of Trece Aguas and Panzós; both localities are very close to each other, but Panzós is nearly at sea level and Trece Aguas is 2,000 feet higher.

The interior valleys are the driest regions of Guatemala, the mountains or highlands which hem them to the north and south intercepting the moisture of the marine winds from both the Atlantic and Pacific. As most of these valleys are rather low they are also very hot. The lowest, driest, and hottest is along the middle course of the Motagua in the region of Zacapa. This area, which, according to Griscom (1932), receives less than six inches, or about 20 centimeters of rain a year, is a true desert with a vegetation similar to that of the deserts of southern Arizona. The valleys of Rabinal and Salamá, though arid enough, are less dry, the annual precipitation at Salamá (figure 1) averaging 76.5 centimeters a year. Parts of these valleys are cultivated, but there are large stretches of xerophytic thorny scrub. A typical plant is the tree cactus, segments of which are used for the construction of fences.

We have no data for the region to the south east of Zacapa, but in the region of Chiquimula, which is as far as we went, streams were dry and the hills barren of vegetation or sparsely covered with scrub. The climate is hot and during our stay in late July at the height of the "little dry season" or *Veranillo,* no rain fell and we were told that none had fallen during the three weeks prior to our arrival.

The lowlands of the Caribbean, except at Panzós, and the great plain of the Petén were not part of our trip. The vegetation in these places is that of the humid tropical zone and the climate has the usual division into a dry and wet season, with very abundant rainfall during the latter (523 centimeters a year at Livingston).

LOCALITIES VISITED

Localities printed in italics were visited by Champion between 1879 and 1881 though in some instances he was not in the actual place but nearby and all material in quotes is from Champion's notes (1915). The numbers in parentheses following each locality indicate the order of our itinerary and correspond with the locality on the map in figure 2. After the numbers follows the name of the department in which the locality occurs.

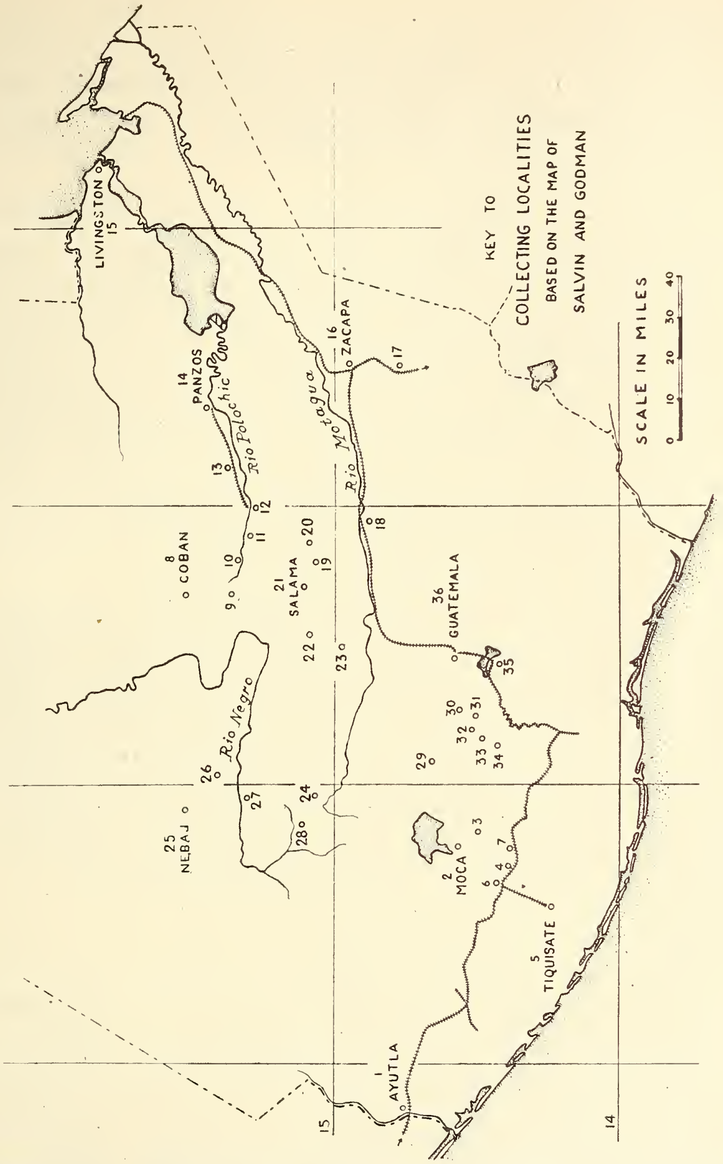

Figure 2. Key to the collecting localities of P. and C. Vaurie in Guatemala.

Pacific Plain.

Ayutla (1), San Marcos; about 100 feet altitude. Port of entry on the Guatemala-Mexico frontier in dense tropical vegetation along the Suchiate River. June 13.

Guatalón (4), Suchitepéquez; 587 feet. A small settlement on the railroad. June 24.

Tiquisate (5), Escuintla; 200 feet. Large United Fruit Company plantation of 100,000 acres. The land has been cleared for many miles, 28,000 acres are at present in bananas, the rest are being replanted in hard woods. There are many tracts of scrub covered with impenetrable tangles of vines. The settlement itself is park like, carefully manicured and heavily sprayed. As a result, collecting was poor except in wooded spots along the Siguacan River, where beating was fairly profitable. An attempt was made to get transportation down to the coast, but heavy rains had washed out the roads. June 26–29.

Río Bravo (6), Suchitepéquez; about 600 feet. Town on river by that name. Narrow gallery forest. June 28.

Variedades (7), Suchitepéquez; 400–900 feet. Hacienda, a combination of cattle ranch, citronella and cocoa plantation, about a mile from the railroad station of Variedades. The hacienda is owned by Norman Lind and was being redeveloped after a period of neglect. It proved to be our best all-round collecting ground in Guatemala, due, in part at least, to the many recently felled trees and uprooted fence posts. A series of the big blue Elateridæ of the genus *Chalcolepidus* was taken in flight. June 30–July 3, August 26–29, September 1–2.

Pacific Slope.

Mocá (2), Suchitepéquez; 3,000 feet. A well known coffee finca on the lower slopes of Atitlán volcano. This plantation is the property of Walter Lind and associates who offered us hospitality. Much of the land is cleared for coffee, but tall trees still exist along the road, as well as a narrow strip of rain forest behind a small lake. Collecting was excellent, though interrupted each afternoon by heavy rain. More Cerambycidæ (mostly subfamily Laminæ) were taken here than anywhere else but at Variedades. Night collecting was far more profitable in

June than on our return in late August. June 19–25, August 30–31.

Panamá (3), Suchitepéquez; 2,400 feet. A coffee finca below Mocá and somewhat drier than Mocá. Champion spent ten days close by at San Agustín (2,250 feet) in December. June 23.

Continental Divide and Volcanic Mountains.

Patzicía (29), Chimaltenango; about 5,000 feet. Roadside station below town of Patzicía, near the Continental Divide, in open country planted in corn and wheat. This house possessed the only electric lights for miles around and when our bus stopped at 11 a.m., many moths, including Saturnidæ, were found still clinging to the walls, both inside and out. The driver and all the passengers let their lunch grow cold to help us collect. Champion passed through here in January on his way from Lake Atitlán to Guatemala City. August 14.

Lake of Amatitlán (35), Guatemala; 4,000 feet. Near the town of that name. Weedy fields and moist ditches along the lake road proved good for collecting. In August the foliage was thick with spiders. Champion, who spent January 13 at Amatitlán, characterized it as an ''arid district'' which it is no longer. He also mentioned ''plantations of Opuntia for rearing the cochineal insect, all inclosed within dusty adobe walls.'' Neither the plantations nor the walls can be found today. July 6, August 24.

Guatemala City (36), Guatemala, 4,852 feet. No concentrated collecting was done here as the quick visits to the city were concerned with other problems. Champion collected ''on the banks of the streams in the barrancas (ravines)'' in March and April, but of course the city has grown tremendously since he was there and conditions today are hardly comparable. Various dates in June, July, August.

Antigua (30), Sacatepéquez; 5,047 feet. Old Guatemalan city and former capital, situated in the broad cultivated valley at the foot of Agua volcano. Most available land is in coffee, the seven miles of dirt road from Antigua to Dueñas being bordered by coffee plantations, enclosed by barbed wire fences or high adobe walls. Collecting was done in the ruins of ancient convents, in adjacent cornfields, in the entrances to coffee groves, and on a hill of pine woods to one side of the valley. There was a noticeable scarcity of Lepidoptera in all this area. Much time was wasted getting out of the interminable walled streets in search of collecting areas. Champion made no remarks about Antigua other than that he was there June 24 and 25. Our dates —August 15–17.

Ciudad Vieja (31), Sacatepéquez; 4,917 feet. Town three miles from Antigua. Collecting was poor. ''Coffee-plantations and cultivated ground, unsuitable for collecting-purposes.'' August 17.

Dueñas (32), Sacatepéquez; 4,680 feet. Town about eight miles from Antigua along the same road as that to Ciudad Vieja. Collecting was fair along a muddy stream, but here also the land is intensively cultivated. Champion spent most of July in this region, making various excursions up the slope of the volcano of Fuego. The Lake of Dueñas has dried up and the ''Opuntia plantations adjacent to the Lake'' are now represented by a few scattered plants along the highway. August 18.

Capetillo (33), Sacatepéquez; 4,800 feet. A coffee and sugar plantation in the valley between the lower slopes of the volcanoes of Acatenango and Agua, not far from Antigua. This was one of Champion's principal localities where he stayed for about a month in the end of April and in May, 1879. At that time it was owned by Juan J. Rodriguez, the Guatemalan naturalist, who, for about thirty years, supplied Salvin and Godman with specimens from his region. His son, Federico Rodriguez Benito, who was our host at Capetillo, told us that his father said before he died, in 1916, that if he had to build up his collection again he could never hope to duplicate it because of changing conditions due to the intensive cultivation of the land. It is still, however, a fine collecting spot. August 20–22.

Réunion (34), Sacatepéquez; 4,000 feet. Coffee plantation on southwestern slope of volcano of Fuego, facing the Pacific plain. Spring water seeping across the road attracted many Lepidoptera and general collecting was good for the short time we spent here. Champion found Zapote, somewhat lower on the slope, ''good for insects'' and he spent most of May and June in that locality. In his time there was ''some very fine forest passed through at

San Cayetano, between Zapote and Capetillo, along the descending coast-road.'' This forest is now reduced to a mere strip along the road, partly because of cultivation, partly because of a destructive eruption of the volcano of Fuego a few years ago. August 22.

Highland Plateau.

Chichicastenango (24), Quiché; 6,032 feet. Important Indian town in the typical cool highland of the Quiché. Cultivation here has been very intensive, maize fields alternating with small open stands of oak and pine, with grass on the rougher slopes. Some insects not seen before on the trip were taken here, though collecting on the whole was disappointing, due, perhaps, to the density of the population and long cultivation. The nights were exceedingly cool, with few insects. Champion was here (it was then called Santo Tomás) July 30 on his way from Joyabaz to Quiché. August 6–7.

Santa Cruz del Quiché (28), Quiché; 6,555 feet. Large active town in the highlands, 11 miles north of Chichicastenango. There is intensive cultivation here as in Chichicastenango but the countryside is more open. The one night we spent here was very cool, and few insects were taken. August 13.

Cuchumatanes Mountains.

Nebaj (25), Quiché; 6,240 feet. Indian town in deep beautiful valley high in the Chuchumatanes, about fifty miles northwest of Quiché. This isolated valley is abundantly watered and produces the finest maize and apples in the country. The lower slopes are mostly cleared, but the higher ones are forested. Until a few years ago, Nebaj was one of the most inaccessible regions of Guatemala, but now a road has been put through. The hinterland directly to the north has scarcely been touched and it seems that a more extended stay in this remote area would be well repaid. Collecting was most productive. August 8–10.

Cunén (26), Quiché; 6,143 feet. Indian village in a small valley in a fold of the southern slope of the Cuchumatanes. Cunén was drier, warmer and less varied than Nebaj, but still very good for collecting. Complete lack of food and lodging unfortunately cut our stay too short. August 11.

Mountains of Alta Vera Paz.

Cobán (8), Alta Vera Paz; 4,241 feet. One of the three largest cities of Guatemala. Champion was here the end of December and again in March and found the "forest nearly all cleared to plant coffee, maize, etc." This is still even more true today, but there are considerable stretches of open pine woods which proved good for collecting. We found lodgings in the city disadvantageous because of the length of time needed to get out to collecting areas, but we were unable to secure accommodations in the coffee fincas in the vicinity. July 7–9, 31.

Tactíc (9), Alta Vera Paz; 4,300 feet. Town in mountainous region 21 miles south of Cobán. Champion passed through in December and in March. "Forest all cleared to near the inaccessible mountain-tops . . . to plant maize." The surrounding hills are now almost completely denuded. No collecting was done by us. July 10.

Wet Polochic River Valley, to the Caribbean Lowlands.

Tamahú (10), Alta Vera Paz; 3,412 feet. Indian village east of Tactíc, near the source of the Polochic River. The valley is very narrow at this point and the slopes are intensively cultivated for maize. Tamahú was visited by Champion for five days in December and even then it was "mostly cultivated ground." Night collecting was very poor. July 10–11.

Tucurú (11), Alta Vera Paz; 1,625 feet. Village nine miles east of Tamahú. Collecting was disappointing, especially at night. Champion came through in November, March, and June. "Mostly cultivated ground." July 11–13.

Pancajché (12), Alta Vera Paz; 275 feet. Station on the lower Polochic, head of the Vera Paz railroad to Panzós. The valley is wider here and more level. Three hours of collecting were very good. The whole of this lower valley is intensely hot, wet, and unhealthy, with the incidence of malaria said to be 100 per cent. July 14.

La Tinta (13), Alta Vera Paz; about 200 feet. Railroad stop along the lower Polochic River. Champion mentioned the "tropical vegetation" here and he found Chacój, also called La Hamaca, nearby "a very good entomological locality." Chacój is no longer to be found on the map and "La Hamaca," which was a rope bridge over the river, has long since disappeared. July 14.

Panzós (14), Alta Vera Paz; 113 feet. Terminal of railway from Pancajché, on Polochic River and at the head of navigation, 45 miles above Lake Izabal. There is a screened guest house about a mile from the small village. This whole area is a vast swamp and the water, due to the overflow of the river during this rainy season, came up to the railroad tracks. Collecting was fairly good. Mosquitoes (including *Anopheles*) were far too abundant, especially so when stirred up by beating. Champion, who spent almost two weeks at Panzós at the end of May, at the beginning of the rains, found them "so bad here, even by day, that it was almost impossible to do more than a few hours collecting at a time." July 14–17.

Livingston (15), Izabal; sea level. Port on the Atlantic at the mouth of the Río Dulce, in the Caribbean lowlands. The locality itself was unsuitable for collecting but on the way down from Panzós in a small launch, we saw mountain slopes, below Lake Izabal, still clothed by inaccessible virgin rain forest. July 18.

Dry Interior Valleys.

Zacapa (16), Zacapa; 603 feet. Important railroad station in the middle Motagua River Valley, with branch line to El Salvador. The town of Zacapa is two miles distant. The vegetation is xerophytic except for screens of trees along the river. Much of the area is fenced in with cactus or barbed wire fences. Collecting was only fair. The first Cicadas of the trip were heard here. July 19–20.

El Rancho (18), El Progresso; 900 feet. Small settlement in the middle Motagua River Valley, 33 miles by rail west of Zacapa. It is an important road junction for Baja and Alta Vera Paz with daily bus service. The landscape was bare and seemed even drier than Zacapa. A few insects were taken while waiting for the bus. July 24.

San Jerónimo (19), Baja Vera Paz; 3,150 feet. Village at the foot of the mountains on the east end of the plain of Salamá. It was hot and dry, but not so dry as the rest of the plain. This was Champion's most important collecting locality and served as his headquarters for about a year, beginning in August. The sugar-cane and coffee plantations mentioned by him no longer exist. There are many cultivated fields around the village, separated by wide, grassy, tree-shaded avenues that may have been intended as future streets and which provided good collecting. A few kilometers away are pine woods up the slopes. July 24–28.

Salamá (21), Baja Vera Paz; 3,000 feet. Town, head of the department, at the center of the plain of Salamá. It was much drier than San Jerónimo, with many tree cacti and other xerophytic vegetation. The whole plain is cut up into fenced fields for cattle grazing or cultivation and there were few sites for good collecting. Beating the scrub and low bushes in the nearby hills, however, produced some series of Coleoptera. Champion found ''some genera of Coleoptera characteristic of the drier portions of Mexico'' in this region. July 29–30.

Rabinal (22), Baja Vera Paz; 3,000 feet. Town to the west of Salamá, but across the mountains in another valley. Although Champion, who passed by on July 27 on his way to the highland region, described Rabinal as a ''dry region, with scrubby woods, cacti, agaves, yuccas, etc., as on the plain of Salamá,'' we found it less dry than Salamá and better watered. A field of composite flowers by a sluggish stream was an ideal spot for all insects. Night collecting was also good until heavy rain made it impossible. August 1–3.

Sacapulas (27), Quiché; 4,420 feet. Small town in isolated and comparatively deep valley on the banks of the Río Negro, south of Cunén and Nebaj and 32 miles north of Santa Cruz del Quiché. Here it is hot, arid, and barren, the vegetation and weather conditions strongly differentiated from the rest of the highland region and more resembling Zacapa and the Motagua Valley. Collecting was not very good, but Cimicidæ could have been collected in great quantities in the only lodgings available. August 12–13.

Three localities visited do not come under any of the previous headings. These are:

Chiquimula (17), Chiquimula; 1,250 feet. Town 18 miles by rail south of Zacapa, from which it is separated by a range of relatively low mountains with badly deforested slopes. Chiquimula is slightly less arid than Zacapa and the Motagua Valley, but still it is dry. The small white blossoms of the ''Chichicaste'' shrub (a species of *Cnidoscolus,* the *Jatropha* of most authors), which grows abundantly in the region, attracted many insects. Collecting was very good in the dry arroyos. July 21–23.

Los Ramones (20), Baja Vera Paz; about 4,500 feet. Small wooded ravine at kilometer 143, route 17, on the road from Guatemala City to Salamá, in the mountains above San Jerónimo. Collecting was excellent in the short time spent here. Champion spent a day nearby, at Santa Bárbara, in September. July 25.

Cumbre Rabinal-El Chol (23), Baja Vera Paz; 6,000 feet. Mountain pass on the road from Rabinal to Guatemala City. During a twenty-minute halt, while the chains were being removed from the bus for the drier down grade, many insects not previously encountered on the trip were caught. These included Scarabaeidae (*Macrodactylus*), Rhyncophora (*Lixus, Rhodobaenus*), and Chrysomelidae (*Leptinotarsa*). August 4.

Following are some of the common local names for insects which might be of use to future collectors:

Animalitos, insects in general
Mariposa, large butterfly
Papalote, small butterfly
Tijereta, earwig
Esperanza, katydid
Saltón, grasshopper
Chapulín, locust
Chícara, cicada
Palito, walking stick
Zancudo, mosquito
Lorita, Chrysomelid, especially Cassidinae
Frijol, Chrysomelid (black *Epilachna*)
Zampopo, leaf cutting ant
Niño dormido, centipede
Broca, wood-boring bee
Chinches, bugs in general
Chinche de cama, bedbug
Chinche de arboles or *chinche del monte,* Pentatomids
Ronrón, scarab
Pimpím, click beetle
Cucujo, click beetle (*Pyrophorus*)
Luciérnaga, firefly
Alacrán, scorpion
Araña de caballo, Tarantula

ACKNOWLEDGEMENTS

To a number of institutions and persons we are indebted for assistance and cooperation. Chief among these is the Carnegie Institution of Washington and its director, Dr. A. V. Kidder.

Dr. Kidder generously offered us the use of his offices in Guatemala for our headquarters and his assistants, Mr. Edwin M. Shook and Mr. Robert E. Smith, as well as the rest of the staff, gave us much cordial help in many ways. We are also indebted for the courtesies personally extended to us by Señor Rivera, Director of the Instituto Agropecuario Nacional; Mr. William L. Taillon, General Manager of the United Fruit Company; and Sr. Fuentes Novella, Director of the Defensa Agricola.

We are very grateful for the generous hospitality which was given us by Mrs. Hempstead at Cobán, Sr. Federico Rodriguez Benito and J. Falla Arís at Capetillo, Mr. and Mrs. Walter Lind at Mocá and by their son, Norman, at Variedades. Sr. Rodriguez Benito and Norman Lind were especially kind and went out of their way to help and to make us feel at home.

Our friend, Mr. Robert G. Stone, Editor of the Bulletin of the American Meteorological Society, read the introductory section, and we are grateful for his discussion and suggestions.

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A REVISION OF THE NORTH AMERICAN SPECIES OF THE GENUS PLAGODIS (LEPIDOPTERA, GEOMETRIDÆ, ENNOMINÆ)

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The confusion that has existed for many years in connection with the North American species of the genus *Plagodis* Hübner has been due, in part, to lack of understanding of the relationship among the various seasonal forms and geographical races, but it has been further complicated by an unusual nomenclatorial mix-up which was begun by Grote and Packard in 1876, and which has never been satisfactorily cleared up. The purpose of this article is not to present an exhaustive discussion of the genus, but rather to clarify the use of certain specific and subspecific names, to correct a few prevalent misunderstandings, and to present a few hitherto unpublished facts.

The nomenclatorial mix-up already mentioned is concerned with the names *kuetzingi* Grote, *keutzingaria* Packard, *nigrescaria* Hulst, *purpuraria* Pearsall, and *altruaria* Pearsall. To promote a clearer understanding of the application of these names as used later in this article, a brief account of their history will be given, followed by what seems to be the most logical interpretation of their correct usage.

When Packard was preparing material for his monograph he had for observation a series composed of three species, but which he regarded as only one. For this supposed species he had evidently chosen the name *purpuraria.* At least, certain specimens, notably two in the Field Museum in Chicago, still exist so labeled in his handwriting. In the meantime Grote had acquired a single specimen of the darkest of these species, and had sent to the Canadian Entomologist a note stating that the type and a description of this *purple-black* species had been sent to Packard, who would include in the Monograph a description of it under the name *Eurymene kuetzingi.* This note was published in the June 1876 issue, almost simultaneously with the appearance of Packard's monograph.

Packard, after receiving this material from Grote, evidently revised his manuscript slightly, changing the name from *purpuraria* to *keutzingaria,* which he regarded as a corrected and more appropriate form of the Grote name. He also added a sentence of description applicable to Grote's specimen, and figured this form on the supplementary plate.

In 1887, Hulst, realizing that the dark purple species was distinct from the paler ones, proposed the name *nigrescaria* for it (Ent. Amer. II, p. 212), evidently assuming that Grote had not described the species, and that the paler ones were the true *keutzingaria.*

In 1907, Pearsall decided that the current application of the names was incorrect (Ent. News, XVIII, p. 206). He assumed that Grote's note in the Canadian Entomologist constituted an adequate description, and that it preceded Packard's Monograph. Thus his solution was to validate *kuetzingi* Grote for the dark species, with *nigrescaria* Hulst as a synonym. He then proposed the name *altruaria* for what he called "the other species," since he felt that *keutzingaria* and *kuetzingi* could not be retained in the same genus. On the next page Pearsall described *purpuraria.* He had seen not only the two specimens which are now in the Field Museum, but also one additional specimen. He recognized these as representing a distinct species, but misinterpreted the significance of the Packard labels, evidently believing that Packard had chosen the name for this as a distinct species, but had not actually published the description.

By 1917, when the Barnes and McDunnough Contributions appeared, the name *keutzingaria* was being applied to the common light colored spring form that occurs in the northeastern states, and they selected a specimen of this form from Packard's original series to be called the type of *keutzingaria.*

The following interpretation of this complicated situation seems reasonable, logical, and not likely to add to the confusion. Since Grote's note in the Canadian Entomologist designates the name *kuetzingi* to apply to a purple-black species, and since that note includes the first published reference to that name, it constitutes a description, regardless of whether Grote intended it as such or not. Furthermore this description was accompanied by a type which is still in existence in the British Museum, and still bears Grote's original type label. Mr. Tams has been kind enough to furnish a photograph of it and of the label. There is no doubt as to the species involved.

The Packard name *keutzingaria* is actually a distinct name, even though it was evidently intended to be merely a revision of the Grote name. Although Packard's concept of *keutzingaria* included Grote's *kuetzingi,* his description, in general, indicates one of the paler forms, and is reasonably harmonious with the lectotype chosen by Barnes and McDunnough. I have examined this specimen, which is now in the Museum of Comparative Zoology at Cambridge.

Pearsall's description of *purpuraria* provides us with a suitable name for the third species.

Thus the names will be applied in this article—*kuetzingi* Grote to the purple-black species, *keutzingaria* Packard to the paler form common in the northeastern states, and now known to be only the spring form of *phlogosaria* Guenée, and *purpuraria* Pearsall to the species with intermediate coloring and more southern range.

Genus PLAGODIS Hübner

Plagodis Hübner, Verz. bek. Schmett., 294. 1823.
Type: *P. Geometra dolabraria* Linnaeus (Monobasic).
Ennomos Treitschke (pars), Schmett. Eur., V (2), 427. 1825.
Eurymene Duponchel, *in* Godart, Hist. Nat. Lepid. France VII (2), 105, 185, 1829.
Type: *P. Geometra dolabraria* Linnaeus (Original description and monobasic).
(Genus proposed and type designated 105, described 185.)
Ennomos Treitschke, Boisduval (pars), Gen. et Ind. Meth. Eur. Lepid., 182. 1840.

An examination of all the North American material available seems to indicate the presence of only six distinct species, all strictly congeneric with the Eurasian *dolabraria* Linnaeus. For purposes of comparison, *dolabraria* is figured on Plate V, Fig. 1, the male genitalia on Plate I, Fig. 1, and the female genitalia on Plate III, Fig. 5. It might also be noted that the larva as figured by Spuler (Die Schmetterlinge Europas, IV, Die Raupen, Plate 41, Fig. 15, 1910) appears almost identical with all known American larvæ of the genus. I can find no record, however, that moths of the summer generation, as they occur in southern Europe, differ in any obvious way from those of the spring generation. Although the species ranges from Portugal and Great Britain to Japan, racial differences are far less pronounced than in the one American species that ranges across the continent.

PLAGODIS SERINARIA Herrich-Schäffer

Plate V, Fig. 2; Plate I, Fig. 2 (male genitalia); Plate III, Fig. 3 (female genitalia); Plate II, Fig. 5 (larva).

Plagodes serinaria Herrich-Schäffer, Ausser. Schmett., 63; Fig. 365. 1855.

Ellopia subprivata Walker, Cat. Brit. Museum, XXVI, 1509. 1862.

Eurymene rosaria Grote, Bull. Buff. Soc., III, 131. 1876.

Eurymene rosaria Grote, Can. Ent., VIII, 111. 1876.

Plagodis serinaria H.-S. Packard, Mon. of Geom. Moths, 469; Plate XI. Fig. 45. 1876.

Plagodis floscularia Grote, Pap. I, 40. 1881.

Plagodis serinaria H.-S., Holland, Moth Book, 349; Plate XLIV, Fig. 33, ♂. 1903.

Serinaria, with its beautiful blending of yellow and rose, is not easily confused with other species, and is too well known to need further description. It varies considerably in the amount and the brilliance of the rose, and, as in some other species of the genus, the discal spot may be either present or absent.

Male Genitalia.—Examination of the male genitalia of the various species of *Plagodis* reveals significant differences only in the shape of the valves; in the number, size, and arrangement of the cornuti; and in the symmetry and spining of the furca. Other features, which seem quite constant throughout the genus, are shown in the figures, and will not be otherwise specifically considered. In *serinaria* the outer portions of the valves are somewhat narrowed, and the cornuti, which usually number from six to nine, are arranged side by side in a single group. In all specimens examined the furca is asymmetrical, both branches tipped with a few spines, more loosely arranged on the long right branch than on the shorter left one. The relative length of the branches of the furca, however, is not too constant in some species of this group, and may be found to vary in this species also.

FEMALE GENITALIA.—As a basis for specific determination, the female genitalia seem more reliable throughout the genus than the male genitalia. They show, on the whole, greater differences among the species, but seem relatively constant within the species. In *serinaria* the most distinctive feature is the long, slender, plaited ductus bursae, moderately chitinized, and separated from the bursa proper by a distinct line of division. The signum is comparatively large for the genus, and there is no chitinized bar above the ostium, such as is found in some of the species.

EARLY STAGES.—The eggs are smooth, pale yellow, ellipsoidal, somewhat flattened, and deposited in irregular clusters upon the leaves. Within a few days they develop a few pinkish flecks, but not the uniform red coloring found in the eggs of many of the *Ennominæ*.

The newly hatched larvæ are pale yellowish green, smooth, with no obvious markings. During the next two instars they remain rather nondescript green larvæ not easily distinguished from those of various other species. In the fourth instar a hump develops on the fifth abdominal segment, and some brown and purplish mottling. In the final instar the larvæ are brownish, irregularly marked with fine darker flecks and larger pale areas, and with an oblique dark lateral stripe on each side of the first abdominal segment. These stripes do not quite meet dorsally to form a V and each is bordered with an indistinct paler stripe immediately back of it. The second abdominal segment has traces of these stripes also. Underneath on each of the first five abdominal segments there are two small but distinct black tubercles, each tipped with a single spine. The fifth abdominal segment has a conspicuous dorsal hump, and the eighth abdominal segment a pair of moderately well developed subdorsal warts. These larvæ do not seem to have the habit of withdrawing the head into the thorax when at rest, but keep it well extended at all times. They feed freely upon basswood (*Tilia americana*), and probably upon other trees and shrubs. In western New York the larvæ are full grown in late July and early August.

The pupa is dark brown, with wing cases almost black, and only moderately glossy. The cremaster is of the eight-hooked type, with the two apical hooks longer and stouter than the other six, and all hooks with recurved tips. The dorsal and lateral grooves of the adjacent abdominal segments, that in most genera accompany the eight-hooked cremaster, are missing, or are indicated only by vestigial lateral grooves. This combination of characters at the tip of the abdomen is unusual, but has been observed in the related genus *Hyperetis,* and probably occurs in *Anagoga.*

In general *serinaria* is the closest of any American species to *dolabraria,* agreeing with it in size, wing form, male genitalia, and in most features of the female genitalia. The species ranges from Nova Scotia westward at least to Manitoba, and south to the latitude of southern Ohio. The types are from the vicinity of Cincinnati. In New York the moths fly in May and June, and there is but one generation a year.

Number of specimens examined: 109 ♂♂, 25 ♀♀. (The numbers recorded for this and each succeeding species do not include the specimens in the Museum of Comparative Zoology at Cambridge, which were seen, but, unfortunately, not counted.)

PLAGODIS KUETZINGI (Grote)

Plate V, Fig. 3; Plate I, Fig. 3 (male genitalia); Plate III, Fig. 4 (female genitalia).

Eurymene kuetzingi Grote, Can. Ent., VIII, 112. 1876.

Plagodis keutzingaria Packard (pars), Mon. of Geom. Moths, 468; Plate XIII, Fig. 51. 1876.

Plagodis nigrescaria Hulst, Ent. Amer., II, 212. 1887.

Plagodis keutzingi (sic) Pearsall, Ent. News, XVIII, 206. 1907.

Plagodis keutzingi (sic) Holland, Moth Book, 349; Plate XLIV, Fig. 36, ♂. 1903.

Plagodis nigrescaria Hulst. B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 249. 1917.

Kuetzingi is recognized at once by the large area of purplish black covering the outer half of the upper wings except along the costa. The postmedial line curves far inward, and forms, in an indistinct sort of way, the inner boundary of this dark area. The antemedial line is indicated only as the outer boundary of a light brown or buff basal area. The lower wings also show a considerable suffusion of purple black scales over the wide terminal area.

MALE GENITALIA.—The male genitalia agree with those of *serinaria* in the narrowed extremities of the valves, but differ from those of all other species in the presence of a well defined notch in the costa of the valve at its base. The furca is quite symmetrical in all specimens examined, with both branches short, and equipped with unusually long spines at the tips. The cornuti are arranged in two groups, usually of two each, those of one group somewhat shorter than those of the other.

FEMALE GENITALIA.—The ductus bursæ, which is less heavily chitinized and less distinctly plaited than in *dolabraria* and *serinaria*, is short, and merges gradually into the bursa proper. A more or less curved, heavily chitinized bar is present above the ostium.

EARLY STAGES.—These were first worked out in the summer of 1946 by Mr. Douglas C. Ferguson of Armdale, Nova Scotia. When, in July of that year, I saw the larvæ he was rearing, they were still quite small, but looked about like those of other species of the genus. They were feeding upon ash, which seemed to be, of all the foods offered, the only one they would accept. Later Mr. Ferguson sent me preserved larvæ for study. In the fourth instar they are still uniform pale green, with a slight hump on the fifth abdominal segment. In the fifth and final instar they resemble the larvæ of *serinaria,* but are considerably paler, with the head contrasting dark brown. The oblique lateral lines are missing, and there is not much of the darker mottling on the first four abdominal segments, although the remaining segments show traces of it. The paired ventral tubercles are present on only the first three abdominal segments. These larvæ, when at rest, withdraw the head into the thoracic segments, but apparently not so completely as do the larvæ of *phlogosaria* and *alcoolaria.* The pupa is structurally similar to that of *serinaria.*

Kuetzingi is one of the most clearly defined species of the genus, differing from all other purplish species in its much darker color, its very narrow median area, and in the more shallow excavation at the anal angle of the upper wing. It has a wide range from Nova Scotia through New England, New York, and Ontario, at least as far west as northern Illinois, but seems local in distribution, and is rare or absent south of the latitude of the Great Lakes. In western New York the moth flies from late May well into June. A single late July record from Illinois may represent a second generation, or, more probably, an accidentally belated individual.

Number of specimens examined: 62 ♂♂, 5 ♀♀.

PLAGODIS PURPURARIA Pearsall

Plate V, Fig. 4; Plate I, Fig. 4 (male genitalia); Plate III, Fig. 6 (female genitalia).

Plagodis keutzingaria Packard (pars), Mon. of Geom. Moths, 468; Plate XI, Fig. 44, 1876.

Plagodis purpuraria Pearsall, Ent. News, XVIII, 207. 1907.

Although *purpuraria* reminds one of *kuetzingi,* it is much paler, and the postmedial line is less incurved. The purple scales are very smoothly distributed over the terminal areas of all four wings, but are denser near the anal angle of each wing, becoming gradually lighter near the costa, without the spotty effect found in *phlogosaria* and its forms. There is a considerable washing of orange in the median area and underneath, but few or no transverse striæ, and no discal spot in any specimen examined. The antemedial line, if visible at all, is very faint.

MALE GENITALIA.—The valves are not much narrowed apically. The furca is symmetrical, with both branches short, not extending to the costal margin of the valves, and each branch is tipped with a few long spines. There are two well separated groups of cornuti, usually two in each group.

Female Genitalia.—The ductus bursæ is short, only slightly chitinized, and scarcely plaited. The chitinized bar above the ostium is about as wide as in *kuetzingi*, but is of more nearly uniform width, and the membrane back of it appears to have a very ragged edge.

Purpuraria seems, in general, to be a rather scarce species, but it has been taken in numbers near Finleyville, Penna. The type is from Scranton, and other specimens have been seen from Delaware, Maryland, southeastern New York, and northern Illinois. I can discover no record of the early stages.

Number of specimens examined: 78 ♂♂, 4 ♀♀.

PLAGODIS PURPURARIA summer form SCHUYLKILLENSIS Grossbeck

Plate V, Fig. 5.

Plagodis schuylkillensis Grossbeck, Ent. News, XIX, 315. 1908.

In the same limited area where *purpuraria* occurs in the spring, a very different looking form flies in July and August. Since the differences between these forms correspond exactly to known differences between the seasonal forms of *phlogosaria*, there can be no doubt that *schuylkillensis* is merely the summer form of *purpuraria*.

This form closely resembles typical *phlogosaria*, but differs chiefly in having the postmedial line nearer the middle of the wing, and in having the dark scales spread evenly over the upper wings, and the terminal areas of the lower wings. There is no discal spot in any specimen seen, and scarcely any indication of the green sheen so often found in *phlogosaria*.

In the male genitalia a remarkable situation has developed, similar to that found in *phlogosaria* and *fervidaria*. The furca in the summer form is asymmetrical, with the right branch fully twice as long as in the spring form, and the left branch somewhat longer than in the spring form. The genus *Plagodis*, so far as I know, is unique among the *Geometridæ* in having species that show constant seasonal differences in male genitalia. Such differences do not occur in the female genitalia.

The types of *schuylkillensis* are from Philadelphia, and all the specimens I have seen are from West Virginia, Pennsylvania, and southeastern New York. Most of the known specimens of this form, as well as of typical *purpuraria,* are from Finleyville, Penna., and are in the Carnegie Museum collection.

Number of specimens examined: 61 ♂♂, 7 ♀♀.

PLAGODIS PHLOGOSARIA (Guenée)

Plate V, Fig. 6; Plate I, Fig. 5 (male genitalia); Plate IV, Fig. 1 (female genitalia).

Eurymene phlogosaria Guenée, Lép. Noct. IX, 146. 1857.

Eurymene phlogosaria Gn., Walker, Cat. Br. Museum, XX, 177. 1860.

Plagodis phlogosaria (Gn.) Packard, Mon. of Geom. Moths, 466; Plate XI, Fig. 42. 1876.

Plagodis phlogosaria (Gn.) Bruce, Ent. Amer., III, 48. 1887. (Early stages.)

Plagodis phlogosaria (Gn.) B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248; Plate XXII, Fig. 3, ♂. 1917.

Eurymene phlogosaria Gn., Oberthür. Etudes de Lép. Comp., Fasc. VI; Plate CLVIII, Fig. 1532. 1920.

In the typical form the ground color is bright yellowish brown, dusted with darker scales, and usually showing a trace of transverse striæ of brown and purple near the costa of the upper wings. The postmedial line of the upper wings is narrow, distinct, and nearly straight, almost always continuous, and usually bordered inwardly by an indistinct, narrow purplish shade. In the terminal area there may be some scattered purple scales, and there is always a smudge of purple and brown near the anal angle. The median area is more uniform in color, may show a strong green tinge, and usually a discal spot. The dark brown antemedial line is almost always well defined, narrow, and widening near the costa. The lower wings are lighter, clearer yellow, overlaid with brown, black, and a few purple scales in the terminal area, especially near the anal angle, where they tend to form lines parallel to the postmedial line. On the underside the pattern is somewhat similar, but the flecks and lines are rosy purple on a bright yellow background. The two sexes are similar in color, but the anal excavation, which is deeper than in any of the species previously considered, is more strongly developed in the females than in the males.

MALE GENITALIA.—The male genitalia are scarcely distinguishable from those of *schuylkillensis,* showing a similar asymmetrical furca and two groups of cornuti. There are usually two cornuti in each group, but occasionally the division is 1–3, 1–2, or 2–3.

FEMALE GENITALIA.—In general these are similar to those of *purpuraria,* but a few significant differences seem constant. The ductus bursæ is a little wider; the signum is larger and carries more points; the chitinized bar near the ostium is narrower, less strongly curved centrally, but with the ends turning abruptly downward; and the ragged membrane behind this bar is less conspicuous and less ragged than in *purpuraria.*

EARLY STAGES.—The eggs undergo greater color change than those of *serinaria,* becoming bright red a few days after being laid. The larvæ in all stages resemble those of *serinaria,* except in the matter of the retractile head in the last instar. Resting larvæ of *phlogosaria* usually withdraw their heads almost completely out of sight, and fold their legs close against the thorax. This performance gives them the appearance of small gnarled twigs, each ending in a smooth rounded knob. The first two abdominal segments often show a trace of pale longitudinal lateral lines, not oblique as in *serinaria.* The paired ventral tubercles are present on each of the first five abdominal segments, but they are smaller than in *serinaria.* Evidently the larvæ will feed upon various trees and shrubs, but I found wild cherry (*Prunus serotina*) and white birch (*Betula alba*) the most satisfactory of anything tried. Dr. McDunnough reported rearing the northern race *intermediaria* on basswood (Can. Ent., June 1933, p. 124).

Structurally the pupa is similar to that of *serinaria,* but the general appearance is quite different, for it is lighter brown, with greenish wing cases, and rather glossy.

Typical *phlogosaria* is the regular summer form in the New England States, New York, and southern Ontario, ranging westward at least to Minnesota, and southward to southern Pennsylvania and Ohio. It flies in July and early August, and in some localities is quite abundant.

Number of specimens examined: 164 ♂♂, 28 ♀♀.

PLAGODIS PHLOGOSARIA spring form KEUTZINGARIA Packard

Plate V, Fig. 7; Plate I, Fig. 6 (male genitalia); Plate IV, Fig. 2 (female genitalia).

Plagodis keutzingaria Packard (pars), Mon. of Geom. Moths, 468. 1876.

Plagodis altruaria Pearsall, Ent. News, XVIII, 206. 1907.

Plagodis kuetzingaria (sic) B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 249; IV, 155; Plate XXIII, Fig. 3. 1917.

Except in the basal area of the upper wings the ground color of the spring form is less tawny than in typical *phlogosaria*, and is usually more heavily striated with purple and brown scales. The postmedial line is broad, dark brown, and inwardly bordered with a much wider and more diffused purple shade than in the typical form, and is usually nearer the middle of the wing. The antemedial line, which is usually not quite so heavy, is similar in color, but outwardly diffused. There is a tendency for the discal spot to be lost, and the greenish sheen of the median area, while often present, may be obscured by the darker striæ. The dark smudge at the anal angle is also more diffused than in typical *phlogosaria.* The lower wings are straw yellow, with some purple scales in the terminal area. The pattern of the under side is similar to that of the typical form, but more liberally flecked with rosy purple, which may cover the terminal area almost uniformly. Occasional specimens of both the spring and summer forms are intermediate in coloring, similar to the northern race *intermediaria* B. and McD.

The male genitalia, as in *purpuraria,* have a symmetrical furca, with both branches quite short, and tipped with shorter spines than in typical *phlogosaria.* The female genitalia are indistinguishable from those of the typical form.

Keutzingaria flies earlier in the spring than any other northern *Plagodis,* sometimes appearing in western New York in early April, continuing on the wing until the middle of May. Until recently it had been regarded as a species very distinct from *phlogosaria,* and it was something of a surprise when, in 1945, I obtained the typical form in the summer from eggs laid by a female of *keutzingaria* in April.

Number of specimens examined: 106 ♂♂, 8 ♀♀.

PLAGODIS PHLOGOSARIA race INTERMEDIARIA Barnes and McDunnough

Plate V, Fig. 8.

Plagodis intermediaria Barnes and McDunnough, Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248; Plate XXII, Fig. 2, ♂. 1917.

Plagodis intermediaria B. and McD., McDunnough, Can. Ent., LXV, 124. 1933. (Early stages.)

In Ontario and Quebec, north of the area where typical *phlogosaria* and *keutzingaria* occur, is found an apparently single-brooded race, flying in May and June, and intermediate in appearance between the seasonal forms found farther south. On the whole it tends more to resemble *keutzingaria,* but the postmedial line is narrower and clearer, the transverse striæ are less noticeable, and the discal spot is usually present. The genitalia are similar to those of *keutzingaria.*

Dr. McDunnough's account of the early stages seems to indicate a larva and pupa identical in appearance with the *phlogosaria* larvæ I have reared in western New York. His statement that the hump is on the seventh abdominal segment is probably a purely accidental slip.

Number of specimens examined: 2 ♂♂, 1 ♀.

PLAGODIS PHLOGOSARIA race **IRIS** new race

Plate V, Fig. 9.

Plagodis approximaria B. and McD. (pars), Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248; Plate XXII, Fig. 1, ♂. 1917. (nec. *approximaria* Dyar)

In Nova Scotia another single-brooded strain occurs, differing sufficiently from any other to warrant separation as a distinct race. Its most striking feature is the brilliant and intense coloring, particularly on the lower wings and under side. The upper wings are like those of a dark and richly colored *keutzingaria,* with bronze undertones and the usual green sheen, but with relatively few transverse striæ. The postmedial line is sharply defined, almost black, and usually set farther from the outer margin than in any other *phlogosaria* form except *approximaria.* The discal spot is usually absent or very obscure. The lower wings have a wide terminal area of purple pink, and frequently the entire lower wings are heavily overlaid with scales of the same color. Underneath the rosy purple suffusion is more complete than in *keutzingaria,* and may almost cover all four wings. The postmedial line on the under side of the lower wings is not usually well defined, as in *keutzingaria,* but the terminal area is very wide and intensely purple. The moths average a bit larger than *keutzingaria,* but about the same size as *approximaria.* The wing form is like that of *keutzingaria,* however, with a deeper anal excavation than in *approximaria.* The male genitalia are like those of *keutzingaria.*

Unfortunately the accompanying photograph (Plate 5) was taken before I had seen an extensive series of Nova Scotia specimens, and the one figured is scarcely typical of the race. It is too pale, and shows a more distinct discal spot than is usual. A few other Nova Scotia specimens seen are even less brilliant, and could easily be referred to *keutzingaria,* or possibly to *intermediaria.*

HOLOTYPE.—♂, Armdale, N. S., June 13, 1947 (D. C. Ferguson). In U. S. N. M. collection (ex Ferguson coll.).

ALLOTYPE.—♀, Armdale, N. S., June 24, 1944 (D. C. Ferguson). In U. S. N. M. collection (ex Ferguson coll.).

PARATYPES.—8 ♂♂, 1 ♀, Armdale, N. S.; 3 ♂♂, Annapolis Royal, N. S.; 4 ♀♀, MacNab's Island, N. S. Dates range from early June to early July. The Armdale and Annapolis Royal specimens were collected by Mr. Ferguson, and are in the Ferguson and Rupert collections. The specimens collected on MacNab's Island, in Halifax Harbour, are in the collection of the Nova Scotia Museum of Science in Halifax.

PLAGODIS PHLOGOSARIA race APPROXIMARIA Dyar

Plate V, Fig. 10 (spring form), Fig. 11 (summer form); Plate II, Fig. 1 (male genitalia, summer form); Plate IV, Fig. 4 (female genitalia).

Plagodis approximaria Dyar, Can. Ent., XXXI, 266. 1899.

Plagodis approximaria B. and McD. (pars), Cont. to the Nat. Hist. of the Lepid. of N. A., III, 248. 1917.

From the eastern spring form *keutzingaria,* the spring form of the western race differs most conspicuously in the form and position of the postmedial line, which is often almost as completely incurved as in *purpuraria*. In general *approximaria* is slightly larger than *keutzingaria,* a little ruddier, with fewer transverse striæ, and a shallower anal excavation of the upper wings. Neither the male nor the female genitalia show, in the spring form, any significant differences from those of the eastern spring form. All specimens seen from Saskatchewan, Idaho, Washington, Oregon, and British Columbia seem to be referable to this race.

The summer form of *approximaria* differs somewhat less in appearance from its spring form than does its counterpart, typical *phlogosaria* in the east. The two specimens before me scarcely differ in general color from the spring form. The postmedial line of the upper wings, while complete and obvious, is not contrastingly dark, as in most forms of the species, but diffused and grayish, and is much less incurved than in the spring form. There are no obvious transverse striæ, but a small discal dot is present. As in the spring form, the anal excavation is rather shallow. On the lower wings the postmedial line is darker, very distinct near the inner margin, and narrower than that of the upper wings.

The male genitalia, in the only specimen examined, have both branches of the furca longer than those of the spring form, but without the much elongated right branch that is characteristic of the eastern summer forms of this and the two related species.

Number of specimens examined: 13 ♂♂, 1 ♀, also 2 ♂♂ of the summer form, taken at Warrendale, Multnomah Co., Oregon, July 8, 1934, and now in the Franclemont collection.

PLAGODIS FERVIDARIA (Herrich-Schäffer)

Plate V, Fig. 12; Plate II, Fig. 2 (male genitalia); Plate IV, Fig. 5 (female genitalia).

Eurymene fervidaria Herrich-Schäffer, Ausser, Schmett., Fig. 203. 1850–58.

Eurymene emargataria Guenée, Lep. Noct., IX, 145. 1857.

Eurymene fervidaria H.-S., Walker, Cat. of the Brit. Museum, XX, 177. 1860.

Eurymene excavaria Morrison, Bull. Buff. Soc., I, 189. 1873.

Plagodis fervidaria (H.-S.) Packard, Mon. of Geom. Moths, 467; Plate XI, Fig. 43. 1876.

Eurymene fervidaria H.-S., Hulst, Ent. News, VI, 104. 1895.

Fervidaria is very closely related to *phlogosaria.* The typical spring form can be separated from *keutzingaria* by the deeper excavation at the anal angle of the upper wing, by the blurred and usually incomplete postmedial and antemedial lines, and by the greater number of transverse darker striæ. These frequently cover the upper wings so completely that the other markings are almost lost among them. As a rule the postmedial line of the upper wing is heavier near the inner margin, wide and diffused, gradually disappearing toward the costal margin. The antemedial line, however, is heavier near the costa, often indicated only as a dark blur at that edge of the wing. Occasionally the complete line is present but faint, and sometimes no trace of it can be found. There is rarely any sign of a discal dot. The lower wings are similar to those of *keutzingaria,* but brighter, purer yellow, and less suffused with purple. The under side is more heavily flecked with purple scales than in *keutzingaria,* and the ground color, which shows most clearly in the basal area of the lower wings and near the apex of the upper wings, is more intense golden yellow.

The male genitalia are almost like those of *keutzingaria,* except in the number of cornuti. In *fervidaria* the usual number in the larger group is from five to seven, with four the minimum number observed, and that in just one specimen. The female genitalia differ from those of *phlogosaria* chiefly in the smaller bursa, and the greater curvature of the bar above the ostium.

So far as I know, the early stages of this species have not been studied. It is more southern in its range than any of the species previously considered, occurring from the southern parts of New York and the New England States to southern Alabama and Georgia.

Number of specimens examined: 35 ♂♂, 3 ♀♀.

PLAGODIS FERVIDARIA summer form ARROGARIA (Hulst)

Plate V, Fig. 13, ♂; Fig. 14, ♀; Plate II, Fig. 3 (male genitalia); Plate III, Fig. 7 (female genitalia).

Eurymene arrogaria Hulst, Ent. Amer., I, 208. 1886.

Plagodis arrogaria (Hlst.) B. and McD., Cont. to the Nat. Hist. of the Lepid. of N. A., III, 186; Plate XIV, Fig. 12, ♂. 1917.

Arrogaria has stood as a recognized species in all lists for many years, but since it bears in all known respects the same relation to typical *fervidaria* that typical *phlogosaria* bears to *keutzingaria,* I do not hesitate to treat it merely as a seasonal form of *fervidaria.*

It is slightly smaller than typical *fervidaria,* brighter yellow in ground color, especially on the lower wings, and with few transverse striæ. The postmedial line is narrow, usually distinct for only a short distance at the inner margin of each wing. In most specimens the remainder of the line is very obscure or entirely missing. The antemedial line is also obscure, often indicated by only a small spot on the costal margin. Every specimen observed has a conspicuous discal dot on the upper wing. Underneath the colors are even more brilliant than in the typical form, and with fewer dark flecks.

The male genitalia show a furca as asymmetrical as that of *phlogosaria,* but the other features are like those of typical *fervidaria.* The female genitalia cannot be distinguished from those of the typical form. *Arrogaria* seems to occur throughout the geographical range of the species.

Number of specimens examined: 20 ♂♂, 7 ♀♀.

PLAGODIS ALCOOLARIA (Guenée)

Plate V, Fig. 15; Plate III, Fig. 1 (male genitalia); Plate IV, Fig. 3 (female genitalia).

Eurymene alcoolaria Guenée, Lep. Noct., IX, 146. 1857.

Eurymene alcoolaria Gn., Walker, Cat. of the Brit. Museum, XX, 178. 1860.

Plagodis alcoolaria (Gn.) Packard, Mon. of Geom. Moths, 469; Plate XI, Fig. 41. 1876.

Plagodis emargataria Holland (nec Guenée), Moth Book, 349; Plate XLIV, Fig. 32, ♀. 1903.

Eurymene alcoolaria Gn., Oberthür, Etudes de Lép. Comp. Fasc. VI; Plate CLVIII, Fig. 1531. 1920.

The ground color is pale yellow, almost white, but with the upper wings considerably flecked with rusty brown scales, especially in the median area, which, as a result, appears darker than the basal and terminal areas. The postmedial line of the upper wings is dark brown, broad, continuous, and nearly straight or slightly wavy, never strongly curved inward or outward. The antemedial line is also dark brown and complete, and may be nearly straight or somewhat excurved. The discal spot of the upper wings is always conspicuous, and may be either uniform dark brown or with a paler center. The fringes of the upper wings are dark brown, especially along the anal excavation. The lower wings are nearly white, with no markings except a trace of the postmedial line at the inner margin, and a few scattered brown scales near the anal angle. On the under side the pattern of the upper side is repeated, but the dark markings tend to be purple brown, on a background of brighter yellow. The depth of the anal excavation of the upper wings is somewhat variable, but is regularly deeper in the females than in the males.

Male Genitalia.—The valves are similar in form to those of *phlogosaria*, and the furca is more or less symmetrical, with long-spined tips that extend just beyond the costal edges of the valves. There are, as a rule, two cornuti, sometimes only one, and they are much longer than in any other species of the genus.

Female Genitalia.—The ductus bursæ is long and slender, and fairly well chitinized, as in *serinaria*, but only slightly fluted, not distinctly plaited. There is no bar above the ostium.

Early Stages.—The eggs are deposited in a formation that resembles a string of miniature beads extending out from the edge of a leaf. Sometimes these egg masses are forked, and there may be as many as twenty eggs in a mass.

The larvæ in all stages are quite similar to those of *phlogosaria*, but are less mottled and lack the lateral markings of the first two abdominal segments. They have the same habit of withdrawing the head into the thoracic segments when at rest. Mr. Wyatt reports having reared the larvæ successfully on *Tilia*, but I had previously assumed the natural food to be oaks of various species. A few years ago I reared the larvæ, starting them on white oak, but when they were about half grown I transferred them to beech, since oak was difficult to obtain in the locality. They accepted the change, but afterward grew more slowly, and the mortality rate was high. In western New York the moths do not seem to occur in areas where oak trees are absent, even though beech and basswood are abundant.

The pupa is glossy, with greenish wing cases, similar to that of *phlogosaria.*

Alcoolaria is the eccentric species of the genus, appearing in the matters of wing form and early stages to be closely related to *phlogosaria,* while the female genitalia show a marked similarity to those of *serinaria.* In the matters of color, form of the discal spot, and structure of the ædoeagus, it is quite different from any other species. It is difficult to fit it into a linear arrangement of the species, and, for want of a better location I am placing it last in the genus. *Alcoolaria* has an extensive range in eastern United States and Canada, from Nova Scotia to North Carolina, and westward at least to Manitoba. In New York the moths fly in May and June.

Number of specimens examined: 153 ♂♂, 43 ♀♀.

PLAGODIS ALCOOLARIA summer form KEMPII Hulst

Plate V, Fig. 16; Plate III, Fig. 2 (male genitalia).

Plagodis kempii Hulst, Jour. N. Y. Ent. Soc., VIII, 220. 1901.

From Pennsylvania southward a summer form occurs in August, which is slightly smaller than typical *alcoolaria,* and brighter yellow, less densely sprinkled with darker scales, and with the other markings sharper and darker. The furca of the male genitalia has longer branches than in typical *alcoolaria,* but in the single specimen examined it is only slightly asymmetrical.

The types of *kempii* are from western Pennsylvania, but I have seen the form from Lakehurst, N. J., and from the mountains of North Carolina. These latter specimens are larger and brighter yellow than the Pennsylvania and New Jersey specimens.

Number of specimens examined: 3 ♂♂, 2 ♀♀.

A discussion of the genus *Plagodis* would hardly be complete without some mention of the very closely related genus *Anagoga* Hübner, which differs so slightly from *Plagodis* that at first I doubted the advisability of retaining both genera. The genus *Anagoga* was erected at the same time as *Plagodis* (Verz. p. 294, 1823), and the European species *pulveraria* Linnæus is recognized as its type. There seem to be no constant differences between the genera in wing venation, antennæ, or other external structures, but differences in the early stages and in the genitalia, while not too great, are probably sufficient to justify the retention of *Anagoga* as a valid genus.

For purposes of comparison, the American species *occiduaria* Wlk. is figured (Plate V, Fig. 17; Plate II, Fig. 4; Plate IV, Fig. 6). *Occiduaria* has usually been considered a race of the European *pulveraria,* but the genitalia are very distinctly different, and according to Bruce (Ent. Amer., II, 51. 1886), so are the larvæ. I have never reared *occiduaria,* but I have a report of the larva from Mr. Franclemont, who has reared it. The mature larva has a slightly bifid, non-retractile head, and the body is thicker at the rear, tapering toward the head. There are humps and warts on the fifth and eighth abdominal segments, somewhat as in *Plagodis,* but smaller. These larvæ, unlike those of *Plagodis,* have the habit of spinning much silk wherever they go, and, in captivity, frequently become hopelessly entangled in their own webs. Mr. Franclemont reared the larvæ on yellow birch (*Betula lutea*).

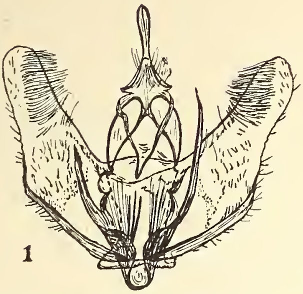
In the male genitalia *Anagoga* differs somewhat from *Plagodis* in the structure of furca and valves, as shown in the figures. These differences are even more marked in *pulveraria* than in *occiduaria.* There are, furthermore, no cornuti in the ædoeagus. In the female genitalia the signum is a chitinized depression without a pointed edge, quite unlike anything observed in *Plagodis.*

* * *

In conclusion, it gives me pleasure to acknowledge the assistance given by a number of entomologists who have helped in some way to make this article possible. Among them are Mr. John G. Franclemont of the United States National Museum, Dr. W. T. M. Forbes of Cornell University, Mr. Douglas C. Ferguson of Armdale, N. S., Dr. Frank M. Jones of Wilmington, Del., Mr. A. K. Wyatt of Chicago, Ill., and Mr. Otto Buchholz of Roselle Park, N. J. I am also indebted to the officials of the Museum of Comparative Zoology for the privilege of examining the material in that collection, and to Dr. Walter R. Sweadner, whose loan to Mr. Franclemont of the material in the Carnegie Museum was of great value in determining the true status of *purpuraria* and *schuylkillensis*.

PLATE I

Figure 1. *Plagodis dolabraria* L., male genitalia; 1a, ædœagus.
Figure 2. *Plagodis serinaria* H.-S., male genitalia; 2a, ædœagus.
Figure 3. *Plagodis kuetzingi* Grt., male genitalia; 3a, ædœagus.
Figure 4. *Plagodis purpuraria* Pears., male genitalia; 4a, ædœagus.
Figure 5. *Plagodis phlogosaria* Gn., male genitalia; 5a, ædœagus.
Figure 6. *Plagodis phlogosaria* spring form *keutzingaria* Pack., male genitalia; 6a, ædœagus.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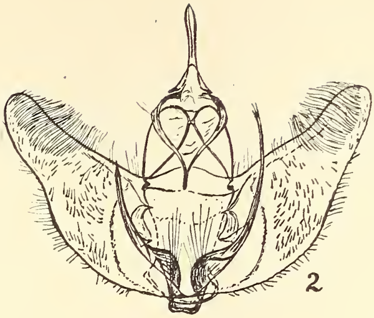
1a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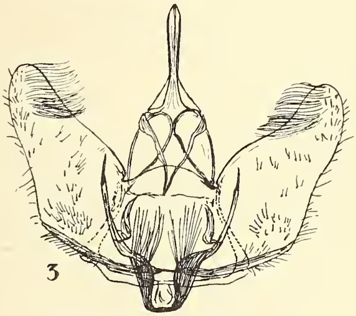
2a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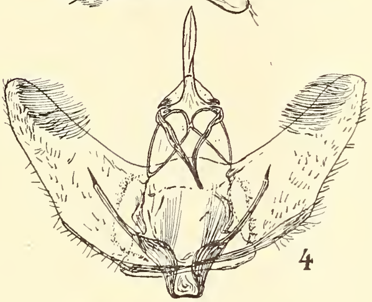
3a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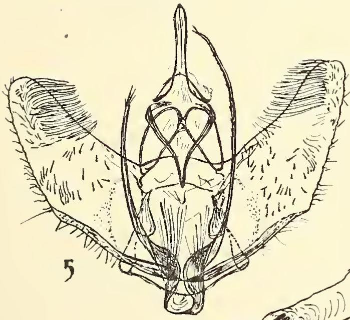
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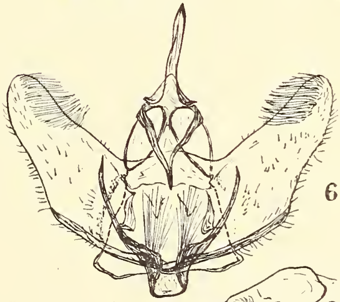
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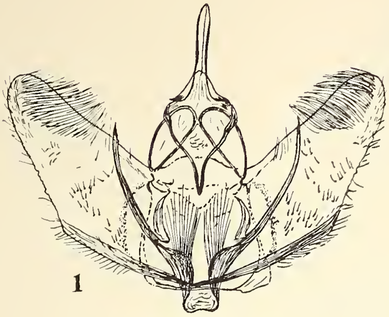
6a

PLATE II

Figure 1. *Plagodis phlogosaria* race *approximaria* Dyar, male genitalia (summer form); 1a, ædœagus.
Figure 2. *Plagodis fervidaria* H.-S., male genitalia; 2a, ædœagus.
Figure 3. *Plagodis fervidaria* summer form *arrogaria* Hlst., male genitalia; 3a, ædœagus.
Figure 4. *Anagoga occiduaria* Wlk., male genitalia; 4a, ædœagus.
Figure 5. *Plagodis serinaria* H.-S., larva.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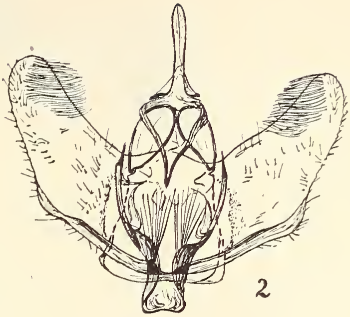
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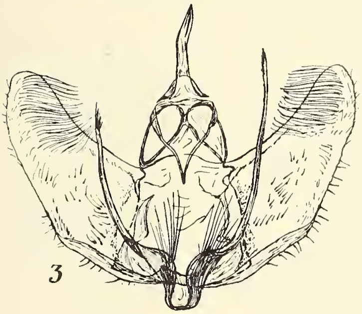
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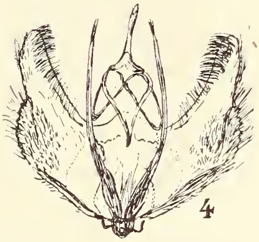
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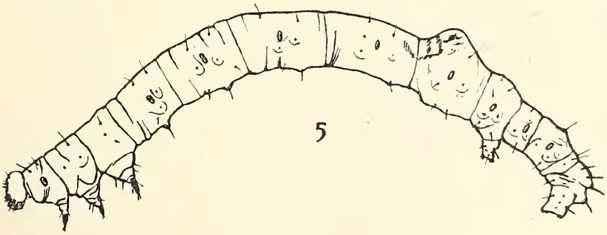
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PLATE III

Figure 1. *Plagodis alcoolaria* Gn., male genitalia; 1a, ædœagus.
Figure 2. *Plagodis alcoolaria* summer form *kempii* Hlst., male genitalia; 2a, ædœagus.
Figure 3. *Plagodis serinaria* H.-S., female genitalia.
Figure 4. *Plagodis kuetzingi* Grt., female genitalia.
Figure 5. *Plagodis dolabraria* L., female genitalia.
Figure 6. *Plagodis purpuraria* Pears., female genitalia.
Figure 7. *Plagodis fervidaria* summer form *arrogaria* Hlst., female genitalia.

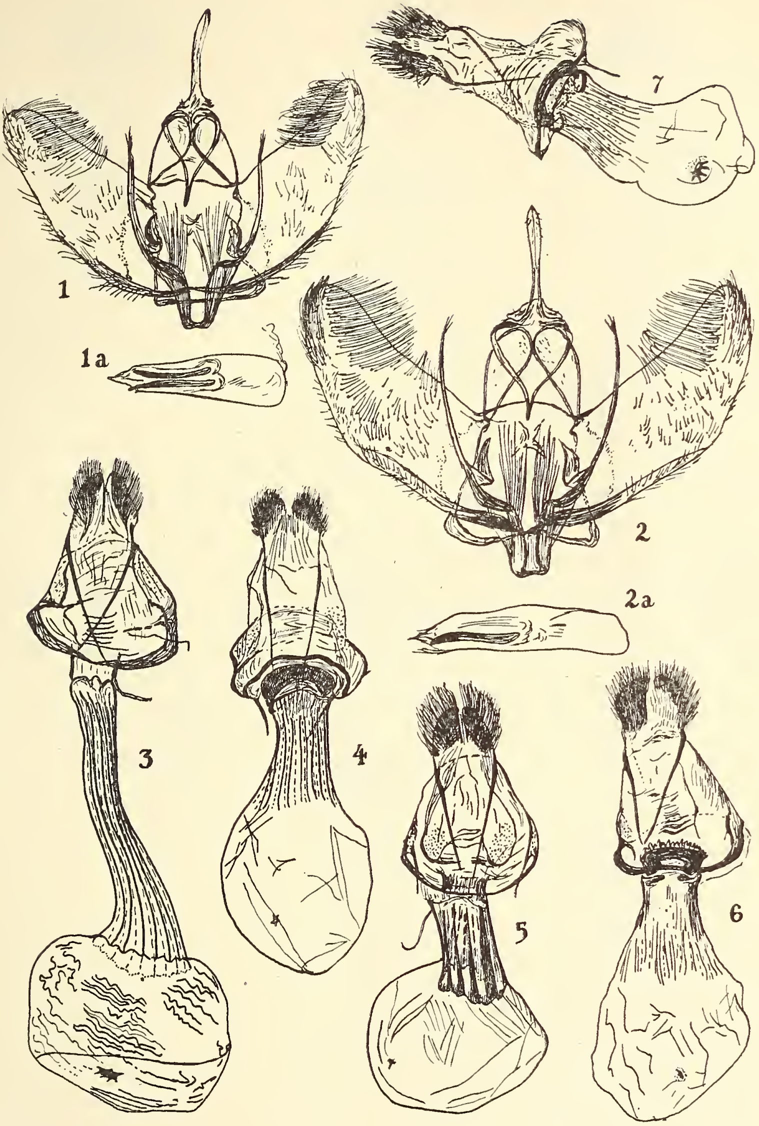
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PLATE IV

Figure 1. *Plagodis phlogosaria* Gn., female genitalia.
Figure 2. *Plagodis phlogosaria* spring form *keutzingaria* Pack., female genitalia.
Figure 3. *Plagodis alcoolaria* Gn., female genitalia.
Figure 4. *Plagodis phologosaria* race *approximaria* Dyar, female genitalia.
Figure 5. *Plagodis fervidaria* H.-S., female genitalia.
Figure 6. *Anagoga occiduaria* Wlk., female genitalia.


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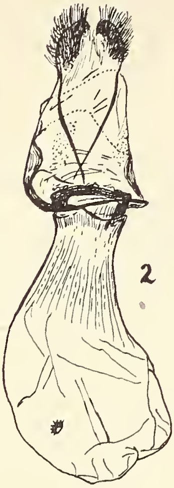
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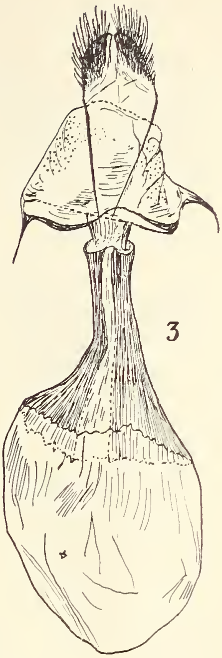
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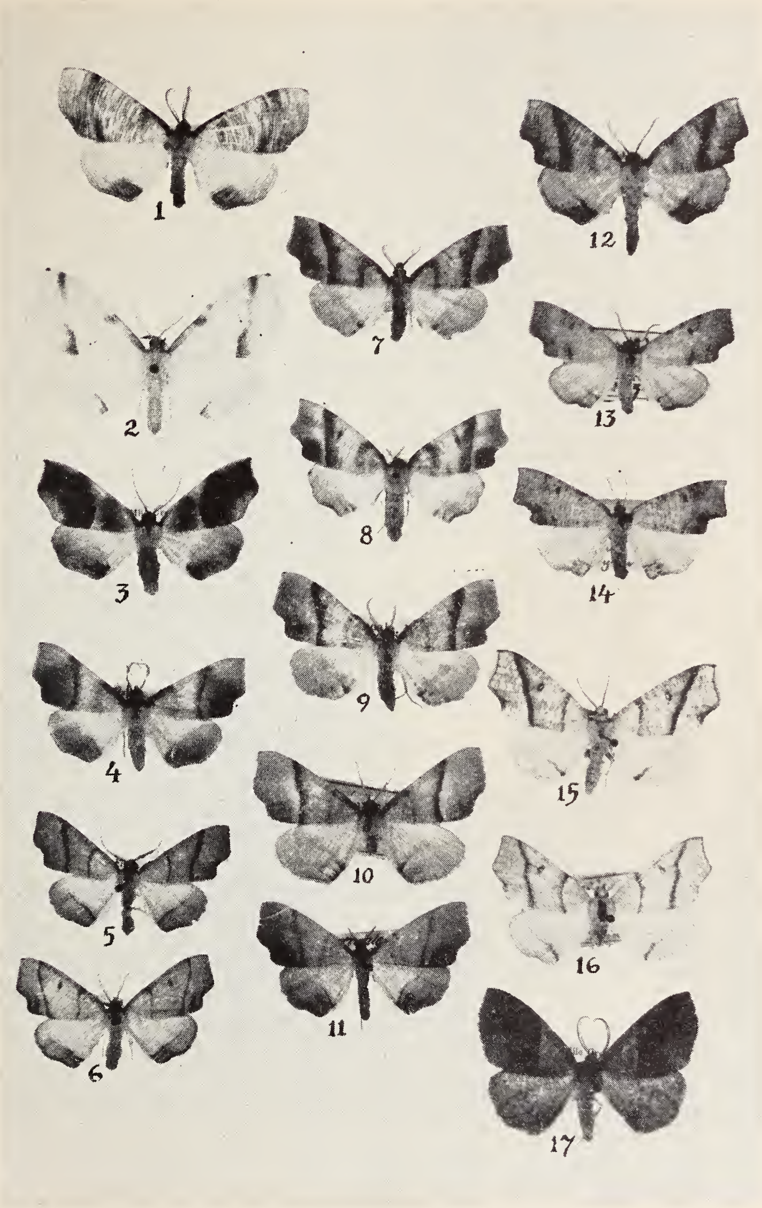
PLATE V

Figure 1. *Plagodis dolabraria* L., ♂ (Kaufung, Germany). Forbes coll.
Figure 2. *Plagodis serinaria* H.-S., ♂ (McLean Bogs, Tompkins Co., N. Y.). Franclemont coll.
Figure 3. *Plagodis kuetzingi* Grt., ♂ (Six Mile Creek, Ithaca, N. Y.). Franclemont coll.
Figure 4. *Plagodis purpuraria* Pears., ♂ (Oak Station, Allegheny Co., Penna.). Carnegie Museum coll.
Figure 5. *Plagodis purpuraria* summer form *schuylkillensis* Grossb., ♂ (Finleyville, Washington Co., Penna.). Carnegie Museum coll.
Figure 6. *Plagodis phlogosaria* Gn., ♂ (Sardinia, N. Y.).
Figure 7. *Plagodis phlogosaria* spring form *keutzingaria* Pack., ♂ (Horseheads, N. Y.).
Figure 8. *Plagodis phlogosaria* race *intermediaria* B. and McD., ♀ (Bobcaygeon, Ont., bred by McDunnough). Franclemont coll.
Figure 9. *Plagodis phlogosaria* race *iris* new race, ♂ (Armdale, N. S.).
Figure 10. *Plagodis phlogosaria* race *approximaria* Dyar, ♂ spring form (Pullman, Wash.). Cornell University coll.
Figure 11. *Plagodis phlogosaria* race *approximaria* Dyar, ♂ summer form (Warrendale, Multnomah Co., Ore.). Franclemont coll.
Figure 12. *Plagodis fervidaria* H.-S., ♂ (Camp Rucker, Ozark, Ala.). Franclemont coll.
Figure 13. *Plagodis fervidaria* summer form *arrogaria* Hlst., ♂ (Monteagle, Tenn.). Cornell University coll.
Figure 14. *Plagodis fervidaria* summer form *arrogaria* Hlst., ♀ (Oak Station, Penna.). Carnegie Museum coll.
Figure 15. *Plagodis alcoolaria* Gn., ♂ (Horseheads, N. Y.).
Figure 16. *Plagodis alcoolaria* summer form *kempii* Hlst., ♂ (Brevard, N. C.). Cornell University coll.
Figure 17. *Anagoga occiduaria* Wlk., ♂ (Six Mile Creek, Ithaca, N. Y.). Franclemont coll.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ENTOMOLOGISTS ARE HUMAN BEINGS

During the early part of 1920 a group of young entomologists of the United States published and circulated an anonymous four page circular calling attention to the fact that younger entomologists engaged in research and teaching were greatly underpaid. As a result many promising entomologists, after working for several years and being rewarded by only beggarly increases, were forced by economic conditions to seek employment in business. Their positions were filled by new men fresh from college who accepted the low salaries with high expectations, only to find within three to five years that their economic positions were almost stationary and that the well-paid positions were mostly filled by men who kept them for long periods of time.

The circular was addressed principally to the heads of departments of entomology, of whom many were, for various reasons, singularly indifferent to the monetary needs of their assistants. At that time salaries of 1,000 and 1,200 dollars per year were not unusual for assistants and increases were slow and uncertain. Considering the facts in the case the plea of the men, for increased recognition as human beings who deserved a living wage, was written with remarkable restraint.—H. B. W.

cf. N.Y. Ent. Soc. Jour., vol. 58, no. 2, p. 97, June, 1950, for authorship of this article.
hge

THE SUBGENUS PYCNOGLOSSA COQUILLETT IN NORTH AMERICA, GENUS HYLEMYIA *SENS. LAT.* (MUSCIDÆ, DIPTERA)

By H. C. Huckett

Riverhead, N. Y.

The subgenus Pycnoglossa is represented in North America by nine species, four of which have not yet been recorded. The described forms include *P. cinerosa* (Zetterstedt), *P. flavipennis* (Fallén), *P. proboscidalis* (Malloch), found also in Europe, and the native forms *P. spinosissima* (Malloch) and *P. gleniensis* (Huckett)[1]. The group is characterized by the possession of an enlarged proboscis, the labellum of which when relaxed may be seen to bear chitinous teeth or hooks. The hind tibia has an apical posteroventral bristle in all species except one of the undescribed forms, in which case the character seems to be variable. The male hypopygium and copulatory appendages do not exhibit any striking characters. However it is evident that within the group these parts tend to conform to a general pattern, which serves to suggest the common kinship of all species (Plate VII).

The distribution of the species extends throughout the eastern and north central regions of the United States and the eastern provinces of Canada. The only record I have seen outside this area is the type of *Pycnoglossa flavipennis* Coquillett, taken in the State of Washington about forty eight years ago.

The larval habits of most of the species are apparently little known. De Meijere[2] has fully described and illustrated the mining of the leaves of the fern *Pteris aquilina* by the species *P. cinerosa* of authors. Two additional hosts, namely *Polystichum sp.* and *Asplenium ruta-muraria* L. are cited by Séguy (1937).[3]

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[1] *Pycnoglossa varipes* Curran (Can. Ent., 59: 255, 1927), in my opinion, does not belong to the group, the type being an aberrant female specimen of *Hylemyia cœnosiæformis* Stein.

[2] Meijere, J. C. H. de. 1911. Über in Farnen Parasitierende Hymenopteren- und Dipteren- Larven. Tijdschrift voor Entomologie, 64: 111–114, figs. 26–30.

[3] Figures in parenthesis refer to literature citation in the synonymies as indicated by the year of publication.

Subgenus Pycnoglossa Coquillett

Pycnoglossa Coquillett, 1901. Proc. U. S. Nat. Mus., 23: 613. Aldrich, 1905. Misc. Coll. Smithsn. Inst., 46: 570. Malloch, 1924. Ann. Mag. Nat. Hist., ser. 9 14: 513. Karl, 1928. Tierwelt Deutschlands, 13 Pt. 3 p. 177. Ringdahl, 1929. Ent. Tidskr., 51: 269. Séguy, 1937. Gen. Insect., 205: 120. Kloet and Hincks, 1945. List Brit. Ins., p. 425.

Pogonomyza Schnabl and Dziedzicki, 1911. Abh. K. Leop.-Carol. Deutsch. Akad. Naturforsch., 95 (2): 99. Malloch, 1921. Can. Ent., 53: 78. Huckett, 1924. N. Y. (Cornell) Agr. Exp. Sta. Mem. 77 (1923) p. 48.

Genotype: *Musca flavipennis* Fallén (by designation of Karl, 1928).

The genus Pycnoglossa was erected by Coquillett (1901) for the reception of a single species, which he named *Pycnoglossa flavipennis.* The author placed the genus with the Scatophagidæ, and as such it was later recorded in Aldrich's (1905) catalogue of North American diptera.

In 1911 Schnabl and Dziedzicki described the subgenus Pogonomyza, and included therein the two european forms *Musca flavipennis* Fallén and *Hylemyia cinerosa* of authors.

Malloch (1924) on examining the type specimen of the genotype of Pycnoglossa noted that the specimen was an anthomyid, and concluded that the genus was synonymous with Pogonomyza and that therefore the name of the genotype was a homonym. The type specimen of Pycnoglossa is a female in poor condition, and it might well be a difficult matter to come to any definite conclusion concerning its identity were it not for the fact that Coquillett mentions in his description that the arista is plumose. With this character in mind however, there seems to me little doubt but that the species is the same as *Musca flavipennis* Fallén.

In 1928 Karl designated *Musca flavipennis* Fallén as the genotype of Pycnoglossa Coquillett.

Subgeneric characters: Head proportionately small; proboscis enlarged and fleshy, labellum toothed; vibrissæ robust, and genal bristles restricted to ventral margin, uniserial; hind tibia with an apical posteroventral bristle (which is not invariably evident in *stratifrons*); wings much broadened, costa setulose on under surface, *m-cu* cross vein erect. Male with a pair of minute parafrontal setulæ at narrowest width of frons; postocular series of setulæ short and stiffish; abdominal terga with discal as well as marginal series of bristles; hypopygium inconspicuous, anal segment (tergum 9) roundish in outline when viewed from above and strongly appressed dorsad (cephalad), sparsely and weakly bristled, nearly bisected by the anal membrane (Figs. 1, 2, 3); processes of fifth abdominal sternum laminate, sparsely and weakly bristled, and finely fringed on inner margin (Figs. 7, 8, 9).

The ventral surface of the scutellum is bare in nearly all species described from North America, the most notable exceptions in this respect being the European species *P. cinerosa* (Zetterstedt) and *P. flavipennis* (Fallén).

KEY TO SPECIES

Males

1. Aristal hairs longer than width of third antennal segment. *flavipennis* (Fall.)
   Aristal hairs shorter than width of third antennal segment 2
2. Hind femur with a series of robust bristles on median section of posteroventral surface, as stout as those on anteroventral surface; aristal hairs not longer than basal diameter of arista 3
   Hind femur with no such bristles on median section of posteroventral surface, at most the stronger bristles restricted to proximal half, otherwise bristles weak or absent 4
3. Wings yellowish; abdomen marked with a series of dorsocentral subtriangular areas; fore tibia with 1 posteroventral bristle. *proboscidalis* (Mall.)
   Wings clear; abdomen marked with a linear stripe; fore tibia with 2 posteroventral bristles .... *delicata* n. sp.
4. Eyes separated at narrowest width of frons by a distance equal to diameter of anterior ocellus, parafrontals contiguous caudad, interrupting interfrontalia .... *stratifrons* n. sp.
   Eyes wider apart at narrowest width of frons than diameter of anterior ocellus, parafrontals narrowly separated caudad, interfrontalia uninterrupted 5
5. Mid femur with one or more stoutish setulæ on distal half of anteroventral surface 6
   Mid femur with only slender setulæ on distal half of anteroventral surface 7

6. Processes fringed uniformly on inner margin with minute hairs, otherwise largely bare; mid femur with notably strong posteroventral bristles, longer than height of femur; all knees distinctly reddish yellow; ventral surface of scutellum bare .... *spinosissima* (Mall.)

Processes not noticeably fringed on inner margin, otherwise sparsely clothed with fine setulæ; mid femur with posteroventral bristles not notably stout nor long; scutellum with a few fine hairs on ventral surface .... *cinerosa* (Zett.)

7. Prealar bristle longish, at least equal to half length of following supraalar bristle, or longer; larger species, 5 mm. .... *filicis* n. sp.

Prealar bristle short, less than half length of following supraalar bristle; smaller species, 4 mm. 8

8. Hind tibia with 3 posterodorsal bristles; mid tibia with an anterodorsal bristle .... *gleniensis* (Huck.)

Hind tibia with 2 posterodorsal bristles; mid tibia with no anterodorsal bristle .... *pusillans* n. sp.

Females

1. Aristal hairs longer than width of third antennal segment. *flavipennis* (Fall.)

Aristal hairs shorter than width of third antennal segment 2

2. Prealar bristle longish, usually about equal to half length of following supraalar bristle 3

Prealar bristle shorter than half length of following supraalar bristle 5

3. Fore tibia with a robust apical posteroventral bristle; aristal hairs not longer than basal diameter of arista 4

Fore tibia with apical posteroventral bristle weak or setulose; hairs of arista slightly longer than basal diameter of arista .... *filicis* n. sp.

4. Abdominal terga 3 and 4 entirely black and shining, tergum 5 polished; caudal pair of ocellar bristles short and inclined forward; lower bristle of caudal pair of sternopleurals well developed, over half length of upper bristle .... *proboscidalis* (Mall.)

Abdominal terga 3 and 4 partly pruinescent, with an ill-defined marking on dorsocentral and anterior regions of terga; caudal pair of ocellar bristles longish and directed outwards; lower bristle of caudal pair of sternopleurals weak, less than half length of upper bristle. *delicata* n. sp.

5. Mid femur with one or more robust setulæ on distal half of anteroventral surface; fore tibia with a robust apical posteroventral bristle 6

Mid femur with no robust setulæ on distal half of anteroventral surface; fore tibia with a weak apical posteroventral bristle 7

6. Cruciate bristles well developed; anterior extension of ocellar triangle opaque and pruinescent; abdomen grayish pruinescent, and with a dorsocentral marking; knees reddish .... *spinosissima* (Mall.)

Cruciate bristles weak; anterior extension of ocellar triangle partly shining (as if abraded); abdomen black, unmarked; knees black. *cinerosa* (Zett.)

7. Second antennal segment brownish or reddish tinged; all knees narrowly brownish tinged .... *stratifrons* n. sp.

Second antennal segment blackish; all knees black 8

8. Hind tibia with 2 posterodorsal bristles; mid femur devoid of posteroventral bristles; sternopleural bristles arranged 1: 1 ... *pusillans* n. sp.

Hind tibia with 3 posterodorsal bristles; mid femur with 1 or 2 posteroventral bristles; sternopleural bristles arranged 1: 2. *gleniensis* (Huck.)

Hylemyia (Pycnoglossa) delicata, new species

MALE, closely allied to *proboscidalis* Mall., grayish black, parafrontals and parafacials whitish pruinescent; mesonotum lightly grayish pruinescent, faintly streaked along planes of acrostical and dorsocentral bristles, subshining; abdomen more densely and more completely grayish than in *proboscidalis,* the dorsocentral vitta linear; wings and calyptræ clear, hyaline, wing veins brownish; halteres yellow.

Head slightly teneral, contracting the frons; proboscis not as enlarged as in *proboscidalis;* aristal hairs not longer than basal diameter of arista; acrostical bristles weak, irregular; prealar bristle long; sternopleural bristles arranged 2: 2, the lower anterior bristle weak; under surface of scutellum with a few hairs; processes of fifth abdominal sternum sparsely and finely setose. Fore tibia with 2 median bristles posteroventrally; mid femur with no robust setulæ on distal half of anteroventral surface, and with the series of bristles on posteroventral surface extending to middle of femur; mid tibia with a median anterodorsal and posterodorsal bristle, 2 fine bristles on posterior surface; hind femur with a series of short robust anteroventral bristles, and with posteroventral bristles extending distad of middle of femur, and becoming stouter; hind tibia with a robust apical posterodorsal and posteroventral bristle, 3 posterodorsal, 3 longer anterodorsal, 4 or 5 anteroventral, of which the distal bristle is much the stronger, with a sparse series of weaker posteroventral bristles; mid and hind tarsi shorter than the respective tibiæ.

FEMALE, frontal vitta reddish on cephalic half; mesonotum more densely pruinescent; abdomen with pruinescence on terga 1 + 2, 3 and 4, tergum 5 largely lustrous, terga 3 and 4 with indications of a dorsocentral marking and dark anterior incisures; wings yellowish tinged. Cruciate and caudal pair of ocellar bristles well developed, the latter longish and directed outwards; lower bristle of caudal pair of sternopleurals weak and short. Fore tibia with 1 median posteroventral bristle, mid and hind femora with posteroventral bristles restricted to proximal half and not so robust; wings broader than in male, costal thorns and setulæ stronger. Otherwise similar to male except for sexual characters. Length, 5 mm.

Holotype: ♂, Wading River, Long Island, N. Y., May 17, 1925 [C. N. C.]. Allotype: ♀, Middle Island, Long Island, N. Y., May 30, 1931 [C. N. C.].

The male of *delicata* structurally resembles that of *proboscidalis,* differing in that the dorsum of abdomen is more completely grayish pruinescent, thereby restricting the dorsocentral marking to lineal dimensions, and in that the wings are hyaline. The female of *delicata* has distinct pruinescence on terga 1 + 2, 3 and 4. In both sexes the proboscis is not so notably enlarged as in other species belonging to the group.

Hylemyia (Pycnoglossa) filicis, new species

Male, blackish with trace of brownish gray pruinescence, subshining; interfrontalia and parafacials brownish to blackish tinged; first and second antennal segments reddish or brownish tinged; mesonotum, viewed from above and in front, with two pale streaks, each placed between the acrostical and dorsocentral series of bristles; abdomen with a series of subtriangular marks and anterior incisures; wings, calyptræ and halteres yellowish.

Eyes at narrowest width of frons separated by a distance slightly greater than that between posterior ocelli exclusive, interfrontalia uninterrupted caudad, cruciate setulæ present; aristal hairs about as long as basal diameter of arista; acrostical bristles weakly developed, prealar bristle at least as long as half length of following supraalar bristle; posthumeral bristle weakly duplicated, sternopleural bristles arranged 1:2; processes of fifth abdominal sternum slightly narrowed distad, sparsely clothed with fine slender setæ. Fore tibia with a median anterodorsal and 2 slender posteroventral bristles, apical posteroventral bristle setulose or lacking; mid femur with no robust setulæ on distal half of anteroventral surface; mid tibia with or without a weak anterodorsal bristle, with 1 posterodorsal and 1 weak posterior and posteroventral bristle; hind femur with a series of 4 or 5 longish bristles on distal two-thirds of anteroventral surface, and with a diverse series of slender bristles and setulæ on proximal two-thirds of posteroventral surface; hind tibia with 2 to 4 anteroventral, 4 to 6 anterodorsal, 3 posterodorsal, and a series of weaker bristles on median third of posteroventral surface, apical posterodorsal bristle nearly as long as apical dorsal, apical posteroventral bristle well developed. Costal thorns well formed.

Female similar to male except for sexual characters; abdomen unmarked, more shiny, less densely pruinescent; cruciate bristles well developed; caudal pair of ocellar bristles longish and directed outwards; mid tibia with a well developed median anterodorsal bristle, hind femur with fewer posteroventral bristles, hind tibia with a weaker apical posterodorsal bristle. Length, 5.25 mm.

Holotype and allotype: ♂, ♀, Hicksville, Long Island, N. Y., May 26, 1944 (H. C. Huckett) [C. N. C.]. A series of 28 specimens was collected on ferns in woods near Hicksville from May 18 to June 12, 1944.

The species *filicis* has a longish prealar bristle, a notably weak or minute apical posteroventral bristle on fore tibia, and has no robust setulae on distal half of anteroventral surface of mid femur.

Hylemyia (Pycnoglossa) pusillans, new species

MALE, blackish, subshining, with scant pruinescence on mesonotum, slightly denser on abdominal terga; mesonotum unmarked, abdomen with a broad poorly defined dorsocentral marking; wings and calyptræ faintly yellowish tinged; halteres faintly reddish tinged.

Eyes separated at narrowest width of frons by a distance about equal to that between posterior ocelli exclusive, interfrontalia uninterrupted caudad; cruciate bristles present, 2 pairs of parafrontal bristles; aristal hairs slightly longer than basal diameter of arista; acrostical bristles weak, prealar bristle short, sternopleural bristles arranged 1:2, scutellum bare on ventral surface; processes of fifth abdominal sternum proportionately broad throughout and broadly rounded at apex. Fore tibia with 1 anterodorsal and 1 posteroventral bristle, apical posteroventral bristle slender; mid femur with 1 or 2 weak posteroventral bristles on basal region, with no robust setulæ on distal half of anteroventral surface; mid tibia with no anterodorsal bristle, 1 posterodorsal, 1 posterior, 1 posteroventral bristle, all short; hind femur with 5 to 8 anteroventral bristles, with 1 or 2 weak proximal posteroventral bristles; hind tibia with 4 anteroventral, 2 long and 1 short anterodorsal, 2 posterodorsal bristles, with a few weak posteroventral bristles, apical posteroventral bristle slender.

FEMALE, abdomen shiny, unmarked; cruciate bristles well developed, caudal pair of ocellar bristles longish and directed outwards; one pair of presutural acrostical bristles longer, sternopleural bristles arranged 1: 1; mid and hind femora devoid of posteroventral bristles; mid tibia with 1 anterodorsal bristle. Otherwise similar to male except for sexual characters. Length, 3.5 mm.

Holotype and allotype: ♂, ♀, Hicksville, Long Island, New York, May 26, 1944 (H. C. Huckett), in author's collection. Paratype: ♂, Ottawa, Ontario, June 25, 1946 (A. R. Brooks) [C. N. C.].

The species *pusillans* may be readily distinguished by the presence of only two bristles on posterodorsal surface of hind tibia, and in the male by the absence of an anterodorsal bristle on mid tibia. The pubescence of arista is slightly longer than in *gleniensis*, which it most nearly resembles on account of its small size. The Long Island specimens were taken along with *filicis* on ferns in woods near Hicksville.

Hylemyia (Pycnoglossa) stratifrons, new species

Male, black, lightly grayish pruinescent, subshining; parafrontals and parafacials pruinose, second antennal segment brownish; mesonotum unmarked; abdomen with a poorly defined dorsocentral mark, which gradually becomes wider basad; knees narrowly reddish or brownish tinged; wings yellowish, and calyptræ faintly so.

Eyes at narrowest width of frons separated by a distance about equal to diameter of anterior ocellus, parafrontals contiguous caudad, interrupting interfrontalia, cruciate setulæ present; hairs of arista about as long as basal diameter of arista; acrostical bristles in two series, with one or two presutural pairs longer, prealar bristle short; sternopleural bristles arranged 1:2; ventral surface of scutellum bare. Basal sclerite of hypopygium with fine weak bristles; processes of fifth abdominal sternum broad, apical margin broadly rounded. Fore tibia with 1 or 2 median posteroventral, and 1 anterodorsal bristle, apical posteroventral bristle weak, setulose; mid femur with no robust setulæ on distal half of anteroventral surface; mid tibia with 1 weak anterodorsal, 1 posterodorsal, and 1 weak posterior and posteroventral bristle; hind femur with a series of 6 to 8 shortish anteroventral bristles, extending to prebasal region, bristles on proximal half of posteroventral surface weak or lacking; hind tibia with 4 to 6 weak anteroventral bristles, with 2 longer and 2 or more shorter anterodorsal, 3 posterodorsal, and a series of weak bristles on median half of posteroventral surface, apical posterodorsal weak, apical posteroventral weak, setulose. Costal thorns well developed.

Female similar to male except for sexual characters; frontal vitta brownish or reddish cephalad, second antennal segment yellowish brown; abdomen blackish, more distinctly subshining, unmarked; knees broadly reddish. Cruciate bristles well developed, caudal pair of ocellar bristles longish and directed outwards; lower bristle of caudal pair of sternopleurals weakly developed. Mid tibia with a well developed anterodorsal bristle; posteroventral bristles on mid and hind femora weak and sparse. Length, 5 mm.

Holotype: ♂, Hull, Quebec, June 15, 1913 (C. H. Curran), allotype, ♀, Buttonwoods, Rhode Island, June 20–21, 1912 (C. W. Johnson) [C. N. C.].

This species was recognized by Johnson (1925) as *proboscidalis* Mall., an error that caused me to apply the name to the same species in my earlier study of the New York fauna (1924).

The male of *stratifrons* may be readily distinguished from allied forms by the contiguity of the parafrontals caudad and the close approximation of the eyes at this point; in the female by the yellowish brown second antennal segment. In both sexes the knees are paler tinged, and apical posteroventral bristle on fore and hind tibiæ may be so weakly developed as to be scarcely distinguishable.

Massachusetts: ♂, Great Barrington, June 15, 1915 (C. W. Johnson) [A. N. S. P.]. ♀, Petersham, July 19, 1926 (A. L. Melander).

New York: ♂, Ithaca, May 15, 1915, 3 ♂, Hempstead, Long Island, June 19, 1921, ♀, Plandome, Long Island, May 21, 1921 (H. C. Huckett).

Ontario: ♂, Ottawa, May 23, 1938 (G. E. Shewell) [C. N. C.].

Pennsylvania: ♀, Darby, June 4, 1904 [A. N. S. P.].

Quebec: ♂, Hemmingford, Quebec, June 27, 1923 (C. H. Curran). [C. N. C.].

Rhode Island: ♂, Buttonwoods, June 20–21, 1912 (C. W. Johnson).

Vermont: ♀, St. Albans, June 21, 1913 (C. W. Johnson) [A. N. S. P.].

Hylemyia (*Pycnoglossa*) *cinerosa* (Zetterstedt)

Aricia cinerosa Zetterstedt, 1845. Dipt. Scand., 4: 1450.
Pycnoglossa luteipennis Ringdahl, 1937. Opus. Entom., 2: 126.
Pycnoglossa cinerosa Ringdahl, 1939. Opus. Entom., 4 (3–4): 147.

According to Ringdahl (1939) Zetterstedt's name *Aricia cinerosa* has been generally misapplied to denote another species, for which Ringdahl proposed the new name *setifemur*. The latter species, in my opinion, had been described earlier by Malloch (1920) under the name *Pogonomyza proboscidalis*. The male of *cinerosa* does not possess the robust postero-ventral bristles of hind femur that serve to characterize *proboscidalis*. In both sexes of *cinerosa* there are one or more stoutish setulae on distal half of anteroventral surface of mid femur, which are not evident in *proboscidalis*.

Massachusetts: ♂, Petersham, July 30, 1926 (A. L. Melander).

Michigan: ♂, Midland County, July 17, 1947, ♀, Missaukee County, July 8, 1941 (R. R. Dreisbach).

New York: ♀, Ringwood, near Ithaca, July 13, 1920 (H. C. Huckett).

Ontario: ♀, Grand Bend, July 11, 1939 (G. E. Shewell) [C. N. C.].

Hylemyia (*Pycnoglossa*) *flavipennis* (Fallén)

Musca flavipennis Fallén, 1823. Muscides, p. 59.

Anthomyia crassirostris Meigen, 1826. Syst. Beschr., 5: 107.

Hylemyia crassirostris Macquart, 1835. Hist. Nat. d. Ins., 2: 319.

Aricia flavipennis Zetterstedt, 1845. Dipt. Scand., 4: 1420.

Hylemyia flavipennis Schiner, 1862. Faun. Austr., I: 628. Stein, 1907. Kat. Paläark. Dipt., 3: 691. Stein, 1916. Arch. f. Naturgesch., (1915) 81 A (10): 148. Séguy, 1923. Faune de France, 6: 95.

Pycnoglossa flavipennis Coquillett, 1901. Proc. U. S. Nat. Mus., 23: 613. Aldrich, 1905. Misc. Coll. Smithsn. Inst., 46: 570. Coquillett, 1910. Proc. U. S. Nat. Mus., 37: 598. Malloch, 1924. Ann. Mag. Nat. Hist., ser. 9 14: 513. Karl, 1928. Tierwelt Deutschlands, 13 Pt. 3 p. 177. Ringdahl, 1929. Ent. Tidskr., 51: 270. Séguy, 1937. Gen. Insect., 205: 121. Kloet and Hincks, 1945. List Brit. Ins., p. 425.

Hylemyia (*Pogonomyza*) *flavipennis* Schnabl and Dziedzicki, 1911. Abh. K. Leop. Carol. Deutsch. Akad. Naturforsch., 95 (2): 99.

Pogonomyza flavipennis Malloch, 1921. Can. Ent., 52: 78. Huckett, 1924. N. Y. (Cornell) Agr. Exp. Sta. Mem. 77 (1923) p. 49. Johnson, 1927. Insect Faun. Biol. Surv. Mt. Desert Region, p. 211.

Hylemyia (*Pycnoglossa*) *flavipennis* Johnson, 1925. Occ. Pap. Boston Soc. Nat. Hist., 7: 235.

The species *flavipennis* may be readily distinguished from its congeners by the long pectinate aristal hairs.

Maine: ♂, S. W. Harbor, June, 1927, 2 ♂, Machias, July 19,— [A. N. S. P.].

Massachusetts: ♂, ♀, Petersham, July, 1926 (A. L. Melander).

Michigan: ♂, Alger County, July 4, 1946, ♀, Ogemaw County, June 30, 1946, ♀, Wexford County, July 5, 1940 (R. R. Dreisbach). 2 ♂, Copper Harbor, June 25, 1940, ♂, Carp Lake, July 16, 1938, ♀, Gaylord, July 17, 1938 (C. W. Sabrosky) [Mich. State Col.].

New York: ♂, Malloryville, Tompkins County, June 18–20, 1904, ♀, Freeville, July 4, 1904.

Nova Scotia: ♀, Kentville, July 15, 1924 (N. A. Patterson), ♂, ♀, Truro, July 13, 1913 (R. Matheson).

Ontario: ♀, Chalk River, August 26–27, 1919 (R. N. Chrystal), ♀, Mer Bleue, June 22, 1916, ♂, Kearney, July 8, 1926 (F. P. Ide), ♀, Ottawa, July 27, 1946 (A. R. Brooks), 2 ♂, Waubamick, July, 1915 (H. S. Parish), ♂, Severn, July 3, 1926 (C. H. Curran), ♂, Washago, June 27, 1926, 4 ♂, 3 ♀, Simcoe, June 6–19, 1939 (G. E. Shewell) [C. N. C.].

Pennsylvania: ♂, Pocono Lake, July 22, 1912 [A. N. S. P.].

Quebec: ♂, Covey Hill, June 25, 1924, 2 ♂, Lac Ste. Marie, July 27, 1936 (F. A. Urquhart), ♂, Wakefield, June 20, 1946 (G. S. Walley), ♂, Gracefield, June 14, 1937 (O. Peck), ♂, Laniel, June 10, 1944 (A. R. Brooks) [C. N. C.].

Hylemyia (Pycnoglossa) gleniensis (Huckett)

Pogonomyza gleniensis Huckett, 1924. N. Y. (Cornell) Agr. Exp. Sta. Mem. 77 (1923) p. 49.

Pycnoglossa gleniensis Leonard, 1928. N. Y. (Cornell) Agr. Exp. Sta. Mem. 101 (1926) p. 839.

The species *gleniensis*, as indicated in keys, is most closely associated with *pusillans*, from which it may be distinguished by the bristling on posterodorsal surface of hind tibia. Further comparisons between the two species may be found in the paragraphs devoted to *pusillans*.

New York: ♂, Coy Glen, near Ithaca, May 14, 1922, type of *Pogonomyza gleniensis* Huckett, ♀, Stanley, May 17, 1920 (C. R. Crosby).

Quebec: ♂, Old Chelsea, May 8 1938 (G. E. Shewell) [C. N. C.].

Wisconsin: ♂, Iowa County, May 19, 1937 (F. M. Snyder).

Hylemyia (*Pycnoglossa*) *proboscidalis* (Malloch)

Hylemyia cinerosa Stein not Zett., 1916. Arch. f. Naturgesch., (1915) 81 A (10): 147.

Pogonomyza proboscidalis Malloch, 1920. Trans. Amer. Ent. Soc., 46: 185. Malloch, 1921. Can. Ent., 53: 79. Frison, 1927. Bull. Ill. Nat. Hist. Surv., 16 Art. 4 p. 208.

Pycnoglossa proboscidalis Malloch, 1924. Ann. Mag. Nat. Hist., ser. 9 14: 513. Leonard, 1928. N. Y. (Cornell) Agr. Exp. Sta. Mem. 101 (1923) p. 839.

Pogonomyza campestris Huckett, 1924. N. Y. (Cornell) Agr. Exp. Sta. Mem. 77 (1923) p. 49.

Pycnoglossa cinerosa Karl not Zett., 1928. Tierwelt Deutschlands, 13 Pt. 3 p. 178. Ringdahl, 1929. Ent. Tidskr., 51: 270. Ringdahl, 1937. Opus. Entom., 2: 127.

Pycnoglossa setifemur Ringdahl, 1939. Opus. Entom., 4 (3–4): 147.

After examining specimens of this species from Europe and North America I have come to the conclusion that *proboscidalis* is none other than the species reported by Ringdahl (1939) to have been generally mistaken for *cinerosa* of Zetterstedt, and for which Ringdahl proposed the new name *setifemur*. The male of *proboscidalis* possesses a series of strong bristles on median section of posteroventral surface of hind femur, as is also present in *delicata*. From the latter species *proboscidalis* may be distinguished by a stouter proboscis, and in the male sex by the wider abdominal marking and yellowish tinge of wings. In the female of *proboscidalis* the abdomen is shining black, lacking pruinescence, and the fifth tergum is polished.

Michigan: ♂, Livingston County, June 6, 1943, ♀, same locality, May 28, 1944 (R. R. Dreisbach).

New York: ♀, Montezuma Marsh, June 1, 1920 (H. C. Huckett), type of *Pogonomyza campestris* Huckett.

Pennsylvania: ♂, ♀, Swarthmore, Delaware County, May 21, 1905, types of *Pogonomyza proboscidalis* Malloch. [A. N. S. P.].

Hylemyia (*Pycnoglossa*) *spinosissima* (Malloch)

Hylemyia (*Pogonomyza*) *spinosissima* Malloch, 1919. Can. Ent., 51: 95.

Pogonomyza spinosissima Malloch, 1921. Can. Ent., 53: 79. Huckett, 1924. N. Y. (Cornell) Agr. Exp. Sta. Mem. 77 (1923) p. 50.

Pycnoglossa spinosissima Malloch, 1924. Ann. Mag. Nat. Hist., ser. 9 14: 513.

The males of *spinosissima* and *flavipennis* are armed with notably stout bristles on posteroventral surface of mid femur, and in the females of both species the abdomen is greyish pruinescent with a dorsocentral marking. However in *spinosissima* the arista does not have the long plumose hairs of *flavipennis*. In the male of *spinosissima* the inner margin of processes of fifth abdominal sternum are distinctly fringed with minute hairs, and in both sexes the knees are all reddish tinged.

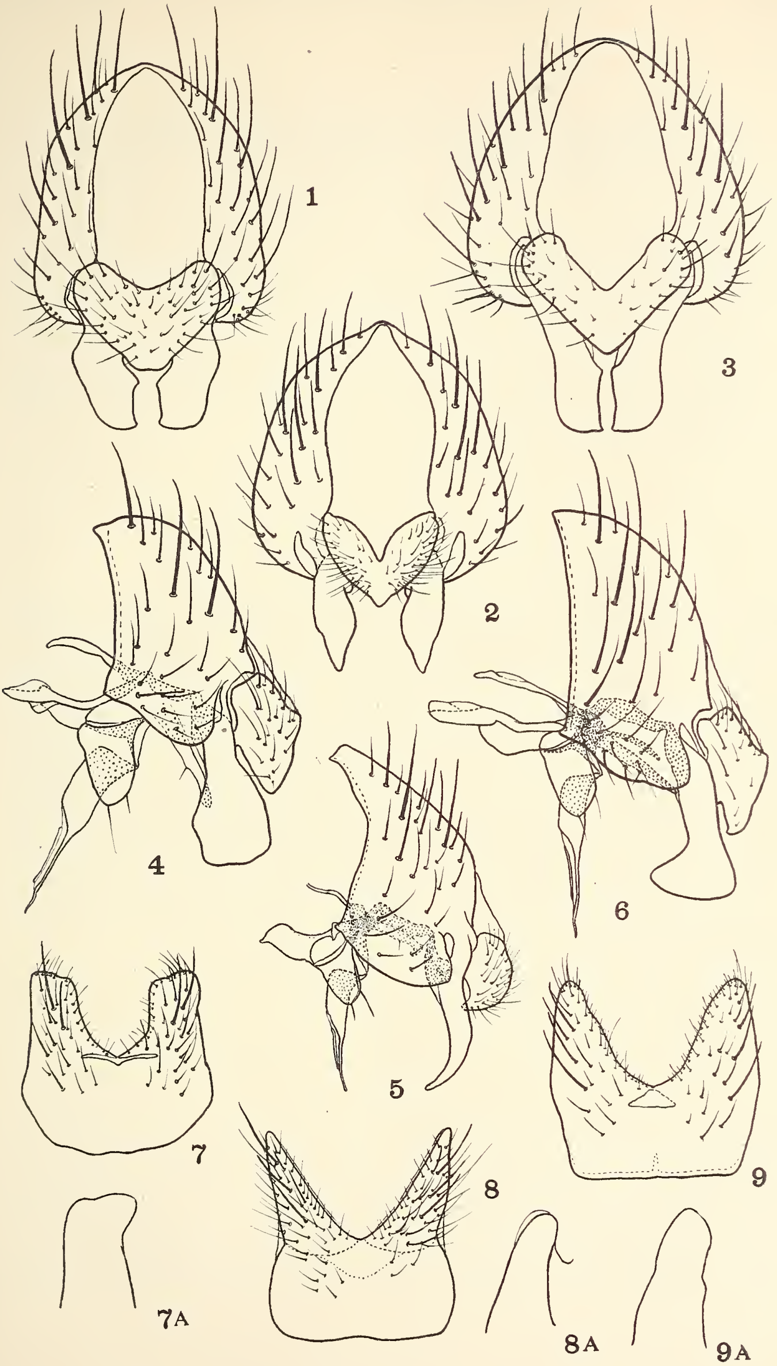
Michigan: ♂, Midland, June 6, 1936, ♂, Bay County, June 2, 1940, ♂, East Lansing, May 28, 1940 (C. W. Sabrosky) [Mich. State Col.].

Quebec: ♀, Laniel, July 18, 1939 (F. P. Ide) [C. N. C.].

Plate VI

Male copulatory appendages, showing dorsal and lateral aspects of tergum 9, ventral aspect of sternum 5 and lateral view of processes with bristles removed.

Figures 1, 4, 7, 7a. *H.* (*Pycnoglossa*) *flavipennis* (Fallén).
Figures 2, 5, 8, 8a. *H.* (*Pycnoglossa*) *filicis* new species.
Figures 3, 6, 9, 9a. *H.* (*Pycnoglossa*) *stratifrons* new species.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FIRST SCIENTIFIC BIBLIOGRAPHY

The first annual scientific bibliography in the United States was compiled by Dr. Charles Girard and published by the Smithsonian Institution in 1851. It is entitled ''American Zoological, Botanical and Geological Bibliography for the Year 1851''. Of its sixty-five pages, fifteen are devoted to entomology. Dr. Girard was a physician who published principally on herpetology, ichthyology and helminthology. At one time he was an assistant to Professor Agassiz, and to Professor Baird at the Smithsonian Institution.—H. B. W.

ENTOMOLOGY DEFINED IN 1835

''Entomology is that branch of natural science which treats of the history and habits of the insect tribes. Its subjects are the most numerous and diversified of any of those topics which engage the attention of the student of nature; and as they exemplify in a most surprising and admirable manner, both by their structure and instincts, the wisdom of the author and creator of all things, and form a highly interesting department of human knowledge, we deem their elucidation deserving of a lengthened dissertation.'' This definition of entomology is from the seventh edition of the Encyclopaedia Britannica, 1835 and was written by James Wilson.—H. B. W.

A NEW GENUS OF NYMPHALIDÆ AND ITS AFFINITIES (LEPIDOPTERA, RHOPALOCERA)

BY EUGENE MUNROE

In the course of a study of the West Indian butterfly fauna, the relationships of the species commonly known as *Mestra* (or *Cystineura*) *teleboas* came into question. Accordingly, an examination of the morphology of this and allied forms was undertaken, in order to determine these relationships as far as possible. It was concluded that *teleboas* is generically distinct from *hypermestra* Hübner, the genotype of *Mestra,* and cannot legitimately be referred to any other described genus. A brief synopsis of the genera studied is therefore presented, together with a description of the new genus.

The genera under consideration belong to a small group of Nymphalinæ, distributed in the Neotropical, Ethiopian, and Oriental regions, and characterized in the adult by the strong inflation of the basal part of subcosta of the fore wing, without a corresponding inflation of any other vein. The adults appear to be similar in habits, in whatever region they may be found; the known larvæ are also similar, and all feed on Euphorbiaceæ, mostly on species of *Tragia.* The homogeneity of the group was recognized by Doubleday and Westwood (1851), who, however, included with it certain aberrant Satyrine genera under the family name Eurytelidæ. Schatz (1887) did not treat the group as a unit, but included all its genera in the Nymphalinæ, and it remained for Aurivillius (1898) to erect the tribe Eurytelidi for the African genera. Seitz (1921) pointed out the similarities of the American genera to those of the Old World, and united them under the tribal name Ergolini.

The following ten genera, which constitute the tribe Eurytelini or Ergolini as understood by Seitz, appear, with the probable exception of *Biblis,* to be closely related. They are certainly also nearly allied to the other swollen-veined Nymphalinæ (*Eunica,* etc.), many genera among which feed on Euphorbiaceæ, while the group as a whole shows the same tendency toward specialization of the eighth abdominal sternite of the male that is so characteristic of the present tribe. There is something to be said for the gathering of all the swollen-veined forms and their allies, including even the highly specialized *Hamadryas* (*Ageronia*), in a single tribe; whether this would be the most convenient arrangement, the writer is not prepared to say: it would have the disadvantage, for instance, of obscuring the fact that the *Ergolis* complex is the only part of the group which is generally distributed, all the remaining genera, with the one exception of *Crenis,* being limited to tropical America.

The internal relationships of the Eurytelini are not entirely clear, owing to the fact that the individual genera diverge rather strikingly in structure and pattern within the limits defined by the characters of the group. Several of the more striking characters, useful in generic diagnosis, appear to be distributed haphazardly, without evident regard to true relationship. Nonetheless, certain affinities can be made out. The three genera *Ergolis, Laringa,* and *Eurytela* are closely allied, agreeing in the angular wing form and in pattern (except in certain species of *Ergolis,* mimetic of *Euplœa*), and also in some characters of the male genitalia, notably in the ædœagus, which is heavy and dorsiventrally flattened, or even trough-shaped, and in the valve, which is emarginate ventrally and closely articulated with the lateral process of the deeply bilobed juxta, so as to form a biramous composite structure. *Byblia* is evidently fairly close to these genera, having the same heavy, flattened ædœagus, but appears to be more primitive in having rounded wings, and in having the valve less intimately associated with the juxta. *Neptidopsis, Mesoxantha,* and the new genus agree in having the valve reduced ventrally but not closely associated with the juxta; otherwise the three genera are not particularly close in structure, although *Neptidopsis* and the new genus agree in pattern. This black and white pattern is suggestive of the Limenitini, and may be the primitive pattern of the group. The stout ædœagus and heavily sclerotized genitalia of *Neptidopsis* are vaguely suggestive of *Ergolis* and its associated genera, but *Neptidopsis* shows none of the definite specializations which characterize them, so the resemblance may be illusory. Like *Mesoxantha, Mestra* and *Vila* have a long slender ædœagus, but differ from all the other genera in having the valve normally developed. *Biblis* is unique in having the male palpi strikingly modified, and its male genitalia differ markedly from those of the other genera here considered; in the writer's opinion it cannot be included in the Eurytelini, and must occupy a somewhat isolated position in the general swollen-veined group.

Genus 1. *Ergolis* Boisduval

Ergolis Boisduval, 1836, pl. 4, f.4. Genotype and sole original species: *Papilio ariadne* Johannson (1763).

Ariadne Horsfield, 1829, pl. 6, f.2. Genotype and sole original species: *Papilio ariadne* Johannson (1763). Homonym of *Ariadne* Savigny (1825).

Palpi long and porrect; eyes naked. Fore wing with cell closed; lower discocellular sinuate (in *merione* and *pupillata* almost straight), terminating posteriorly at the fork of M_3 and Cu_1. Hind wing with cell closed; basal part of M_2 (middle discocellular) strongly curved; lower discocellular concave outwards, terminating at the fork of M_3 and Cu_1. Male with prominent sex scaling on the posterior half of the fore wing beneath and on the anterior part of the hind wing above, in some species also on the upper side of the fore wing. In *E. obscura,* M_3 and Cu_1 of both fore and hind wings are stalked for a short distance.

Male genitalia showing considerable specific variation; sometimes highly specialized. Eighth tergite with a weak anterolateral process on each side. Eighth sternite variable, always bilobed and spined posteriorly; in the genotype the lobes are inconspicuous and rounded, in *pupillata* they are somewhat more conspicuous and upturned, in *enotrea* they form long slender processes, which bear a comb-like row of spines and a stout terminal spine, and extend dorsad beyond the costa of the valve. Saccus slender, straight or curved, length varying with the species. Uncus rather broad, pointed, not clearly distinct from tegumen. Valve rather slender, somewhat emarginate ventrally, rounded or hooked at the tip. Juxta deeply divided, lobes closely associated with ventral margin of valves. Aedœagus variable; in the genotype long, rather slender, and slightly decurved, with a blunt tip, in other species much stouter, upcurved, and dorsiventrally flattened or even trough-shaped.

A moderately large genus, distributed throughout the Oriental and Ethiopian regions. The great variation in structure, even among the few species examined, is striking, and a morphological study of the full range of species should be most fruitful. It is quite possible that the results of such a study would necessitate the splitting of the genus, while they would certainly reveal interesting interrelationships among the species.

Species examined: *ariadne* Joh., *enotrea* Cr., *isœus pupillata* Fruhst., *merione* Cr., *actisanes* Hew., *obscura* Fldr. (external characters); *ariadne* Joh., *enotrea* Cr., *isœus pupillata* Fruhst. (male genitalia).

Genus 2. *Laringa* Moore

Laringa Moore, 1901: 24. Genotype, by original designation: *Eurytela horsfieldii* Boisduval (1833).

Palpi densely scaled, moderately long, porrect; eyes naked. Cell of fore wing closed; lower discocellular gently concave externally, ending at or slightly beyond the fork of M_3 and Cu_1. Hind wing with cell closed; M_2 sharply angled shortly beyond its origin from M_1, then rather gently curved; lower discocellular slightly concave outwards, terminating at fork of M_3 and Cu_1. Male differing from female in colour, in *horsfieldii* moderately, in *castelnaui* strikingly. Male without conspicuous sex scaling.

Male genitalia of the *Ergolis* type, but less specialized. Eighth sternite elongate, somewhat emarginate laterally, very moderately bifid posteriorly, without spines. Saccus long and slender, slightly upcurved anteriorly. Uncus simple, not sharply distinct from tegumen. Subscaphium moderately well developed, connected by lateral arms with the tegumen. Valve narrow, bearing ventrally at the base a lobe belonging to the juxta. Aedœagus heavy, depressed, upturned posteriorly.

This genus is closely related to *Ergolis,* with which it might perhaps be united, but in certain respects it appears to mark a transition to *Eurytela.* It is limited to tropical Asia.

Species examined: *horsfieldii* Bsd. (external characters and male genitalia); *castelnaui niha* Fruhst. (external characters).

Genus 3. *Eurytela* Boisduval

Eurytela Boisduval, 1833: 54. Genotype: *Papilio dryope* Cramer. Doubleday (1844) selected a genotype by elimination; this action was accepted as valid by Scudder (1875), who formally designated *dryope* as the genotype.

Palpi very long, third joint porrect; eyes densely hairy. Fore wing with cell weakly closed; lower discocellular very gently concave, terminating beyond fork of M_3 and Cu_1. Hind wing with cell closed; M_2 arising just beyond fork of RS and M_1; lower discocellular straight, arising well beyond fork of M_1 and M_2, terminating at fork of M_3 and Cu_1; fork M_{1-2} nearer base than fork Cu_{1-2}.

Male genitalia of the *Ergolis* type; eighth sternite moderately elongate, trilobed posteriorly, but with posterior median portion, including median lobe, very weakly sclerotized; lateral lobes spined. Uncus simple, clearly distinct from tegumen. Subscaphium well developed, connected with tegumen by a pair of lateral arms. Saccus moderately long, tapering anteriorly. Valve narrow, bearing ventrally at the base a lobe belonging to the juxta. Aedœagus stout, flattened, straight.

The only genus of the tribe with hairy eyes. Confined to the Ethiopian region, where three species are known, *alinda* Mab. certainly being distinct.

Species examined: *hiarbas* Dru. (external characters and male genitalia); *dryope* Cr., *alinda* Mab. (external characters).

Genus 4. *Byblia* Hübner

Byblia Hübner, 1819: 28. Genotype and sole original species: *Papilio ilithyia* Drury (1773).

Hypanis Boisduval, 1833: 55. Genotype: *Papilio ilithyia* Drury (1773), designated by Scudder (1875), who believed the two original species to be identical.

Palpi finely scaled, third joint very long and porrect; eyes naked. Cell of fore wing weakly closed; lower discocellular concave outwards, ending just beyond fork of M_3 and Cu_1. Hind wing with cell closed; M_2 strongly curved at base; fork RS–M_1 slightly nearer base than fork Cu_{1-2}; lower discocellular concave outwards, ending at fork of M_3 and Cu_1. As pointed out by

Aurivillius, in occasional specimens the hind wings have the cell open.

Male genitalia: eighth tergite with an antero-lateral process; eighth sternite long and heavy, somewhat upturned posteriorly; posterolateral angles somewhat produced, bearing three or four somewhat fusiform spines. Saccus long, slender, and curved. Uncus very slender, pointed, and decurved, clearly distinct from the tegumen; the latter bears a small posteriorly directed process on either side of the base of the uncus, representing the subscaphium, which is otherwise totally absent. Valve posteroventrally emarginate. Juxta well developed, articulating with the lower margin of the valve. Aedœagus heavy, depressed, upturned posteriorly.

A small genus, distributed throughout the tropics of the Old World.

Species examined: *acheloia* Cr. (external characters and male genitalia); *ilithyia* Dru. (external characters).

Genus 5. *Neptidopsis* Aurivillius

Neptidopsis Aurivillius, 1898: 155. Genotype: *Papilio ophione* Cramer (1779), new designation.

Palpi long, finely scaled, porrect; eyes naked. Fore wing with cell closed; lower discocellular gently concave externally, ending at fork of M_3 and Cu_1. Hind wing with cell open; fork RS–M_1 about opposite to fork Cu_{1-2}, both very close to base; M_2 strongly curved at base.

Male genitalia; eighth sternite long and slender, somewhat bilobed posteriorly, each lobe bearing a single fusiform spine. Eighth tergite with a strong antero-lateral process. Saccus long, slender, and straight. Uncus pointed, not clearly distinct from tegumen. Subscaphium well developed, connected by lateral arms with the tegumen. Valve narrow. Aedœagus long, heavy, cylindrical, straight.

Distribution Ethiopian. Of the two species included by Aurivillius, *ophione* is here selected as the type.

Species examined: *ophione* Cr. (external characters and male genitalia); *fulgurata* Bsd. (external characters).

Genus 6. *Mesoxantha* Aurivillius

Mesoxantha Aurivillius, 1898: 157. Genotype and sole original species: *Papilio ethosea* Drury (1782).

Palpi rather slender, porrect, with bushy scaling; eyes naked. Fore wing with discocellular strongly concave externally, ending slightly beyond fork of M_3 and Cu_1. Hind wing with cell closed; middle discocellular straight, arising from fork $RS–M_1$, longer than lower discocellular, the latter character being unique in the tribe; lower discocellular ending about midway between forks Cu_{1-2} and $M_3–Cu_1$.

Male genitalia: eighth sternite slightly elongate, weakly bilobed posteriorly, unspined. Saccus long, slender, and straight. Uncus simple, distinct from tegumen. Subscaphium moderately well developed, connected by lateral arms with the tegumen. Valves somewhat emarginate postero-ventrally. Aedœagus long, slender except at base, pointed, bent upwards somewhat before the middle.

The genus is confined to tropical Africa. The contrast between the primitive genitalia, which do not differ greatly from those of *Eunica,* and the specialized wing venation is striking. The venation has perhaps become modified in connection with the development of Acræine mimicry.

Species examined: *ethosea* Dru. (external characters and male genitalia).

Genus 7. **Archimestra** new genus

Genotype: *Argynnis teleboas* Ménétriés (1832)

Palpi long and porrect; eyes naked. Fore wing with cell closed; R_2 and R_3 arising together before end of cell; lower discocellular strongly concave outwards, ending at fork of M_3 and Cu_1. Hind wing with cell closed; M_2 strongly curved at base, arising slightly beyond fork $RS–M_1$; latter farther from base of wing than fork Cu_{1-2}, but both fairly close; lower discocellular concave outwards ending between forks Cu_{1-2} and $M_3–Cu_1$.

Male genitalia weakly sclerotized, with the parts somewhat reduced; eighth sternite not elongate, faintly bilobed posteriorly, without spines, though with a rather stout apical seta on each lobe; eighth tergite with a weak antero-lateral process. Saccus of moderate length, slender and slightly sinuate, pointed anteriorly. Uncus simple, clearly distinct from tegumen. Subscaphium absent, although the lateral arms articulating with the tegumen are weakly represented. Valve narrow, ventral part reduced.

Juxta weak and bifid. Aedœagus short, weakly sclerotized, moderately thick, upturned at about the middle.

The single species referred to this genus has been placed by all recent authors in *Mestra,* usually under the synonymous name *Cystineura.* The anomalous nature of the species has, however, frequently been recognized, and Seitz (1921) suggested that it might well be referred to *Neptidopsis,* in view of the similarity in wing pattern and length of palpi, but did not go so far as to make this revision himself. In point of fact, the detailed correspondence in pattern between the two genera is not too good, and, as already pointed out, the genitalia and wing venation are not similar. From *Mestra,* the new genus is easily distinguished by the closed cell of the hind wing, the sharply curved base of M_2 in the same wing, the absence of the subscaphium, and, superficially, by the strongly contrasting wing pattern of black and white. The absence of the subscaphium and the generally weak development of the male genitalia are probably secondary; the other characters of the genus may well be primitive. There is no clear indication of an immediate relationship with either *Mestra* or *Neptidopsis.*

Archimestra has a relict distribution, being confined to Hispaniola, where it is locally common. It no doubt represents an archaic type—a conjecture which has suggested the name.

Species examined: *teleboas* Mén. (external characters and male genitalia).

Genus 8. *Mestra* Hübner

Mestra Hübner, 1825, vol. 2, pl. 45. Genotype and sole original species: *Mestra hypermestra* Hübner (1825).

Cystineura Boisduval, 1836, pl. 9. Genotype and sole original species: *Papilio hersilia* Fabricius (1777).

Palpi moderately long, porrect; eyes naked. Fore wing with cell closed; R_2 and R_3 arising together at approximately the end of the cell; lower discocellular bent rather sharply near its posterior extremity. Hind wing with cell open; fork $RS–M_1$ somewhat farther from base than fork Cu_{1-2}; M_2 rather gently curved at base.

Male genitalia: eighth sternite long, narrow, bilobed posteriorly; eighth tergite with a weak, downwardly directed antero-lateral process. Saccus long, slender, and straight. Uncus simple, not clearly distinct from tegumen. Subscaphium moderately well developed, connected by lateral arms with the tegumen. Valve of normal width, bilobed at tip. Juxta weak, entire. Aedœagus pointed, slender except at base.

A Neotropical genus, with a small number of closely similar species, whose precise limits are not yet fully understood.

Species examined: *hypermestra* Hbn., *amymone* Men., *dorcas* F. (external characters and male genitalia).

Genus 9. *Vila* Kirby

Vila Kirby, 1871: 217. Genotype: *Olina azeca* Doubleday (1848), automatically, as this name was proposed to replace *Olina* Doubleday, of which *azeca* is the type.

Olina Doubleday, 1848, pl. 31. Genotype and sole original species: *Olina azeca* Doubleday (1848). Homonym of *Olina* Robineau-Desvoidy (1830).

Palpi moderately long, porrect, with third joint rather short; eyes naked. Fore wing with cell closed; lower discocellular straight, ending between forks M_3–Cu_1 and Cu_{1-2}. Hind wing with cell closed; fork RS–M_1 somewhat farther from base than fork Cu_{1-2}; M_2 rather strongly bent at base; lower discocellular strongly concave outwards, ending basad of fork M_3–Cu_1.

The above description was made from *V. cæcilia; V. emilia* agrees with it; *V. cacica* differs in having the cell of the hind wing open and that of the fore wing very weakly closed, while *V. azeca,* the genotype, has the cell open in both wings. These species are otherwise very similar in structure, and the differences mentioned do not appear to be of more than specific value.

Male genitalia (*V. azeca*): abdomen with very wide membranous pleural region; behind tergites 4 and 5 are conspicuous invaginated and presumably eversible mid-dorsal pockets, containing long, black scales. Eighth tergite with a long anterolateral process. Eighth sternite very long, extending anteriorly into segment 6; at the anterior extremity it is slender and furcate, posteriorly it is prolonged into two long, upwardly directed processes, bearing a comb-like row of long spines on the posterior margin. Saccus slender, of moderate length, bent upwards anteriorly. Tegumen broad and heavy, with a slender lateral process articulating with the valve. Uncus stout, spatulate, not clearly distinct from tegumen. Subscaphium prominent, lateral arms connecting with tegumen rather short. Valve slender, hairy, simple in outline, rather deeply emarginate basally between dorsal and ventral articulations. Juxta bilobed. Aedœagus fairly thick, upturned before middle, pointed distally.

V. cæcilia differs in having a third pouch of scales behind the sixth abdominal tergite, in having the eighth sternite only moderately expanded and bilobed posteriorly, the lobes being thickly set internally with short spines, in having the uncus slender and pointed, in the valve being provided with a hand-shaped expansion distally, and not being emarginate basally between the articulations, in the saccus being long, slender, and straight, and in the form of the juxta. Other species would no doubt show correspondingly great differences.

The genus is Neotropical in distribution.

The data concerning the original publication of *Olina* Doubleday are taken from Scudder (1875); the plate cited bears no date. Whether or not it antedated the corresponding text is immaterial from the present standpoint, as *azeca* remains the genotype in the latter event, on the basis of Scudder's designation. Those interested in this question may consult Brown (1941) and Hemming (1941).

Species examined: *azeca* Dbl., *cæcilia* Fldr. (external characters and male genitalia); *emilia* Cr., *cacica* Stgr. (external characters).

Genus 10. *Biblis* Fabricius

Biblis Fabricius, 1807: xi, no. 14. Genotype, by absolute tantonymy: *Papilio biblis* Fabricius (1775).

Zonaga Billberg, 1820: 7. Genotype and sole original species: *Papilio biblis* Fabricius (1775).

Palpi long, those of female very long; in the male the third joint is considerably modified, being short, compressed, and rounded at the tip; in the female this joint is of normal form, moderately long, and pointed at the tip. Eyes naked. Fore wing with cell closed; lower discocellular very gently convex outwards, ending distinctly basad of fork M_3–Cu_1. Hind wing with cell open; M_2 strongly curved at base, arising well beyond fork RS–M_1, which is opposite fork Cu_{1-2}. Male with a conspicuous oval patch of modified scales on the under side of the fore wings, just anterior to A_2.

Male genitalia highly modified; eighth tergite without an antero-lateral process; eighth sternite heavily sclerotized, greatly expanded, especially at front, with anterior and posterior angles heavily spined; saccus moderately long and stout; uncus deeply bifid, distinct from tegumen; subscaphium long and broad, boat shaped, with short and very broad lateral arms, which narrow rapidly toward the tegumen; valve of normal width, pointed at tip; juxta strongly bilobed; ædœagus long, slender, tubular and straight, pointed at tip.

The genitalia differ in almost every important character from those of the Ergolini, and there is little probability of a direct relationship. The single species is Neotropical.

As pointed out by Scudder (1875), D'Almeida (1942), and Comstock (1943), the type of *Didonis* is a Satyrine, and the name cannot legitimately be used for the present genus.

Species examined: *hyperia* Cr. (= *biblis* F.).

ACKNOWLEDGMENTS

The writer is greatly indebted to Dr. Wm. T. M. Forbes of Cornell University, and to Mr. Wm. P. Comstock of the American Museum of Natural History for permission to examine and dissect material in the collections of those two institutions. In addition, Dr. Forbes was kind enough to read preliminary manuscript of this paper, and offered some valuable suggestions as to arrangement and terminology.

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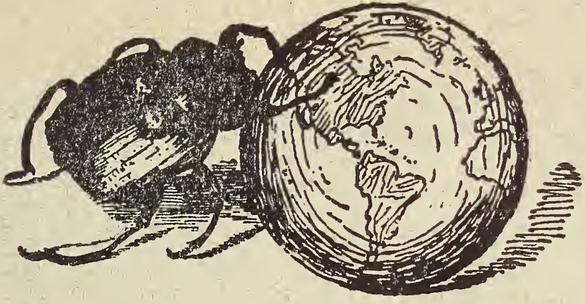
Vol. LVII No. 2

JUNE, 1949

Journal
of the
New York Entomological Society

Devoted to Entomology in General



Edited by HARRY B. WEISS

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HARRY B. WEISS JOHN D. SHERMAN, Jr.
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Subscription $5.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1949

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NOTICE: Volume LVII, Number 1, of the Journal of the New York Entomological Society was published on February 26, 1949.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

Vol. LVII June, 1949 No. 2

PHYSIOLOGICAL EFFECTS OF INDUCED HEMORRHAGE IN JAPANESE BEETLE LARVÆ

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In the course of studying various aspects of Japanese beetle (*Popillia japonica* Newm.) larvæ infected with *Bacillus popilliæ* Dutky (Beard, 1945) it was observed that blood (hemolymph) samples could be taken repeatedly from individual grubs without apparent ill effects. Since the size of the samples was relatively large on occasion, rapid replacement of blood was indicated. Confirmation of this was the primary objective of the observations reported here.

These investigations were made upon third instar larvæ of the Japanese beetle, incubated in soil with sprouting grass seed for food and maintained at a constant temperature of 80°F.

In interpreting the effects of loss of blood induced by puncturing the integument, it is important to know the normal blood volume present in an individual grub. The total blood volume of insects is difficult to determine with accuracy because of unsatisfactory techniques. Approximations can be made, however, using several methods (Richardson *et al,* 1931; Yeager and Tauber, 1932; Yeager and Munson, in press). As much as 29 per cent of the body weight of a third instar Japanese beetle grub has been lost at a single bleeding, so the total blood volume must exceed this figure at least in some individuals.

The method of Richardson *et al.,* (1931) for determining blood volume, in which the animal is cut open and the blood taken up with filter paper, yielded values ranging from 25.1 per cent to 40.8 per cent of the body weight, the mean of ten determinations being 31.9 per cent . Since these figures are little more than can be obtained by draining blood from punctured grubs killed by immersion in water heated to 60° C., the values are undoubtedly low. The difficulties with this method lie in the facts that blood in the legs, head, and other inaccessible places, is not removed, and on the other hand, as blood is removed, the fat body and other soft, loosely attached tissues may be taken out inadvertently.

Although the dye dilution method of determining blood volume is the simplest and is suitable for some insects (Yeager and Munson, *loc. cit.*), it is not usable for Japanese beetle larvæ. The dyes most useful for this purpose—Amaranth or Ponceau 3 R—when injected into beetle grubs, are not circulated promptly, but appear to be taken up locally by other tissues. Moreover the injection irritates the insect to the extent of inducing the grub to bite itself, thus causing hemorrhage. Attempts to artificially circulate the dye by gently massaging the grub while under carbon dioxide anaesthesia, have not been successful because the gut usually ruptured with such treatment.

The injection of chloride (as NaCl) and its subsequent determination after dilution by the blood likewise did not prove feasible. With this technique the chief difficulty is in the lack of a precise end-point when the chloride is titrated with silver nitrate. Neither the method of Yeager and Munson (*loc. cit.*) nor the adsorption indicator method described by King (1947) yielded reliable results with this species of insect.

Another technique, which is peculiarly adapted to determining the blood volume in Japanese beetle larvæ, has several advantages but certain technical disadvantages. This method depends upon the presence of bacterial spores (*Bacillus popilliæ*) in the blood. Infected individuals can be found in the field or infection can be induced readily by rearing grubs in inoculated soil. The technique assumes that the spores are resident only in the blood and that their distribution in the blood is uniform. Both of these assumptions are entirely reasonable in view of observations reported previously (Beard, 1945). The results obtained, however, must be expressed in terms of infected individuals, for at present it is not known if the presence of the bacteria otherwise affects the blood volume of the insects. The method, then, is to determine the number of spores in a given quantity of blood and also the total number of spores present in the grub. From these data the blood volume can be calculated simply. The concentration of spores in the blood is determined by making suitable dilution and counting with a hemocytometer. The total number of spores present is found by macerating the grub, suspending the brei in water, and counting the spores in representative samples, using the counting chamber. The spores have a characteristic shape and usually can be distinguished from the other particles in the suspension. The procedures involved are relatively simple, but two factors make for inaccuracy. One is that the spores are so numerous that great dilution is required for counting. This means that large sampling errors may occur. The other is that even though the spore is characteristic in shape, it cannot always be distinguished with certainty from other bits of tissue of the macerated grubs. A different type of counting than is usually employed, however, tends to reduce the personal error and makes possible a statistical check on the reliability of the sampling method, (Bliss, 1948). Instead of making only a total numerical count of the spores present within a given number of squares of a counting chamber, the number of squares containing 0, 1, 2, 3, . . . n spores is recorded for a total of 80 squares in each of four fields sampled separately. Agreement with Poisson distribution then serves to check on the randomness of the sample and subsamples. Bliss (*loc. cit.*) has described a method for using a truncated Poisson distribution, in which the squares of the counting chambers would be recorded in terms of those containing 0, 1, 2, 3, and 4 or more spores. While this simplifies somewhat the actual recording of data, it seems more satisfactory to record the entire series for greater precision, and in some respects, for greater ease of both execution and calculation. As might be expected, this technique demonstrated that the determination of the number of spores per unit volume of blood was more accurate than the determination of the total number of spores present in the grub. The technique can be used, however, to yield figures in which some confidence can be placed. The time required for making the determinations and calculations was great enough that, when a simpler method, described below, presented itself, no more determinations were made than were required to establish the validity of the technique.

A third dilution technique differing from those mentioned above was employed successfully by taking advantage of the spectrographic method of analysis. A known amount (7 lambda[1]) of a 3 per cent solution of manganese chloride was injected into a beetle grub of known weight anaesthetized with carbon dioxide. After a definite time interval, the grub was killed by immersion in water heated to 60° C. to inhibit blood coagulation, and a sample of blood (20 lambda) was withdrawn and absorbed on filter paper. The filter paper was then ashed, the residue taken up in 1 ml. of water, and samples were tested spectrographically[2] for manganese. This element was chosen because it is a normal constituent of the blood of this insect and because its spectrographic lines are very sensitive. Blanks and standards were prepared simultaneously by adding a known volume of $MnCl_2$ to known volumes of pooled blood. Samples (20 lambda) of these were absorbed on filter paper and analyzed in the same way as the other blood samples. By this means the normal manganese of the blood was taken into account without further correction. The standards prepared yielded reliable and reproduceable curves with which the unknowns could be compared and calculated in terms of blood volume. Determinations were made on three groups of nine grubs each, samples being taken after killing the grubs five, 10, and 20 minutes after injection. This was done because the time required for circulation, and hence good distribution, of the injected material was not known. Too short a time interval would be expected to give erratic results, whereas too great a time interval might permit the injected material to be taken up by other tissues, excreted, or possibly even induce dilution of the blood if the osmotic balance

[1] (= .007 ml.)

[2] The writer gratefully acknowledges the assistance given by Mr. W. T. Mathis in designing this technique and executing the spectrographic analyses.

was appreciably upset by the $MnCl_2$. The volume of blood found for each grub was converted to volumes per cent based on body weight, the means being as follows:

TABLE 1

	Mean blood vol. per cent	Standard error
Grubs killed 5 min. after injection	38.91	1.62
Grubs killed 10 min. after injection	42.85	2.03
Grubs killed 20 min. after injection	40.91	2.34
All determinations	40.89	1.16

Although the lower figure might suggest that five minutes was not sufficient time for the $MnCl_2$ to circulate, the difference between the mean of this group and that of grubs killed 10 minutes after injection is not statistically significant. It would appear, then, that the mean of all determinations could serve as a reasonable figure for the average blood volume of a Japanese beetle larva.

Although the hemolymph of the Japanese beetle grub coagulates promptly upon exuding from a wound, this coagulation has little effect in reducing hemorrhage, chiefly because there is an immediate and copious outflow of blood when the integument is punctured. This is borne out by the following experiment. Each of ten grubs was pricked with a needle and as the blood flowed out it was taken up with absorbent paper before it coagulated. Another series of ten grubs was similarly pricked, but the blood was allowed to coagulate before it was wiped off. Weight measurements before and after bleeding indicated the amount of hemorrhage. In the former group the loss of blood per grub ranged from 8.86 per cent body weight to 23.89 per cent with a mean of 15.74 per cent. Among the grubs whose blood was allowed to coagulate, the blood loss ranged from 5.72 per cent to 25.44 per cent, with a mean of 14.08 per cent. These differences are not significant. Bleeding tends to be less in quiet individuals which maintain good muscle tonus. The wounds in flaccid individuals do not seem to close as promptly as in others, and those highly active tend to "pump out" blood by their body movements. It has also been observed that the activity of grubs when removed from soil may open up old wounds, indicating that coagulation has not formed an efficient plug before tissue growth has healed the wound.

The maximum amount of blood a given grub can lose at one time without fatal results is, of course, impossible to determine. Among different grubs the amount that flows freely from an induced wound, without external pressure being applied, varies within broad limits. It has already been noted that in one instance 29 per cent of the body weight was lost, and among 200 grubs punctured with a needle, the loss of blood ranged from 1.3 milligrams to 59.7 milligrams, or from 0.9 per cent to 22.5 per cent of the body weight. Several observed grubs have survived losses of blood in excess of 20 per cent of their body weight, indicating that possibly as much as 50 per cent of their total blood volume might be lost at one time without fatal effects.

The effect of a single bleeding upon subsequent growth as measured by body weight was observed by wounding a series of grubs and comparing the body weights with those of uninjured grubs incubated under the same conditions. If the initial weight is taken as a point of reference, the uninjured larvæ followed the more or less expected sigmoid growth curve. Among the punctured grubs, the loss of blood, of course, resulted in an immediate reduction in body weight. This was followed by a slight further reduction in weight which may have been associated with interrupted feeding activity, as it has been observed that normal grubs when taken from abundant to restricted pasture may similarly lose weight temporarily. Although the weaker grubs continue to lose weight and eventually die, the tendency is toward a recovery of the original weight within three days after injury and a continued increase in body weight at a rate depending upon the vigor of the individual. The most vigorous individuals gain weight more rapidly than the uninjured controls, but the general tendency is to parallel the growth rate of the controls with a definite time lag. Depending upon the amount of blood lost, pupation may be delayed two or even three weeks.

Similar observations were made on the effect of repeated hemorrhages in terms of the body weight changes during a period of two weeks. Groups of grubs were punctured one, two or three times each week, or two, four or six times during the period of observation. Individual weight records were kept and the amount of blood lost was noted. The data obtained from the grubs surviving treatment are summarized in Table II, which indicates the changes in body weight based upon the means within each group and expressed in terms of the per cent of the initial weight. The net increase represents the body weight changes exclusive of the blood removed, whereas the gross increase includes the weight of the blood lost as this is tissue formed by the insect, but withdrawn from it. Data on one individual are included to indicate an extreme case.

TABLE 2

Mean Changes in Body Weight

Number of woundings	Number of insects	Per cent of initial weight		
		Blood lost	Net increase body weight	Gross increase body weight
0	16	......	47	47
2	20	25	38	63
4	22	45	28	73
6	15	51	14	65
6	1	68	−17	51

Although these summary data obscure the individual variation, it is apparent that the greater the loss of blood, the slower is the rate of increase of net body weight. In other words, blood replacement is made at the expense of other tissue formation. It is significant, however, that 50 per cent or more of the body weight can be lost as blood in a two week period and there still be an increase in net body weight. This means that the volume of blood lost probably more than equalled the normal blood volume present at one time, considering the normal blood volume to be the 40.89 per cent mentioned above. In an extreme case of the one individual indicated, which lost 68 per cent of its body weight as blood in six hemorrhages, replacement of this loss was made at the expense of maintaining its initial body weight. Even so, if this blood is included as tissue formation, the gross increase is more than equal that of the mean of the uninjured controls.

As might be expected not all grubs can withstand the drastic treatment imposed upon them in the above test, and the mortality reflects the severity of hemorrhage. This is evidenced by the mortality figures of three series of observations involving a total of 160 grubs—40 in each of the groups indicated below.

TABLE 3

Number of grubs	Number of hemorrhages	Per cent mortality at end of two weeks
40	0	17.5
40	2	37.5
40	4	35.0
40	6	52.5

In this series the higher value of 37.5 per cent over 35.0 probably has no significance.

It is doubtful if infection was responsible for any of this increase in mortality attending wounding. Although fatal infection invariably occurs if the gut is punctured, it has rarely been observed that infection from soil bacteria has resulted from wounding. Beard (1945) has given experimental evidence that preliminary wounding does not increase the infection rate among grubs exposed to heavy spore concentration of *Bacillus popilliæ,* a bacteriemic parasite of this insect.

Although the above experiments suggest a fairly rapid quantitative replacement of blood following hemorrhage, a somewhat more direct estimate of the time required for the blood volume to return to normal can be made. Actual volume determinations using the manganese dilution technique would of course be the most precise, but a simpler method can be used for comparative purposes in determining the time factor, if not the actual volume relationships. If grubs are heat-fixed to prevent blood coagulation, it is found that considerably more blood can be drawn from normal grubs than from grubs that have been wounded previously. Accordingly, by determining the amount of blood that can be drawn from wounded grubs at various times after hemorrhage in comparison with that from intact controls, the approach to normal can be approximated. In such a test, the wounded grubs yielded 67 per cent of that from uninjured controls seven hours after hemorrhage, 88 per cent 24 hours after hemorrhage, and 91 per cent after 48 hours. Of course these figures definitely exaggerate the difference in terms of the true values because of the residual blood that cannot be drained. Although the return to normal is probably more or less asymptotic, these data tend to support the impression gained in the above experiments that normal blood volume is essentially restored within two to three days after hemorrhage.

Some consideration was given to the qualitative effects of induced hemorrhage.

Specific gavity determinations were made on samples of blood taken from grubs seven, 24, and 48 hours after wounding, using a falling drop technique essentially that of Barbour and Hamilton (1926). Similar determinations were made on samples taken from intact grubs handled under the same environmental conditions. Successive samples could not, of course, be taken from the same grub, so for each time interval, groups of 5 larvæ each were tested independently. The mean specific gravity for each group was found to be as follows:

TABLE 4

	Mean loss of blood (mg/gm body weight)	Specific gravity Hours after hemorrhage		
		7	24	48
Wounded grubs	45.6	1.0294		
	95.2		1.0308	
	61.4			1.0311
Intact controls	0.0	1.0408	1.0346	1.0338

As compared with the controls, the specific gravity of blood from the test grubs was significantly less among the samples taken seven hours after hemorrhage but, as time went on, it gradually approached the normal control, the differences being not statistically significant at the 24 and 48 hour intervals. It will be noted, however, that the reduction of the difference between the groups is due less to an increase in specific gravity of the test insects than it is to a decrease in the specific gravity of the blood from the control grubs. The reason for the latter is not known, but it may be associated with the change in pasture, since all grubs were removed from a common rearing container to individual containers for each group with a replenished source of food. The fact that the second group of wounded grubs lost an appreciably greater amount of blood than the other groups does not seem to affect the recovery trend.

Spectrographic analyses were made* of pooled samples of blood taken from grubs seven, 24 and 48 hours after hemorrhage induced by wounding. Similar analysis was made of blood from comparable controls, duplicates being run of both series. The spectrographs of all samples were similar in most respects and, while certain slight variations appeared, these could not be attributed to the effect of loss of blood prior to sampling. The lines representing aluminum, copper, magnesium, and phosphorus were remarkably uniform. Those of sodium, calcium, manganese, and iron showed more variation, but the control samples varied as much among themselves as with the samples from bled grubs. One notable difference appeared, however, in both of the duplicate blood samples taken seven hours after hemorrhage. This was a difference in the potassium lines, indicating a definite reduction in the blood K, which was not apparent in the samples taken 24 and 48 hours after injury. It would seem that chemical balance is restored within 24 hours, but following bleeding there is a depletion of blood K due either to a selective withdrawal of K by other tissues, or what is more likely in view of the reduction in blood density, to a slower replacement of K than of the other common elements at the time the internal water balance is being restored.

From previous observations, both published and unpublished, it is known that the blood cell counts of Japanese beetle larvæ may vary within wide limits even under apparently normal conditions. It is not surprising then, to find that blood cell counts taken approximately six hours after induced hemorrhage do not differ significantly from those of grubs not wounded, as judged

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* These analyses were made through the kindness of Mr. W. T. Mathis.

by four determinations in each group. The data obtained are as follows:

TABLE 5

Blood cells per mm³ in

	Wounded grubs	Intact grubs
	6,200	10,450
	8,600	14,825
	19,600	19,300
	34,950	33,100
Mean	17,337	19,419

Although the accumulation of a larger mass of data might demonstrate a statistically significant reduction in the number of blood cells in wounded grubs, it seems apparent from these few figures that there is no very striking difference and additional counts do not seem called for in an attempt to prove a difference.

Concluding from a single test series, there is no apparent change in the blood pH following hemorrhage, as measured by a quinhydrone electrode designed to measure pH of single drops of fluid. Six hours after hemorrhage was induced by puncturing the integument, determinations were made on the blood of each of five wounded grubs and of five intact grubs as controls. Although too much confidence should not be placed in the results because of the technique employed, the variation among the grubs within a group was great enough to indicate no statistical difference between the groups. The pH of normal blood exposed to air may be taken to be approximately 7.2.

Discussion: From the data presented, it is obvious that although loss of hemolymph is not uniformly tolerated, surprisingly large volumes may be drained from a grub, particularly if repeated wounds are inflicted. Comparatively little is known about hemotopoiesis in insects, although it is generally believed that new blood cells are formed from those in circulation. The wide variation in numbers of hematocytes normally found make it difficult to learn much about blood replacement from them, but in view of the various functions of the blood, perhaps the plasma relationships are more important. The diminished specific gravity of the residual blood following wounding suggests that other tissue fluids are poured into the circulating fluid which is thereby diluted, but this cannot be adequate in meeting the loss because the total blood volume remains subnormal for a period of two to three days. Apparently this is not restored until ingestion of succulent food and the accumulation of metabolic water make up the loss. There also appears to be a rapid mobilizing of the common inorganic constituents with the exception of potassium, the replacement of which is delayed. Undoubtedly the picture would be clearer if quantitative determinations had been made of the organic constituents of the blood, particularly those of glucose, glycogen, and amino acids. In any case it seems certain that when tissue fluid replaces that lost from the circulation, various constituents are contributed more or less independently and at different rates before the "normal" balance is restored.

SUMMARY: The mean volume of blood in a third instar Japanese beetle larva was estimated to be approximately 40 volumes per cent body weight, as determined by a manganese dilution technique using spectrographic analysis.

Coagulation has little effect in reducing hemorrhage induced by puncturing the integument, and in some individuals an estimated 50 per cent or more of the blood volume can be lost at one time without fatal results. Hemorrhage results in a loss of body weight greater than the weight of the blood lost, but this tends to be restored within two to three days following injury. Thereafter body weight increases tend to parallel the growth rate of uninjured controls, but with a definite time lag. Pupation may be delayed two to three weeks, depending upon the amount of blood lost. Repeated hemorrhage causes mortality in direct relation to the extent of bleeding, but among the survivors of such treatment, 50 per cent or more of the body weight can be lost as blood in a two week period and there still be an increase in net body weight.

Quantitatively, blood replacement approaches completion two to three days following hemorrhage. Qualitatively, the specific gravity of the blood becomes less following hemorrhage, but approaches the normal after 24 hours. Similarly there is a de-

crease in blood potassium following loss of blood, but this is restored within 24 hours. Other elements tested appear to be unaffected by this type of injury. The pH of the blood and the number of blood cells per unit volume appear to be relatively unchanged as a result of bleeding.

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BOOK NOTICE

Coleoptera or Beetles East of the Great Plains. By J. Gordon Edwards. Lithoprinted by Edwards Brothers, Inc., Ann Arbor, Michigan. 1949, 181 pp.

This book consolidates much information that will be of use to students of Coleoptera. Illustrated and simplified keys are given to the families of beetles occurring east of the Great Plains (east of the Mississippi River), and a general discussion is given of each family and in some instances of the genera and species in these families. The latest family nomenclature has been followed and, although the families have been arranged alphabetically throughout most of the book, a phylogenetic list based primarily upon the morphology of the beetle larvæ is presented. A glossary of terms used in the book is included for the use of the beginning student and a list of important supplementary references follows the discussion of each family. An interesting tabulation of the 136 families occurring in the United States, based on Leng's catalogue, reveals that in the area east of the Mississippi River there are approximately 8,346 species and 553 varieties described to date. In the area west of the Mississippi River there are known to be some 15,371 species and 1,548 varieties. The book will be a valuable addition to the libraries of beginning students and amateur coleopterists.—Mont A. Cazier.

DISTINCTIVE FEATURES OF THE LARVÆ OF AEDES ALLENI TURNER (DIPTERA: CULICIDÆ)[1, 3]

By Osmond P. Breland[2]

The University of Texas

INTRODUCTION

The adult of the mosquito, *Aedes alleni* Turner was described in 1924 from insects reared from larvæ collected in a rot cavity of a willow tree at Mission, Texas (Turner 1924). The larva was described during the same year from specimens taken at the same locality (Dyar 1924). Since the original description, the collection of the species has been reported several times in the literature, but it has not been collected in large numbers, and has been considered relatively rare. The mosquito is now known to occur in Texas, Oklahoma and Kansas (Jenkins and Carpenter 1946). According to Jenkins and Carpenter (1946), willow is the only kind of tree from which larvæ had been collected at the time their paper was published, although these authors state that larvæ have been found in artificial containers.

In reported collections, *A. alleni* larvæ have usually been associated with *Aedes triseriatus* (Say), another tree hole breeding form. The adults of these two species are relatively easy to distinguish, one of the outstanding differences being the white banded tarsi of *A. alleni* as opposed to the dark tarsi of *A. triseriatus*. The larvæ of the two species, however, have been considered to be almost identical, although various structures have been reported to distinguish them. Within the past few years it has become increasingly evident that at least some previously used criteria cannot be relied upon for the separation of the two species.

During the past several years the writer and his associates have made a large number of collections of tree hole breeding mos-

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[1] Supported by The University of Texas Research Institute.

[2] The writer greatly appreciates the assistance of Mr. Orin Wilkins, who helped with the collections of the larvæ discussed in this paper, and of Mrs. Roland Schmitt who made the drawings.

[3] Considered by some to be a *Synonym* of *Aedes zoosophus* Dyar & Knab.

quitoes from central Texas. *Aedes alleni* occurs in fair numbers in this area, but it is considerably outnumbered by *A. triseriatus.* Numerous larvæ of both species have been studied with the objective of finding constant distinguishing features between the two species. In the writer's collections *Aedes alleni* has usually been associated with *A. triseriatus,* and it is conceivable that this almost invariable association has been one reason for the confusion now existing regarding distinguishing features of the two forms. Workers may have studied a mixed population, believing that it consisted of only a single species.

Larvæ of *A. alleni* have been collected from tree holes in several species of trees including live oak (*Quercus virginiana*), post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*) and elm (*Ulmus crassifolia*). The writer has not collected the mosquito from artificial containers.

METHODS

Larvæ of *Aedes alleni* and *A. triseriatus* were collected and brought into the laboratory for rearing. They were placed in individual staining dishes and reared at laboratory temperature in tree hole water which was replenished by water from an artificial pond as it evaporated. Some of the water was so dark that the larvæ could not be seen, and in such cases clear water was added until the insects could be distinguished. When the adults emerged, the fourth larval skins were checked for distinguishing features. As soon as such structures were discovered, living larvæ were then isolated on the basis of these features, and the distinctions confirmed by rearing the larvæ to adults.

The conclusions to be presented are based upon a study of a large number of living larvæ, freshly killed specimens, mounted and preserved larvæ and larval skins from which known adults have been reared. More than 50 larvæ and larval skins of each species from several localities have been studied in detail, and certain structures have been checked on many more specimens. Larvæ of *A. alleni* have been studied from many collections near Austin, Texas, and the conclusions confirmed by reared specimens from Round Rock, Stephenville, Bartlett and Fredericksburg, Texas. Larvæ of *A. triseriatus* have been examined from

Austin, Luling, Round Rock, Stephenville, Bartlett and Marquez, Texas. Since numerous specimens from several localities have been examined, it is believed that the most important variations in the populations of this general area have been noted. Additional collections from distant localities may reveal other variations.

LARVAL FEATURES STUDIED

The following larval features were studied with the results indicated below.

HEAD HAIRS: According to Dyar (1928) the larvæ of *A. triseriatus* have two branches in the lower head hairs while those of *A. alleni* have four. However, there is considerable variation in both upper and lower head hairs. In the majority of both species, the upper head hairs are single, but in some cases the upper head hairs are double, and in a few specimens one hair is single while the other is double. Double upper head hairs occur more often in *A. alleni* than in *A. triseriatus.* Lower head hairs vary from two to four in both species, and the number may be different on opposite sides of the head. Two larvæ of *A. triseriatus* were seen that had only one branch in one lower head hair and two in the other, while a single larva of the same species was examined in which both lower head hairs were single.

SUBVENTRAL TUFT (*Siphonal Tuft*): The majority of both species in this area have a subventral tuft of two branches with an occasional specimen having three. Two larvæ of *A. triseriatus* were examined with a single hair, but no single-haired *A. alleni* were discovered.

COMB SCALES: Matheson (1944) distinguishes the two species on the basis of shape of comb scales. There is some average variation in the number, arrangement and shape of the comb scales, but the differences are slight and overlapping occurs. In both species the comb scales may be different on the two sides. In *A. triseriatus* the number of comb scales vary from 6 to 14 on one side, and they form a partial double row in most cases. In a few specimens with a low number of comb scales, the structures occur in a single row. The individual scale of *A. triseriatus* is usually somewhat more slender and thorn-like than in *A. alleni,* but these differences are not invariable. The larvæ of *A. alleni* have from

6 to 12 comb scales, sometimes arranged in a partial double row, and in other cases forming a single essentially straight row. More larvæ of *A. alleni* than *A. triseriatus* have been examined in which the comb scales are arranged in a single row.

LATERAL HAIR ABDOMINAL SEGMENT: Dyar (1928) indicates that 4 branches occur in this hair in *A. alleni* while larvæ of *A. triseriatus* have 7. The number of branches in the writer's specimens varies from 2 to 8 in *A. triseriatus,* and from 3 to 7 in *A. alleni.* The number of branches is frequently different on the two sides. As will be indicated more in detail later, the position of attachment of this hair to the dorsal plate differs somewhat in the two species.

DORSAL BRUSH: Matheson (1944) states that larvæ of *A. alleni* have a dorsal brush consisting of 1 long hair plus 6 shorter hairs on each side, as opposed to 1 long hair and 7 shorter hairs in *A. triseriatus.* Jenkins and Carpenter (1946) report specimens of *A. alleni* with 7 or 8 short hairs in addition to the long one. In this area, larvæ of *A. alleni* that were studied have a dorsal brush that varies from 4 to 8 short hairs plus the long hair. More specimens have 5 short hairs than any other number. *A. triseriatus* varies from 4 to 8 short hairs with 6 being the most common number. The number of short hairs may be different on opposite sides in both species.

SIPHON: As a rule, the siphon of *A. alleni* is somewhat stouter than that of *A. triseriatus,* but the distinction is slight and overlapping occurs so that the feature is of doubtful value in separating the two species.

COLOR: All larvæ of *A. alleni* that have been seen are almost white in color, the head, siphon, dorsal plate of the abdominal segment and comb scales usually being the only dark parts. The thorax is occasionally of a light brown color, but the abdomen is frequently semi-transparent so that tracheæ, parts of the digestive tract and other structures can be seen through the body wall. The dorsal posterior margins of the abdominal segments are usually obscure, and no specimens have been noted in which the abdomen contained dark pigment.

Most larvæ of *A. triseriatus* are dark or black in color, but some appear almost as light as *A. alleni* when they are examined with the unaided eye. Under the binocular microscope, however, even these light specimens usually exhibit some dark pigment near the dorsal posterior edges of the abdominal segments so that the margins can be easily distinguished. So far as could be determined, pigmentation differences are not influenced by the color of the water in which the larvæ are developing. Both light and dark specimens may occur together in clear as well as in very dark tree hole water.

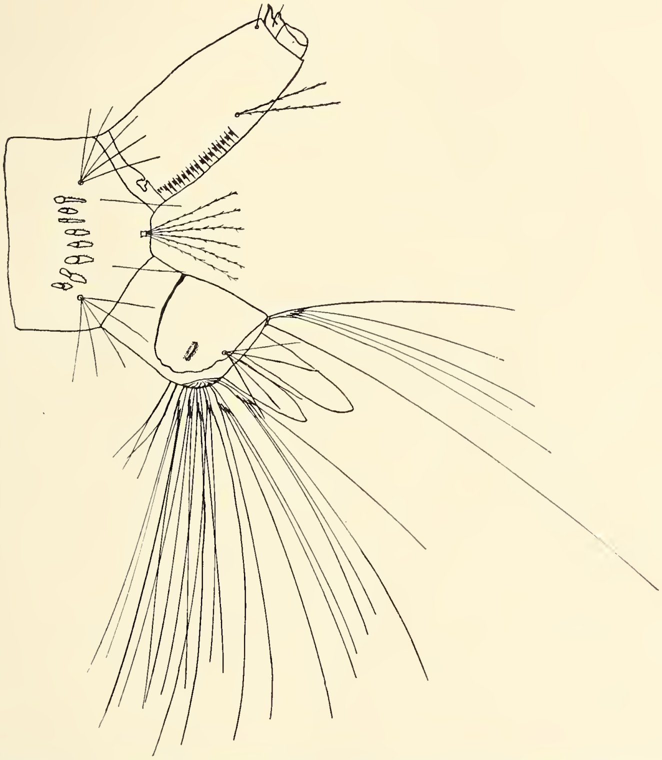

Figure 1. Posterior segments of larva of *Aedes alleni* Turner.

It is thus frequently possible to separate tentatively living larvæ on the basis of color, but this feature is not as reliable as structural differences to be noted later. Pigmentation differences are frequently not of value in distinguishing preserved or mounted specimens.

DORSAL PLATE ANAL SEGMENT: This plate is the only structure in which invariable differences between the two species of larvæ have been found. The larvæ of *A. alleni* have a definite depression in this plate on each side near the ventral margin (Fig. 1). The appearance of these depressions varies considerably. In some specimens it is large, almost round, and under the low power of a dissecting microscope the area is so transparent that it appears to be a hole. In other larvæ of *A. alleni,* the depressions are not obviously thinner than the surrounding areas of the plate. A dark margin about each depression causes it to be noticeable. Details of structure of these depressions are difficult to distinguish. If the dorsal plate is removed from the anal

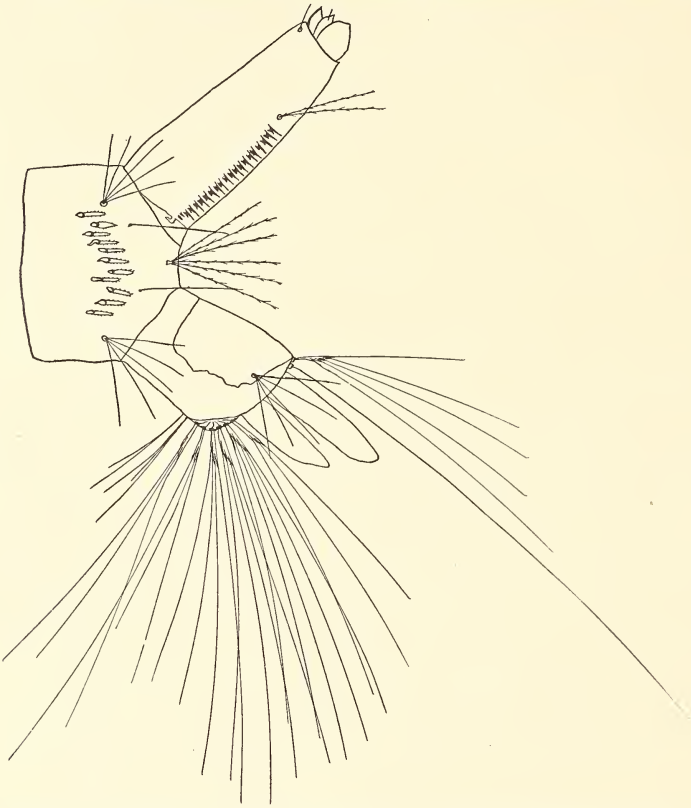

Figure 2. Posterior segments of larva of *Aedes triseriatus* (Say.)

segment, a thin membrane, very difficult to dissect away, adheres closely to the under surface of the plate. It appears, however, that in some instances the depressions completely penetrate the plate, but not the membrane, while in other cases true depressions rather than holes are formed.

These depressions do not occur in *A. triseriatus* (Fig. 2), although the lower margin of the plate may be irregular or notched. The dorsal plate frequently extends farther ventral in *A. alleni*, and the attachment of the lateral hair of the abdominal segment in this species is usually near the center of the posterior border of the plate. The attachment of the lateral hair in *A. triseriatus* is near the ventral edge of the plate in most cases.

The writer does not have any suggestions as to the possible function of these depressions, but it appears that the structures may have arisen by one of two possible methods. A single mutation may have resulted in the depressions appearing fully developed, or they may have arisen by a series of steps. The depressions have never been found in *A. triseriatus*, although a notch frequently occurs near the center or the ventral margin of the plate on each side. A mutation causing an extension of the plate on each side of and ventral to the notch, could conceivably have resulted in the condition now present in *A. alleni*. This later theory would be more tenable if it could be demontrated that notches and depressions in the dorsal plate have more survival value than plates with smooth ventral margins.

SUMMARY AND CONCLUSIONS

1. A study has been made of series of larvæ of *Aedes alleni* Turner and *Aedes triseriatus* (Say) collected from tree holes at several localities in central Texas. The objective of this study was to determine if there are distinct morphological differences of practical value for distinguishing between the larvæ of the two species. Distinctive features were discovered by rearing the larvæ individually and by studying the fourth instar larval skins of known adults.

2. It was found that criteria used in the past are of doubtful value in distinguishing the species, since in a large series overlapping occurs; or the differences are so slight that their use is impractical for one unfamiliar with the two species. Previous

records of *A. alleni* based only upon larval determinations are thus open to question. Records of *A. triseriatus* from larval determinations are not as doubtful, since *A. triseriatus* is much more common than *A. alleni,* and in most instances, collections of *A. alleni* have also yielded *A. triseriatus* larvæ.

3. All larvæ of *A. alleni* that have been examined are light in color, while most of *A. triseriatus* are dark to black. The two species may thus be tentatively distinguished on the basis of color, but this feature alone is not as reliable as certain structural differences. Some larvæ of *A. triseriatus* are almost as light as those of *A. alleni,* and pigmentation differences are not as evident in preserved or mounted specimens.

4. The structure of the dorsal plate of the anal segment has been found to be different in all larvæ of the two species that have been examined. In *A. alleni* there is a definite depression near the ventral margin of the plate on each side. Larvæ of *A. triseriatus* do not have these depressions, although the ventral margins of the plate are frequently notched or irregular. The lateral hair of the abdominal segment is usually attached near the center of the posterior edge of the plate in *A. alleni,* while in *A. triseriatus* the attachment is most often farther ventral. The dorsal plate frequently extends farther ventral in *A. alleni* than in *A. triseriatus,* and in some instances the plate almost surrounds the segment in the former species.

5. This study emphasizes that a large series of larvæ may exhibit considerable individual variation, and that such structures as hairs and comb scales may be different on opposite sides of the same specimen.

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EXPERIMENTS ON THE COLONY FOUNDATION OF EUROPEAN ANTS[1]

BY DR. ARNULF MOLITOR
PERCHTOLDSDORF BEI WIEN, AUSTRIA

Since experiments on colony foundation in general have been needed for a long time, and since I have been able to work with only a few species and individuals up until now I am quite aware in presenting the following observations of the impossibility, at this time, of drawing from them conclusions that are relatively broad in their significance. I offer these observations to the public nevertheless, since as Eidmann[2] has pointed out, "Each success [of such an experiment] is to be marked down as a lucky incident," upon whose repetition we must not count with certainty. Above all, I hope to interest younger American myrmecologists in similar experiments, especially with the American races of the European species treated in this paper, since these races may show some degree of deviation in their behavior and may therefore deter us from making hasty generalizations.

1. *Messor barbarus structor* (Latr.)

This species is common in this vicinity. For some years I have observed as early as April, but never much later, numbers of the young wingless queens following the nuptial flight. This seems strange inasmuch as the mating of the other Myrmicinæ

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[1] TRANSLATOR'S FOOTNOTE: This paper was translated from the manuscript of Dr. Molitor, which was entitled: "Versuche betreffend die Koloniegründing Europäischer Ameisen." Inasmuch as there is a critical paper shortage in many parts of Europe, few workers can now publish the results of their work. I was happy therefore to help Dr. Molitor in the matter of translating the present paper.

I wish here to express my appreciation to Miss Doris Sharpe of the Department of English for her kindness in eliminating some of my errors of English from the preliminary manuscript. Many thanks are also due my wife who kindly consented to type the final manuscript.—Prof. M. W. Wing, North Carolina State College of Agriculture and Engineering of the University of North Carolina, Raleigh, North Carolina.

[2] "Weitere Beobachtungen über die Koloniegründung einheimischer Ameisen", *Zeitschr. vergleich. Physiologie,* 7. Band, 1. Heft, 1928.

does not take place before the beginning of the astronomic summer (at the earliest, in late June for *Tetramorium;* at the latest, August to the end of October for *Solenopsis*). And furthermore the nuptial flight of *Messor structor,* a so-called ''xerothermic species'' of decidedly more southern distribution, would be expected in a warmer season. The mating takes place in November in the Mediterranean region, at least in the Balearic Islands, according to information received from Prof. Eidmann. In the vicinity of Vienna the sexual forms of our species are to be found from the end of August in the nests, where they overwinter. The riddle then is solved very simply by the assumption that the seemingly very early nuptial flight is in actuality a delayed one caused by the comparatively colder autumn weather of our region where, after the emergence of the males and the queens in a given year, nothing more can take place.

Concerning the colony foundation of *M. structor,* there exist so far as I know only the experiments of E. Meyer[3], who on this subject states among other things: ''The nutrition of the young ant family and the mother ant herself, while they are still shut off from the outer world occurs . . . above all at the cost of the eggs laid by the queen, and also to a certain degree other immature stages (larvæ).'' Prof. Eidmann is inclined, and I think correctly, to associate this kind of ant nutrition with the independent[4] method of colony foundation. If it occurs in *M. structor* (a grain ant), which lives principally on vegetable food, then it certainly must occur in carnivorous ants.

My own experimental plan varied from that of Meyer, with which I was not then acquainted, in that I placed together in a roomy glass container furnished with some moist earth, two young wingless queens which had just been collected on the surface of the ground. The queens were fed with rice, dough, and seeds. The result was that they soon began to lay eggs, from which larvæ hatched. By the beginning of the summer these larvæ had developed into large and small workers. *Messor* work-

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[3] ''Die Ernährung der Mutterameise und ihrer Brut während der solitären Koloniegründung'', *Biol. Zentralbl.* Band 47, 1927. Cited from the above-mentioned work of Eidmann.

[4] That is, colony foundation by a lone queen, without the help of workers of her own or of another species.

ers are typically dimorphic. The two queens lived at complete peace with each other not only before the appearance of the workers, but also for a long time thereafter. During this time I never observed fights between them, but one day I found the body of one of the queens without the head. It lay nearby, appearing to have been bitten off. Unfortunately, it was impossible to determine whether the other queen or perhaps some of the workers were the culprits.

In one of the cases which Meyer reported a *M. structor* queen lived 396 days without food, but did not succeed in founding a colony. She had replenished the dwindling reserve materials of her body by eating her own brood. It should not, however, be assumed that the success of colony founding is dependent upon food. On the contrary, according to the accounts of Prof. Eidmann, which, of course, deal with other species also characterized by independent colony foundation, it appears that the feeding of the queen before the emergence of the first workers tends to endanger the outcome.

2. *Tetramorium cæspitum* (L.)

About four or five young deälated queens were captured at the end of June last year. They were all put into a glass container like the one mentioned above. They received moist sand[5] for nest material, but they were not fed. After a relatively short time, still in the month of July, I found adhering to one another in this nest a sizable group of eggs, which the queens, who were completely friendly, were tending together. Unfortunately I lost this colony because of my lack of attention and my forgetfulness. I neglected it when it should have been watered. Whether the artificial Pleometrosis (in the sense of Wasmann) would have continued is difficult to say. Since I collected the queens all in close proximity to one another and at the same time, approximately within one or two hours, it is quite possible that they all came from the same nest. The possibility of their all having the same common nest odor may have accounted for their friendly association with one another. In

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[5] Sand is especially suitable for this purpose, since it becomes moistened throughout, does not mold, and allows the ants to dig and build with ease.

nature I have never found more than one queen in a *Tetramorium* nest.[6]

3. *Formica fusca rufibarbis* Fabr.

In June of last year I found a young queen that was crawling over the surface of the ground after the nuptial flight. I put her in a broad glass medicine bottle, which was partially filled with moist sand and was closed with a metal screw cover.[7] On the first of July I saw the first eggs which she had laid; there were about half a dozen of them in all. About two weeks later there were four small larvæ, which had pupated by July 27. These cocoons were the smallest I have ever observed for *rufibarbis*. The workers emerged in August. I kept only occasional notes on this colony and not a really complete record, and therefore I cannot say with certainty that some eggs, or the larvæ that hatched from them, were not at times devoured by the queen. I believe, however, that it was no more true than with my comparable experiments of this year. At least I was unable to note any difference in this behavior.

Again on June 21 I found a *rufibarbis* queen and put her in a bottle of the type mentioned above. By digging in the sand she made a cavity in one corner of the bottle, which was square in cross-section. On July 4 I noticed about six to ten eggs stuck together in this brood chamber, which was open above. On July 8 the eggs were still stuck together, and apparently their number had neither increased nor decreased, but they were no longer in their corner. The queen had moved them, presumably because of the disturbance made when the cover was unscrewed. The eggs had hatched at the latest by July 14. By July 19 the small larvæ had grown visibly, and after a few days they were no longer in the brood chamber, but rather were

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[6] In order to capture the queens, large flat stones are laid suitably on the soil nest in question. This is best done in the early spring during the late afternoon hours. Later on in the season toward summer, it is best done in the evening hours, particularly after long rains. The stones are turned over after a few days. Not only is the queen usually found, but also the greater part of the brood and, above all, the myrmecophiles (beetles, etc.). This method can also be used profitably with other species which build earth nests.

[7] This screw-type cover is advantageous if the cover is not closed so as to exclude all air, but is rather used to slow down a too rapid evaporation.

piled in a small heap on the surface of the sand near the opening. The queen remained by them constantly.

On July 24 all the larvæ had pupated. The pupæ rested in relatively very small cocoons; they were approximately the size of *Lasius* cocoons. By August 9 there were no changes; the queen seemed quite lively and vigorous. This was also the case on August 12. On August 15 the first worker emerged. The duration of the pupal period was about three weeks, as in the previous year. Up to the time of the emergence of the first workers, the queen was not fed. From that time up to August 29 there were no changes in this colony, which seemed to be in the best of health. Particularly worthy of note is the fact that the queen laid no more eggs in so far as I was able to observe, even though I often looked with a magnifying glass.

4. *Formica rufa rufa* L. and *Formica rufa pratensis* Retz.

The colony founding of this species, and of the species group in general, is known to be ''dependent''; that is, the young fertilized queens require the help of workers of their own or of a closely related species. Usually *Formica fusca* subserves this function, and then there results at first a ''temporarily mixed'' colony (in the sense of Wasmann) of *rufa* and *fusca* or of *pratensis* and *fusca,* which later becomes a pure *rufa* or a pure *pratensis* colony following the dying off of the *fusca* workers. I am aware, of course, of the fairly common case in which a young *rufa* queen is accepted in a colony of her own species. This is about the way myrmecological literature represents the matter. Since I was trying to duplicate these relationships as faithfully as possible, following their nuptial flight, I placed the young deälated queens, which I had captured in various places, on the surface of the ground (May to June), in containers with *fusca* workers. In order to facilitate the acceptance of the queen, I first bathed her so as to free her as much as possible from the foreign *fusca* nest odor and of the species odor, or in the latter case at least to weaken it temporarily. Furthermore, I isolated her for a period of at least a day in a container with nest material from the *fusca* nest in question. Also I always used only a small number of *fusca* workers on the supposition that they would be less belligerent than a large group, and I introduced them one at a time and gradually (at least for all the later experiments) into the queen cage. These *fusca* workers were without brood—only workers. In spite of all of these precautions, I never did get anything in the way of positive results. If the *rufa* and *pratensis* queens were not attacked, as occasionally occurred, then they were merely tolerated, without being adopted in any true sense of the word. I never observed feeding of the queen by the workers, and always after a few days I found the queen dead. I was unable to account for the persistent failure of these experiments.

5. *Formica sanguinea* Latr.

At first I was unable to get any better results in comparable experiments on this species until I decided to furnish the queens with pupæ, not workers, of a different species. I found two young deälated queens crawling on the surface of the ground on June 26 and put each one of them into a separate glass container of the type already described for *rufibarbis*. Each one of the queens received a small number of *pratensis* pupæ, which were thrown in to them irregularly. They immediately took the pupæ and carefully made a little pile out of them. On July 4 and 5 the first *pratensis* workers emerged. I noticed on July 19 in one of the culture bottles, that had obviously become too moist, a heavy growth of mold, which had killed all of the *pratensis* workers. However, the *sanguinea* queen was left safe and sound. She was changed to another culture bottle, which contained only *rufibarbis* pupæ, the first of which began to emerge on August 14. On July 25 the queen had laid a few eggs, which, however, had disappeared a few days thereafter. It is possible that they were eaten. Up until August 31 there were no changes which could be detected in either of these colonies; particularly there were no more eggs laid. On occasions I observed the feeding of the queen by the *pratensis* workers.

The normal slave ant of *F. sanguinea* in Europe is *F. fusca* and its race *rufibarbis*, occasionally and by way of exception (in this vicinity at least) *F. fusca gagates*. There are, however, naturally occurring mixed colonies of *sanguinea* and *rufa* and also of *sanguinea* and *pratensis*. Since *pratensis* is much more common in certain localities, *sanguinea* is more likely to locate this race. My experiments were not intended to demonstrate this possibility, but rather to clarify the beginning stages of a *sanguinea* colony, particularly in comparison with those of a colony of *Polyergus rufescens.*

6. *Polyergus rufescens* (Latr.)

On July 24 I captured a young queen of this species after the nuptial flight, and on the following day I placed her in an observation nest. It contained likewise a small number of *pratensis* worker pupæ, to which she, however, quite unlike the *sanguinea* queens, gave no attention at all. A few days thereafter I found her dead. The usual slave ant of *Polyergus* is *F. fusca* and *rufibarbis.* However, according to Wasmann, naturally occurring mixed colonies of *Polyergus rufescens* and *Formica rufa pratensis,* which I had wanted to duplicate, are occasionally found. The fact that the *Polyergus* queen did not pay any attention to the *pratensis* pupæ may have had its basis in that it is not the normal slave species. In my experiments,[8] on

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[8] I am borrowing material on this subject from my daily notebook: On July 27 I took from their nest a considerable number of *Polyergus* workers and some of their slave ants (*rufibarbis*). About ten steps away from this nest, I poured out onto the ground a small pile of *pratensis* worker pupæ and, since it was not easily avoidable, also a few *pratensis* workers themselves. Then I poured the *Polyergus* together with their few slave ants on them. Naturally at first there was a battle with *pratensis,* which, however, did not result in any deaths. After a few minutes single *Polyergus* workers seized a few pupæ in their mandibles and carried them around in the tumult, apparently without any plan or purpose, usually letting them drop again soon. Also the *rufibarbis* joined in, only more effectively, and soon I noticed two of them on the way toward their nest with pupæ. To be sure, in the grass their movements were rather meandering, but on the foot path, which they had to cross, they moved with ''purpose'' in a perfectly straight line. About a quarter hour after pouring out the ants, these two had reached the nest. After another quarter hour the *rufibarbis* had carried into the nest two pupæ, which I believed to be *Polyergus* although I could not ascertain definitely; and like the previous *rufibarbis* workers, they moved in a winding manner in the grass, but travelled in a straight line on the foot path to the nest. Thirty-five to forty minutes after the beginning of the experiment they had reached the nest with their burdens. At the place where the ants were poured out, a few *Polyergus* were still running about, some with and some without pupæ.

On August 7 I repeated the same experiment with *Polyergus* workers from the same nest. This time, however, I obtained fewer results. Only the contrary, workers have carried off such pupæ. Probably more consistent with a true picture and with the former indifference, if not the psychic inability of *Polyergus* to do nest-work of all kinds (not merely brood care) is the assumption that the queen of this species is completely incapable of founding a colony in this way, but rather that such a fertilized queen requires the help of slave ants. Does she break vigorously into the nest and kill the queen, or is she taken into a queenless colony in a friendly way by the workers? With *F. sanguinea,* on the other hand, it appears to me that according to the foregoing experiments the queen normally appropriates by robbery and brings up a small number of pupæ of the slave ant, although the other two above-mentioned possibilities should not be excluded. Only further experiments by a number of observers in different regions can clarify these matters.[9]

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a few workers seized the *pratensis* pupæ and carried them about a little, described Turner curves with them, but did not carry them to the nest. Others seemed indisposed to bother with them, as if these pupæ were too big for them. They were, to be sure, particularly well-developed pupæ, so that it is, in fact, quite possible that the behavior of the ants, which differed from the previous time, may be explained by this circumstance. Then I placed directly on the spot for them a small pile of *rufibarbis* pupæ, which are considerably smaller than those described above. The ants immediately seized them and very rapidly carried them to the nest, with fewer and shorter curves. On August 8 I performed the same experiment once again, but with workers from another nest. These ants seemed to struggle a great deal with these large, heavy *pratensis* pupæ, but they obviously could not handle them any more than their colleagues of the day before could. None succeeded in taking one of these pupæ between their mandibles in the normal manner. Immediately thereafter, I placed some *F. fusca* pupæ before them; these lay there quite unnoticed, although here the pupal size could play no part. The *Polyergus* crawled over them again and again without making a single attempt to seize them. In both of the nests here mentioned *rufibarbis* was the slave ant. It almost seems as though in the last experiment the usual species or race odor of *rufibarbis,* which differs from that of *fusca,* had played the deciding role, although it still remains difficult to understand why a like factor should not have value *a fortiori* for *pratensis.* This is especially puzzling because in a region next to open country, such as prevails, *rufibarbis* is clearly favored, occuring as the slave ant of *P. rufescens. F. fusca* also occurs as the slave of *P. rufescens,* if only by way of exception, as for example, at the edges of woods, etc. Only further experiments can clarify this matter.

[9] It is possible that this behavior of ants is also regionally different.

THE IDENTITY OF TWO INTRODUCED CLOVER SEED WEEVILS (COLEOPTERA: CURCULIONIDAE)[1]

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Within recent years two introduced species of seed weevils have established themselves in the United States and Canada as pests of clover. Hitherto, these two species have been confused and, to the present, their identity has not been clearly defined. Because the two weevils appear to have become increasingly more important as pests in the clover seed producing areas of this country, as well as in Canada, the limited study presented in this paper was undertaken.

In North American curculionid literature the two species under discussion have always been assigned to the genus *Tychius,* which was established by Germar in 1817 (Mag. der Ent., vol. 2, p. 340, No. 19). It is obvious that the two are generically distinct; one belongs in the above genus and the other must be placed in *Miccotrogus* Schoenherr. Since the latter, as a generic name, has never been applied to a species of these weevils in the North American literature it seems advisable to elaborate slightly on the status of the name.

Considering the species known to belong to this group of weevils, Schoenherr in 1825 listed six in *Tychius* proper and erected the subgenus *Miccotrogus* to which he assigned three species, indicating *M. cuprifer* (Panz.) as the typical species. In 1826 this same worker characterized the species assigned to his subgenus as possessing only six segments in the funicle (the term funicle includes the pedicel of the more generalized antenna) whereas typical *Tychius* species have seven segments. In a subsequent classic by the same author (1836) he used *Miccotrogus* as the name of a small group of species within the genus *Tychius.* But, in a later volume of the same work (1843, p. 312) Schoenherr appears to have discontinued the use of the name employed in the same sense as before and merely indicated

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[1] Paper No. 2418 of the Scientific Journal Series of the Minnesota Agricultural Experiment Station, St. Paul, Minnesota.

the group as follows "Grex II-Funiculus 6-articulatus. *Miccotrogus* Schh. *olim.*" Schoenherr had never, therefore, employed the name in a generic sense.

Stephens (1839) apparently was the first to use *Miccotrogus* as a generic name; in previous works he did recognize *Miccotrogus* and credited it to Schoenherr but actually did not assign any species to it. Laporte (1840) also used the name in a generic sense. Since that time in most of the numerous European publications dealing with the Coleoptera the name *Miccotrogus* has been recognized and applied to a group of species distinctly different from *Tychius*.

Our North American literature has not been enlightening with regard to the correct nomenclature of our two introduced clover seed weevils, chiefly because they have been incorrectly identified or confused by most workers. Although Blatchley and Leng (1916) described specimens of a species that belongs in *Tychius* they used the name of a species belonging to *Miccotrogus*. Leng (1920) used *Miccotrogus* (cited in error by authors, not Schoenherr) as being synonymous with *Tychius*. This led to some confusion because Detwiler (1923), dealing with a misidentified species he called *picirostris*, stated "It has been called *Miccotrogus picirostris* by various authors, but not by Schoenherr, who established the genus *Miccotrogus*," and gives as references Blatchley and Leng, and Leng. Baker (1934) correctly pointed out that no such information was to be found in these sources. He might have added that Schoenherr did include *picirostris* Fab. in *Miccotrogus*. Apparently Detwiler's statement was the result of some misinterpretation of information given under *Tychius* in the Leng catalog.

The principal difference between *Tychius* and *Miccotrogus* is that species of the former have a seven segmented funicle while species of the latter have but six segments in the funicle. This difference is at least generically significant, which has been recognized by European workers, for example Joy (1932) and Kloet and Hincks (1945).

These two introduced clover seed weevils have been frequently misidentified by both European and North American workers. They are potentially serious pests particularly in clover seed producing areas. For this reason it is important to establish as soon as possible their correct identity which is the purpose of this paper. The synonymy as given for each species refers almost entirely to the North American literature, being as complete as possible and intended for use by interested workers in this country.

Tychius stephensi Schoen.

1836. *Tychius stephensi* Schoenherr, C. J., Gen. et Spec. Curc., 3 (1) : 412 (Emend. of *stepheni,* the orig. spelling).
1908. *Tychius griseus* Schaeffer, Chas., Jour. N. Y. Ent. Soc., 16 : 217, (New synonymy).
1915. *Tychius* (*Microtrogus*) *picirostris* Fabr., Schaeffer, Chas., Jour. N. Y. Ent. Soc., 23 : 197.
1915. *Tychius picirostris* DuPorte, E. M., 47th Ann. Rpt. Ent. Soc. Ont., pp. 49–50.
1916. *Tychius picirostris* Fabr., Blatchley, W. S. & C. W. Leng, Rhyn. or Weevils, N. E. Amer., p. 246.
1916. *Tychius picirostris* DuPorte, E. M., 8th Ann. Rept. Que. Soc. Protect. Plts., pp. 73–74.
1916. *Tychius picirostris* DuPorte, E. M., Jr. An. Behav., 6 : 138–149.
1917. *Tychius picirostris* Fabr., Felt, E. P., 32nd Rpt. St. Ent. N. Y., p. 81.
1919. *Tychius picirostris* Fab., Herrick, Glenn W. & J. D. Detwiler, Jour. Econ. Ent., 12 : 209.
1920. *Tychius picirostris* (Fab.), Leng, C. W., Cat. Coleop. Amer., p. 320 (No. 17074).
1923. *Tychius picirostris* Fab., Detwiler, J. D., Cornell Agr. Exp. Sta. Bul., 420, pp. 20–27.
1925. *Tychius picirostris* Fab., Petch, C. E. and J. Armstrong, 17th Ann. Rpt. Que. Soc. Protect. Plts., p. 73.
1927. *Tychius picirostris* Fab., Criddle, N., 58th Ann. Rpt. Ont. Ent. Soc., p. 98.
1928. *Tychius picirostris* Fab., Leonard, M. D., Cornell Agr. Exp. Sta. Mem., 101, p. 498.
1931. *Tychius picirostris* Fab., Gorham, R. P., G. P. Walker & L. J. Simpson, 62nd Ann. Rpt. Ont. Ent. Soc., p. 18.
1931. *Tychius picirostris* Fab., A.A.E.E. Comm. on Nomen., Jour. Ec. Ent., 24 : 1310.

1937. *Tychius griseus* Schaeff., A.A.E.E. Comm. on Com. Names, Jour. Ec. Ent., 30: 560.
1940. *Tychius picirostris* F., Chagnon, G., Coleop. de la Prov. de Que. Fasc., 6, p. 367.
1942. *Tychius griseus* Schaeff., Muesebeck C. F. W., Jour. Ec. Ent., 35: 101.
1947. *Tychius griseus* Schaeff., Muesebeck, C.F.W., Jour. Econ. Ent., 39: 448.
1947. *Tychius griseus* Schaeff., Stirrett, G. M., Can. Ins. Pest Surv., 25: 17 (In part).
1947. *Tychius griseus* Schaeff., Arnott, D. A., and W. N. Coleman, Can. Ins. Pest Surv., 25: 131 & 155 (In part).
1947. *Tychius griseus* Schaeff., Arnott, D. A., Can Ins. Pest Surv., 25: 210 (In part).
1947. *Tychius griseus* Schaeff., Arnott, D. A., Can Ins. Pest Surv., 25: 288.

Recently the writer strongly suspected that the species we were calling *griseus* was in reality the same as *tomentosus* Herbst. Ohio specimens of *griseus* were sent to the British Museum (N. H.) and found to be identical with the authentically identified specimens of *tomentosus* Herbst (and *stephensi* Schoen.). The fact that Herbst and Schoenherr were dealing with the same species had not been generally realized by all European coleopterists even though such was indicated as early as 1843 by Schoenherr (p. 303) and 1849 by Gaubil. It happens that Herbst's name is a homonym of Olivier's *tomentosus* and therefore has to be discarded. The next available name is *stephensi* of Schoenherr which is clearly shown by Kloet and Hincks (1945). Thus, the correct name for this species of clover seed weevil hitherto known as *griseus* appears to be *stephensi*.

Available data indicate that *T. stephensi* was introduced into eastern North America apparently sometime during the early part of the present century. It first came to our attention in New York in 1908 when Schaeffer described it as a new species.[2] It has now spread westward at least as far as Edmonton, Alberta, Canada and southward as far as southern Ohio. Since the record from Alberta is associated with specimens captured in 1921

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[2] One specimen is known from Ithaca, N. Y., July 8, 1907.

it is not unreasonable to assume that an intensive search likely would reveal that by now the species has extended its range all the way to the Pacific Coast.[3]

Sufficient records are at hand to show that the species is widely distributed in the following Canadian Provinces: Nova Scotia, New Brunswick, Quebec and Ontario, and as already mentioned, it is known to occur as far west as Alberta. Records in the United States show it to be present in Maine, Massachusetts, New Hampshire, New York, Michigan, Ohio, Wisconsin and Minnesota. Undoubtedly it occurs in localized areas in the remaining New England states and very likely in several additional mid-Atlantic and mid-western states.

In Europe this species does not appear to cause serious damage but in this country we are beginning to regard it as an important pest of red clover. In Europe it attacks red clover, and adults are said to occur on *Melilotus, Fragaria, Crataegus* and vetch. Although adult weevils may have been taken on plants other than *Trifolium* in North America, the species appears to confine its attack entirely to red clover, *Trifolium pratense* L. Apparently the only biological treatment of this species is the very good account published by Detwiler (1923), under the name *Tychius picirostris* Fab.

Miccotrogus picirostris (Fab.)

1787. *Curculio picirostris* Fabricius, J. C., Mant. Insect., p. 101.
1825. *Tychius* (*Miccotrogus*) *picirostris* (Fab.), Schoenherr, C. F., Isis v. Oken, col. 583.
1839. *Miccotrogus picirostris* (Fab.), Stephens, J. F., Man. Br. Coleop., p. 229.
1934. *Tychius picirostris* Fab., Hyslop, J. A., Jour. Ec. Ent., 27: 563.
1934. *Tychius* (*Miccotrogus*) *picirostris* Fab., Baker, W. W., Jour. Ec. Ent., 27: 1103.
1943. *Tychius picirostris* (Fab.), Venables, E. P., Can. Ent., 75: 118.
1947. *Tychius griseus* Schaeff., Stirrett, G. M., Can. Ins. Pest Rev., 25: 17 (In part).

[3] The writer since has seen specimens of this species from the state of Washington.

1947. *Tychius griseus* Schaeff., Arnott, D. A. & W. N. Coleman, Can. Ins. Pest Rev., 25: 131 & 155 (In part).

1947. *Tychius griseus* Schaeff., Arnott, D. A., Can. Ins. Pest Rev., 25: 210 (In part).

1947. *Tychius griseus* Schaeff. (Ont. Mthly. Crop Rpt.) Can. Ins. Pest Rev., 25: 253.

M. picirostris appears to have been introduced into North America on the West Coast. The first published record of its occurrence here refers to specimens taken from clover in 1929 and 1931 at Puyallup, Washington, as recorded by Hyslop (1934) and reported on by Baker (1934). Numerous subsequent adult collections showed that it not only occurred there but also at Sumner, Graham, near Falls City and Monroe, all in western Washington. It also has been taken at Clackman's Lake in Oregon. Authentic identification by Mr. W. J. Brown of the Canadian Department of Agriculture, Ottawa, reveals that the species was taken at Vancouver as early as 1920, and later in southern British Columbia at Summerland, where it is very abundant, and at Vernon. Other records indicate that the species has spread eastward at least as far as southwestern Ontario, Canada, in the counties of Kent, Lambton, Elgin, Norfolk and Haldimand, where it is doing considerable damage to alsike clover (D. A. Arnott, in litt.) Although the species must occur generally through the intervening area, few records are available. The writer has studied numerous specimens collected from alsike clover, near Baudette, Minnesota, and has collected specimens from mixed clovers at St. Paul. Some of the latter appear to have infested white Dutch clover.

In Europe the species has been reported occurring on alsike clover, *Trifolium hybridum* L., red clover, *T. pratense* L., species of the genus *Genista,* and on plantain. However, there is some question whether the identifications in all cases are correct. Valle's (1936) investigations indicate that this species has become a pest of alsike clover in Finland.

Regarding the hosts of this species Baker (1934) stated "it appears that here they prefer white, alsike and red clovers in the order named." He also referred to adults being swept from *Rubus* spp., *Spiraea,* a plantain, and a species of sedge, and observed others feeding in the blossoms of native strawberry, and on the drupelets of the Evergreen blackberry where damage to the fruit was noted.

Apparently nothing has been published on the biology of *M. picirostris*.

DISTINGUISHING CHARACTERS OF THE TWO SPECIES

Superficially these two weevils are strikingly similar and this has resulted in numerous misidentifications. The following distinguishing features are given to facilitate correct identification, especially of specimens lacking antennæ or where the segments of the funicle are difficult to count due to awkward or concealed position.

Tychius stephensi Schoen.	*Miccotrogus picirostris* (Fab.)
1. Scales above yellowish gray, to ash gray especially on younger specimens.	1. Scales above ash gray.
2. Scales on pronotum denser, those on the extreme posterior margin thicker and slightly wider but otherwise not conspicuously different from those on the disk (except center).	2. Scales on pronotum sparser, those on extreme posterior margin conspicuously wider and thicker than those elsewhere on pronotum.
3. Most scales in striæ anteriorly on elytra at least $\frac{1}{2}$ as wide as interstitial scales which are compactly arranged in three very irregular rows. Row of scales on each side of "suture" whitish, broad, and similar to those on venter.	3. Scales in striæ on elytra more uniform in width and less than $\frac{1}{2}$ as wide as the interstitial scales which are not especially compact, and the majority are arranged in what would appear to be two very irregular rows. No broad, whitish scales along the "suture," except posteriorly.

In addition the beak of *stephensi* is nearly straight in lateral aspect and is reddish from the antennal base to the tip; whereas the beak of *picirostris* is weakly curved, attenuate and frequently reddish only at the tip.

Acknowledgements

The writer is indebted to several individuals who have rendered assistance. Mr. J. Balfour-Browne, of the British Museum

(N. H.), London through the courtesy of Mr. R. B. Benson of the same institution, kindly compared North American specimens of *stephensi* with authentically identified European specimens of that species as well as those of *tomentosus* Herbst. Mr. W. J. Brown of the Canadian Department of Agriculture at Ottawa, and Dr. D. A. Arnott at the Entomological Laboratory, Chatham, Ontario supplied numerous distribution records of these two species, both in Canada and the United States. And Mr. Ray T. Everly, U. S. Bureau of Entomology and Plant Quarantine, Columbus, Ohio contributed numerous specimens of both species for study.

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DROSOPHILA IN NEW ENGLAND

By Eliot B. Spiess

INTRODUCTION

With the current growing interest in genetic analysis of natural populations of Drosophila, it has become important to fill in the many gaps in our knowledge of distribution and seasonal fluctuations of the numerous species of the genus. One of the sections of the United States which has most urgently needed collecting heretofore is the northeast.

This section is an interesting one because it lies in the northeastern part of the Transition Life Zone on the eastern edge of the Canadian Life Zone. Conditions are particularly severe in winter, and only a few species of the genus are actually able to survive in the wild state. Just what species these are and what adaptations they possess in order to establish themselves as native wild species are of particular interest. The limits of distribution of these species and those of more southerly distribution throughout the New England region cannot be definitely stated as yet.

MATERIALS AND METHODS OF COLLECTING

Collections were begun in 1946 in an effort to discover good material for genetic studies. The collections cover the seasons of 1946 and 1947. At the end of the second season the genetic work was terminated, but the data obtained from trapping flies should provide for possible future patterns of collecting for any desired cytogenetic analysis.

During the 1946 season two methods of trapping were used, and improvements were made from time to time so that by the 1947 season an efficient scheme was worked out. At first, pint mason pars were used with molasses cornmeal agar food yeasted to attract the flies. However, this trap, which was used during April and May of 1946, proved to be too heavy and bulky. Paper cups and fermenting banana mash were used from then on.

Traps were left out for from three to five days depending on the drying rate of the food surface. Fresh banana mash was added, or new cups were set out whenever the surface of the bananas became hard or unsatisfactory for collecting.

All specimens were etherized in the field in the following manner: a flat finely meshed net which fitted snugly around the top of a paper cup was used to prevent escape of flies; the cup was turned so that etherized flies would not fall into the sticky banana; ether was applied to the net, and after about thirty seconds the flies could be collected into a vial.

In all cases traps were placed in areas of continuous shade. It was found that most flies in summer occurred in large wooded areas which were somewhat more cool and moist on hot days than open country. Whenever more than one collection was made on one day, it was always observed that more flies were caught toward evening than during the sunny hours of the day. Such behavior agrees with Dobzhansky's observations that *D. pseudoobscura* comes to traps in largest quantities just after sunrise and just before sunset.

THE 1946 BREEDING SEASON

Collecting was started in the Arnold Arboretum, Jamaica Plain, Massachusetts. A great deal of time was spent in developing technique in this locality, so that the data are not as complete as could be desired. Also because the locality was constantly being visited by crowds of sight-seers this was not kept up as a trapping area after early July. The results of this collection and subsequent collections are given in tables at the end of the text.

The writer is very grateful to Mr. Gorden Allen who was kind enough to set out a few traps at North Haven Island, Penobscot Bay, Maine, during the last week in June.

The third collecting locality was Windham township, Vermont, at an elevation of 1800–2000 feet in sugar maple, beech, birch, and conifer forest. Human habitations in this area are very few and were approximately one fourth to one half mile from the trapping locality at the very nearest. Two collections were made, one in late June and early July, the other in early August.

A fourth area was in a woodland in Braintree, Massachusetts, during July, August, and September. This is a residential suburban district where houses are widely separated, and open meadows and small woods are common. Collecting here was done close to fruit trees where the last year's fruit covered the ground and also in the nearby small woodland of oak, birch, and maple.

The last and most rewarding area from the standpoint of numbers of individuals and species was the Gray Herbarium Gardens located in Cambridge, Massachusetts. The gardens occupy an area of about seven acres which before the war had included well-cultivated plots and groves of native and exotic plants, but at present they are untouched and seldom visited by outsiders. The gardens are fenced in and are located near a residential suburban area.

THE 1947 BREEDING SEASON

The Gray Herbarium Gardens site was chosen for the 1947 season's collection, and it was decided that the entire season should be sampled in that area alone to discover which populations undergo significant seasonal fluctuations. In order to get as accurate an estimate as possible of the species' concentrations, sampling was performed in the following manner: fresh food or new traps were put out as needed approximately every three to five days; six traps were continually maintained in the area; and samples were taken on convenient evenings about twice a week (that is, on evenings when there had been no rain nor considerable cloudiness during the afternoon). The temperature and state of the weather were recorded at each collection. Taking the samples just prior to sunset each time should have largely eliminated any variation in numbers coming to the traps owing to diurnal periodicity in activity of the flies.

The weather data included in the table following are from the Boston Weather Station. No significant differences were found between temperature readings at the collecting area and the readings given by the Boston Weather Station.

GEOGRAPHICAL OCCURRENCE OF SPECIES

From a total of about thirty species of *Drosophila* which have been found in or near the New England area (that is, as far west as Ohio or south to New Jersey) only seventeen species were definitely identified by this writer during 1946–47 from the localities mentioned above. However two species may be added to this number: (1) *D. narragansett* was not distinguished from *D. athabasca* in this work; yet because it is such a rare species, it would not greatly alter the numbers given for *athabasca.* (2) A species in the *quinaria* group was found which is either a subspecies of *D. subquinaria* or possibly a new species.

Subgenus *Hirtodrosophila*

No members of this subgenus were found, although *D. duncani* and *D. chagrinensis* have been reported in the past from eastern Ohio.

Subgenus *Dorsilopha*

D. busckii was found in small quantities in Cambridge, Mass., during July, 1946, and from July to October, 1947. This species is unquestionably associated with human habitations and probably does not overwinter in the wild state.

Subgenus *Sophophora*

(1) *Melanogaster* group. Either *D. simulans* or *D. melanogaster* or both occurs in every locality at which more than one collection was made during the stated breeding seasons. It is of interest, however, to note that in no case was a single individual trapped prior to June 26 (the date of first occurrence in the Cambridge, Mass., area for 1947). Also in the Windham, Vermont, collection only one female was found in the middle of August. Evidently the season is so short at that locality, and the area is so isolated from any markets or stores that this group has a difficult time establishing itself in a wild environment. The town of Windham lies on the northeast side of one of the Green Mountains of Southern Vermont in the Canadian Life Zone and is evidently located in a region too severe for large expansion of the *melanogaster* group.

(2) *Obscura* group. Certainly three of the members of the *affinis* subgroup are found throughout this area and undoubtedly constitute a native population. These are *D. affinis, D. algon-*

quin, and *D. athabasca.* A few *athabasca* individuals were recorded in the Gray Gardens which might have proved to be *narragansett.* From the results of the small collections within the Canadian Life Zone it would appear that *D. athabasca* is the most successful species in getting established there: it was the most common species in the North Haven Island, Maine; the Vermont; and the Mount Washington collections. Probably *D. algonquin* holds an intermediate position between *D. athabasca* and *D. affinis* in regard to success in this area although it is possible that *D. algonquin* and *D. affinis* are about equal in their ability to withstand the adverse conditions of this region.

Subgenus Drosophila

(1) *Quinaria* group. Together with the *affinis* subgroup *D. quinaria, D. transversa,* and possibly a third species (as yet undescribed from this area intermediate between these two and strikingly similar to *D. subquinaria* in morphological characters) form what seems to be the principal native population of the genus in New England.

D. transversa is most common; it occurs in every collection in which more than one species was found. It accompanies *D. athabasca* into the Canadian Life Zone and is successful in all the regions in which *athabasca* is established. *D. quinaria* is much less common in all parts of the area; but possibly fewer *quinaria* come to banana traps than to other fruits like tomato for instance. Normal *D. quinaria* as described by Sturtevant was not obtained in any of the Vermont collections (although the numbers are so listed in the accompanying tables because of undecided classification). A smaller fly which is intermediate in color pattern between *quinaria* and *transversa* was present instead (four specimens). It is suggested that this intermediate form is a subspecies of *D. subquinaria* or a new species strongly resembling *D. subquinaria.* This type was also found in the Arnold Arboretum, Boston, and in the Gray Gardens, Cambridge. In the latter locality, however, normal *D. quinaria* was much more common (22 *D. quinaria* specimens and 3 *D. subquinaria* (?) specimens).

(2) *Testacea* group. *D. putrida* is about equal in numbers

of individuals to *D. transversa* among the native wild populations. This species occurs in almost every locality in which *transversa* and *athabasca* are found. There seems to be a slightly greater difficulty on the part of *putrida* in becoming established in colder regions or colder seasons of the year than in the case of the other two common species. Perhaps the figures are not too significant, but *putrida* is slightly less numerous than *transversa* in the Vermont collection; it is not found at all in the Maine island collection; and it is more warm-weather-loving in the Gray Gardens 1947 collections.

D. testacea is a rare fly which occurs in August in the Vermont collection and in summer and fall in Cambridge. The Vermont area may represent the borderline of its distribution region.

(3) *Melanica* group. Perhaps the most common and successful species of the genus in summer except for *melanogaster-simulans* is *D. melanica paramelanica.* This subspecies is rare in Vermont at the height of the summer, but it is very common in lower country.

D. nigromelanica, on the other hand, is quite rare even in the low regions. This species has been collected only around Boston.

(4) *Robusta* group. The last group which can be considered native is represented by *D. robusta* which occurs in small numbers in practically every locality. It is as common as *transversa* in Vermont where it can be found in deep forest of conifers, maple, and beech. It was especially common near small streams in the woods, showing that it prefers high humidity and cool conditions. It is somewhat less common near Boston where summer heat is more intense and woodland is not so dense. The 1947 collection was unexpectedly deficient in this species.

(5) *Funebris* group. *D. funebris* is not common in any locality and is quite spotty in distribution, having been found only in Vermont (one specimen) and around Boston.

(6) *Immigrans* group. *D. immigrans* accompanies *D. funebris* in the discontinuity and rarity of its occurrence. There can be no doubt that these two species do not overwinter in the wild state here, and they represent a small percentage of the

genus which is associated with man but breeds in small quantities during the summer in the wild.

(7) *Tripunctata* group. It was a surprise to discover *D. tripunctata* in the Gray Gardens in August and September, 1947. According to the latest distribution map (Patterson, 1943) it had never been recorded farther north than New Jersey. It is a fly of predominantly southern distribution, but it seems to breed here for two or three generations during the summer (Gray Gardens: Aug. 15, 2 specimens; Aug. 25, 1 specimen; and Sept. 18, 1 specimen).

(8) *Repleta* group. Because the writer was chiefly interested in obtaining flies in forested areas at some distance from human habitation, *D. repleta* was of rare occurrence. At any rate it was found only in collections near Boston, and is obviously not a wild species.

THE UNCLASSIFIED SPECIMENS IN THE QUINARIA GROUP

In May, 1946, a male specimen of this group and intermediate in many key characters between *D. transversa* and *D. quinaria* was found at the Arnold Arboretum, Mass. The specimen differed from ordinary male *quinaria* in the following characters: clouds on the apices of the second, third, and fourth longitudinal veins were absent; only two brown spots on tergite 6; and the lateral marginal spots on each tergite were nearly absent.

Later on in Vermont four females were obtained, which were of this intermediate type. No clouding at the apices of the longitudinal veins was observed; the abdominal tergite spotting was typical of *quinaria* in size except on tergite six where the spotting was variable, usually reduced in size in comparison with normal *quinaria*. The small lateral marginal spots typical of *quinaria* were greatly reduced or absent. Egg filaments were characteristic of *quinaria* rather than *transversa*. Male progeny from these females had only two spots on tergite six and no definite marginal spots at all. These males surprisingly had six or seven short recurved hairs on the median side of the fore-tarsus as described by Sturtevant (1942) for *D. subquinaria* rather than the long hairs in double row as in *D. quinaria*. Ordinary *D. quinaria* females were larger and darker in color than these specimens. A few attempts were made to cross *quinaria* to the new type both in single pair matings and in mass matings of about five parents each. No fertile eggs were laid in any of the matings, but it is known to be difficult to raise *quinaria* by itself in the laboratory.

Some single pair matings of *D. quinaria* and of the new subspecies (or species) were made separately with interesting results: (1) In *D. quinaria* a few progenies lacked some or all of the clouding at the apices of the longitudinal veins; often reduction in size and number of abdominal tergite spots was encountered; that is, in females loss of lateral spots on the sixth tergite and in males loss of both these and the median spots. (2) In the progenies of the questionable specimens further reduction in spotting was quite common. Females often tend to lose all spots on the sixth tergite while males often showed a reduction or complete loss of lateral spots on the fifth tergite as well. This latter pattern is the common type of *D. transversa,* and shows that there is a possible breakdown here in the taxonomic characters.

If the difficulties involved in breeding these flies can be surmounted, it seems that a vast storehouse of easily recognizable morphological variation is involved in these species.

It is evident that we are dealing either with a new species or with an eastern subspecies of *D. subquinaria.* Since collecting has not been extensively carried on north of this area in New England heretofore, there remains the possibility that *subquinaria* occupies the Canadian region and extends down into the Canadian and Transitional Zones of New England. At any rate we do know that some members of the *affinis* subgroup do occupy the entire northern section of the country, and undoubtedly some members of the *quinaria* group accompany them. This supposition will merit further investigation, and the writer has reason to believe that specimens are not too rare for adequate collecting of this type or species in the future.

FLUCTUATIONS OF DROSOPHILA SPECIES POPULATIONS

For the breeding season of 1947 it was decided that sampling should be done for a single small area convenient to the laboratory at Harvard University. The Gray Herbarium Gardens appeared to be the best site, and continuous collecting was carried on as often as possible from early April until late October. (The methods of sampling this area have been given previously.)

If we consider only the fluctuations in species populations of large enough size to be statistically significant, we can observe some rather interesting facts. Also a comparison of results for species with those obtained at the Aldrich Farm by Patterson (1943) shows some interesting parallels.

A graph has been constructed (see supplementary material) to show the maxima of each species during the season. In each species the data have been weighted to conform with the number of collections each month. Each point in the graph represents that per cent of the weighted number of specimens which was collected in that month (considering the total number for one species equal to 100%).

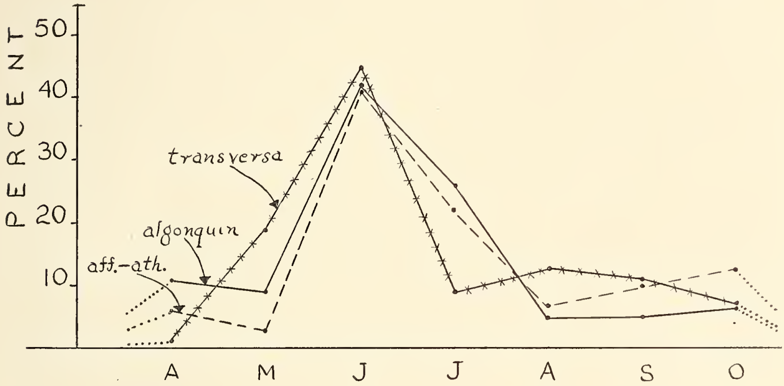

Figure 1. Gray Herbarium Gardens, Cambridge, Massachusetts, for 1947. This graph shows the fluctuations of those species whose maxima occur in the spring. Each point represents that per cent of the weighted number of specimens which was collected in that month (considering the total number for one species equal to 100 per cent.

(1) The *affinis* subgroup together with *D. transversa* form a definite peak in June, then fall off for the remainder of the season. All of these species increase again slightly but not significantly as temperatures get cooler in late summer and early fall, but they fail to increase to their former proportions be-

cause other more aggressive species are then present in great number competing for space and food. The Aldrich Farm data for *affinis-algonquin* for 1939–40 show a very significant negative correlation with temperature (the writer has calculated r = –57.0 per cent. In New England too there is a very real preference in the *affinis* group and in *D. transversa* for mild temperatures. Temperature is apparently one of the most effective ecological factors in the distribution of these populations.

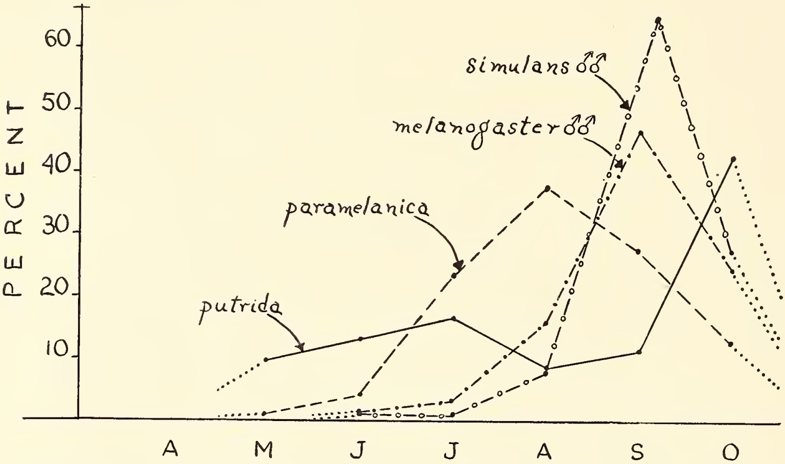

Figure 2. Gray Herbarium Gardens for 1947, showing the fluctuations of those species whose maxima occur in summer and early fall.

(2) During the month of July when temperatures average highest for the summer *D. putrida* attains a moderate peak; but probably this peak is not so much because of high temperature as because the previously dominant species have dropped considerably in numbers so that competition is effectively reduced. The fluctuations in size of *putrida* populations have always appeared somewhat enigmatical when compared with the weather data. Patterson (1943) has stated that some of the peaks of *putrida* in Texas coincide with rainfall peaks which in turn tend to increase fungus growth. However the writer has found no significant correlation between the rainfall data and the number of *putrida* specimens collected at the Aldrich

Farm. On the contrary the only significant correlation found from all the weather data given in the Patterson report was negative between humidity and number of specimens (r = – 64.3 per cent). This correlation is more or less substantiated by the evidence here in New England: August was the most humid month but had the lowest number of *putrida* for the summer; October was an unusually dry month with exceptionally low rainfall, and *putrida* had its highest peak of the season. Probably *D. putrida* is a species which can increase in frequency when other species are not successful under dry conditions. It seems to be a mild temperature dry air fly; but when other more dominant species occur in the same environment, *putrida* is prevented from expressing much increase in size. It would appear from the accompanying graph that competition with larger species is a very important factor in the distribution of *putrida.*

(3) *D. melanica paramelanica* succeeds in forming an almost perfectly normal curve with its peak in August, the hottest month of the season. This species certainly follows the mean monthly temperature very well. Because it is a species which probably does overwinter in Boston and environs, it gets started early in the season and becomes well-established in the wild after the cool-loving species have dropped in frequency and just before the melanogaster-simulans complex becomes too numerous.

(4) No members of the *melanogaster* group were found until late June. As in the case of the Aldrich Farm collection *melanogaster* males appeared first to be followed by *simulans. Simulans* lagged slightly behind *melanogaster* for July and August but then formed a tremendous peak in September. Both species are quite significantly correlated with temperature in the Aldrich Farm data (the writer calculates r = 79.0 per cent), and unquestionably warm temperature is one of the chief ecological factors effecting a peak here in New England as well.

Considerable variation may possibly be encountered from year to year owing to changes in external conditions, but the pattern described here for this single seasons' fluctuations among the more prominent northeastern species will in general remain the same.

New England Collections—1946

Gray Herbarium, Cambridge, Mass.	July	August	September	Totals
No. of collections	4	1	4	9
D. affinis	9	0	6	15
D. algonquin	31	0	16	47
D. athabasca	6	1	30	37
D. busckii	8	0	0	8
D. immigrans	0	0	2	2
D. paramelanica	22	5	15	42
D. mel-simulans	21	10	88	119
D. nigromelanica	0	0	1	1
D. putrida	30	0	47	77
D. quinaria	4	0	0	4
D. robusta	7	0	4	11
D. testacea	1	0	0	1
D. transversa	20	0	9	29

New England Collections—1946

Arnold Arboretum, Boston, Mass.	April	May	June	July	Totals
No. of Collections	1	4	1	3	9
D. algonquin	1	1	1	2	5
D. immigrans	0	2	0	0	2
D. mel-simulans	0	0	0	3	3
D. putrida	0	6	1	14	21
D. quinaria	0	1	0	1	2
D. robusta	0	0	0	3	3
D. transversa	0	9	2	5	16

New England Collections—1946

Windham, Vermont	June	July	August	Totals
No. of collections	3	2	2	7
D. affinis	15	2	2	19
D. algonquin	0	1	3	4
D. athabasca	5	0	71	76
D. funebris	0	0	1	1
D. immigrans	0	1	0	1
D. mel-simulans	0	0	1	1
D. paramelanica	0	0	1	1
D. putrida	3	0	3	6
*D. quinaria**	3	1	0	4
D. robusta	5	5	3	13
D. testacea	0	0	2	2
D. transversa	5	3	5	13

* All individuals of this species in the Windham collection are atypical. See text.

New England Collections—1946

Braintree, Mass	July	August	September	Totals
No. of collections	3	1	2	6
D. algonquin	12	0	1	13
D. athabasca	23	2	13	38
D. funebris	0	1	0	1
D. immigrans	0	1	0	1
D. mel-simulans	20	41	40	101
D. nigromelanica	1	0	0	1
D. paramelanica	7	0	13	20
D. putrida	12	0	0	12
D. repleta	1	0	0	1
D. robusta	4	0	3	7
D. transversa	4	1	1	6

Northhaven Island, Penobscot Bay, Maine	June 23rd
D. algonquin	4
D. athabasca	46
D. transversa	1

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Gray Herbarium Collection—1947

	April	May	June	July	August	September	October
D. algonquin	44	13	147	90	14	18	14
D. athabasca	22	3	70	49	7	23	30
D. affinis	0	0	43	15	6	7	3
D. transversa	2	30	165	32	40	43	17
*D. quinaria**	0	1	4	12	3	3	2
D. putrida	0	25	78	99	44	76	173
D. testacea	0	0	4	0	9	2	4
D. funebris	0	6	16	0	1	1	1
D. paramelanica	0	2	33	206	298	273	50
D. nigromelanica	0	0	0	8	6	7	4
D. robusta	0	0	3	1	1	1	1
D. immigrans	0	0	0	1	2	15	10
D. busckii	0	0	0	4	8	9	11
D. tripunctata	0	0	0	0	3	1	0
D. repleta	0	0	0	1	0	0	0
D. melanog. ♂♂	0	0	1	15	71	262	83
D. simulans ♂♂	0	0	1	3	43	459	117
D. mel-sim. ♀♀	0	0	3	27	84	452	157
Totals **	68	80	568	563	640	1652	677
Number of Collections	11	4	9	9	8	10	6

* Includes three specimens of doubtful classification referred to in text.

** Total—♂♂ = 2406.
♀♀ = 1843.

BOSTON WEATHER DATA—1947

	April	May	June	July	August	September	October
Temperature, F.							
Mean	47.2°	56.9°	65.4°	74.4°	73.2°	64.8°	61.6°
Maximum	75°	87°	89°	90°	99°	88°	89°
Minimum	30°	36°	46°	59°	54°	37°	38°
Greatest Daily Range	33°	33°	32°	22°	28°	29°	36°
Humidity							
Av. Rel.	65%	69%	70%	74%	78%	72%	71%
Precipitation							
Total	4.15″	4.36″	2.88″	3.98″	2.19″	3.95″	1.13″
Snow	0.60″	0	0	0	0	0	0

N.B. Maximum temperature for March was 58°, Average 37°

N. B. Maximum temperature for November was 59°, Average 41°.

Drosophila is very inactive at temperatures below 55° F. For all practical purposes the populations can be considered at 0 per cent for March and November. The first specimen of the season was collected on April 10, an *algonquin* female, although two collections had been made previously. The weather suddenly turned cold at the end of October and no collections were made in November.

BOOK NOTICE

A Century of Entomology in the Pacific Northwest. By Melville H. Hatch. University of Washington Press, Seattle, 1949. 9 × 6 inches. V + 43 p. 9 pl. $1.50

This is a study of the progress of entomology in British Columbia, Washington, Idaho and Oregon involving collectors, exploring expeditions, laboratories, institutions, control work, important insect pests, and insect collections. Dr. Hatch begins with 1834 and outlines the principal entomological happenings, from that time until the present, with particular emphasis upon outstanding individuals, their accomplishments, and their contributions to the science of entomology. The author's interesting and authentic narrative of the development of entomology in the Pacific Northwest is an example of what is needed for other regions of North America and a welcome contribution to the literature on the history of entomology. Dr. Hatch's account concludes with a bibliography, a taxonomic index and an index of names. Entomology, although a comparatively young science, has enough of a historical background for entomologists to be conscious of it and it would not be a bad idea for our two national organizations to work out plans for a comprehensive national history of it.—H. B. W.

NOTES ON OREGON COCCINELLIDÆ, (COLEOPTERA)

BY BORYS MALKIN

The following are the more interesting records of the beetles of this family that came to the writer's attention chiefly from the collection of Mr. K. M. Fender of McMinnville, Oregon and some from his own. New State records are indicated by an asterisk preceding Leng's catalogue number. These supplement the published state list.[1] Collectors names are given in parentheses.

10873. *Hyperaspis lateralis montanica* Csy. Ten Cent Lake, 29 July, 1937 (Fender).

10972. *Brachyacantha ursina* (Fab.) Eugene, 6 June, 1942 (Malkin). This is the first record of this species from the western part of the state.

*10997. *Nipus niger* Csy. Siskyou Summit, 10 June, 1945 (Fender). This is only the second known record of the species. Described from unique collection in Sonoma Co., north of San Francisco.

*————. *Scymnus renoincus* Csy. Government Camp, 5 July, 1942 (Malkin), Siskyou Summit, el. 3000 ft. 5 July, 1946 (Malkin), Crater Lake nr. Hq. 4 Aug., 1930 (Scullen).

*11044. *Scymnus humboldti* Csy. Eagle Point, 4 July, 1946 (Malkin), Talent, 21 April, 1933 (Gentner).

11079. *Scymnus nanus* Csy. Bear Spgs. 18 May, 1940 (Fender), Eagle Point, 19 October, 1939 (Gentner).

*————. *Scymnus sp. nov.?* nr. *cinctus*. McMinnville, May, 1931 (Fender).

11181c. *Coccinella trifasciata subversa* Lec. Redmond 2 May, 1940 (Scullen). This is the first record of this species from eastern Oregon. Generally restricted to the western portion of the state.

11185b. *Coccinella transversoguttata nugatoria* Muls. Harper 22 May, 1947 (Malkin), Middle Fork of the Willamette River,

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[1] Malkin B. 1943. Jour. N. Y. Ent. Soc., Vol. LI. no. 3. p. 191–198.

22 May, 1947 (Malkin). Additional records of this uncommon species.

11187a. *Coccinella difficilis* Cr. Malheur Lake 21 May, 1941 (Fender), Durkee 6 May, 1941 (Fender), Middle Fork of the Willamette River, 22 May, 1947 (Malkin). All these are records from the eastern portion of the state.

ORGANIC INSECTICIDES

Review No. 1, on ''The Mode of Action of Organic Insecticides'' by Robert L. Metcalf has just been published by the Chemical-Biological Coordination Center of the National Research Council. This important review prepared at the request of the Entomology Subcommittee of which Dr. Roger B. Friend is chairman summarizes in 84 pages the major contributions to the literature of organic insecticides. There are nine chapters each dealing with such insecticdes as nicotine, pyrethrum, rotenone, organic thiocyanates, dinitrophenols, phenothiazine, DDT, benzine hexachloride, and organic phosphates. For each material or class of insecticides, there is a brief review of ts chemistry, relation of chemical structure to toxicity, theories of toxic action, physiological effects, biochemistry, etc. In view of the current interest in organic insecticides this well organized and presented review should gain the immedate approval of economic entomologists, and credit is due also to the Entomology Subcommittee of the Chemical-Biological Coordination Center for its sponsorship of the study.—H.B.W.

OBSERVATION ON THE COURTSHIP OF BRENTHIS ANCHORAGO L. (COLEOPTERA, BRENTHIDÆ)

By Borys Malkin

The following observations were recorded by the writer while on a collecting trip in the vicinity of Tolosa, Oaxaca, in Mexico, during the first two weeks of September 1947. Tolosa is located on the Trans-Isthmian railroad on the Atlantic side of the Isthmus of Tehuantepec about 10 miles south of the Vera Cruz border. The country is low, the hills not exceeding 500 feet, the average being less than 200 feet. There is some grassland but, in the main, dense tropical rainforest covers the area.

The visit took place during the peak of the rainy season. The rains fell throughout the night and also with interruptions during the day. Only two days, in the four weeks that the writer remained in the locality, could be considered as completely sunny. On other days the sun appeared only sporadically.

Brenthis anchorago L. is certainly the most common beetle of the family *Brentidæ* in the area, in fact it is probably the most common of all Central American representatives of this group. The beetles were numerous and gregarious. Sometimes as many as 40 specimens would appear on a log or a portion of it. No preference for any particular section of the log was observed. However, exposure to direct sunshine was obviously avoided. The beetles retreated to the shaded part of the fallen timber as the sun's rays fell upon them. The greatest activity was observed during the morning hours, slackening toward noon until most of the insects would gradually disappear in crevices or under bark by 5:00 P.M.

The courtship activities of these insects may be summarized as follows: The male is the active party while the females remain passive at least until males appear in their vicinity. Occasionally the female may remain unreceptive and walk away from the approaching male. Usually, both male and the female in each other's presence show excitement in moving the antennæ about rapidly and in their nervous, haphazard movements. Then the male will wander about the female until he succeeds in placing his proboscis upon her thorax or head. The male attempts to place the proboscis as close to the head as possible. This apparently stimulates the female who remains on the spot. The male then proceeds to rub the proboscis against her thorax and head. Should it slide, the male will promptly adjust the proboscis and restore it to the former position.

This action may last for a considerable length of time. While the average time ranged from 5 to 10 minutes, I observed certain males continuing this action for much longer. This seems to be preparatory to copulation which almost never takes place without it. Unlike the copulation in some beetles, notably the *Coccinellidæ,* here it is brief. A number of observed pairs remained in contact for 30 to 100 seconds with 45 seconds being the average. If the male is larger than the female they usually remain in one spot. If smaller, which does not happen frequently, the female may wander around carrying the male on her back.

As soon as the male mounts the female she begins boring into the wood by moving her thorax up and down. This she usually keeps on doing during the actual mating and after it has been completed, seemingly ignoring the male's presence. The courtship does not end with the copulation but continues after it has been consummated. As in the initial approach the male attempts to rub the female's thorax or head with his proboscis. Some pairs were observed courting for 15 minutes until the second mating took place. Casual contacts with the female occur but rarely. One pair may remain together for as long as half an hour or longer. In one instance that much time elapsed between the initial and the second copulation. This is in striking contrast with the *Coccinellidæ* where the mating is long when compared with the duration of the courtship.

Leaving the female, the male wanders away in search of other partners. In the meanwhile the female will remain passive continuing her borings. These are very dense. On one side of a log I counted from twenty to thirty to a square inch which shows that one female makes several of them in a day. The use of these I do not know. Very likely the eggs are deposited in them although I have never observed this myself. Beeson* believes that some of the Indian species of the family lay their eggs in this manner.

The males usually do not attempt to mate with another male unless the individual is already in contact with a female. Then hurriedly and excitedly they crawl upon the back of a more successful male and attempt to mate with either the male or female indiscriminately. It seems that the smaller male will attempt this more frequently as this is the time when they presumably can approach the female unnoticed while the larger individual is totally preoccupied with her.

In general, however, the size of the male seems to have little effect on his ability to find a mating partner. In direct approaches to the female, large size is rather detrimental as the larger male specimens are slower and clumsier in walking on the rough surface of the log than the smaller ones. Their enormously developed thorax and proboscis are detrimental in this respect. The male is inclined to the exclusive possession of the female during the courtship and will drive off any competitor that may come close to the scene. These fights are not intense and consist chiefly of pushing each other with the proboscis until one of them retires. The victorious male will follow the intruder occasionally as far as 10 inches from the female. Usually the male, already in possession of the female, wins the contest. Here it is that size seems to be of some advantage as the larger male always succeeds in driving the competitor off. These intrusions are frequent. In one observed instance a large male remained with the female for 38 minutes during which time he had fought off four different males. Each time when the danger had passed he returned to the female.

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* Beeson C. F. C. *Notes on the Biology of Brenthidæ.* Indian Forest Records. Vol. XI. part. IV. p. 178–188.

BOOK NOTICE

Larvæ of Insects. Lepidoptera and Hymenoptera. Part I. By Alvah Peterson, Ph.D. Edwards Brothers, Inc. Ann Arbor, Mich., Lithoprinted, 8¼ x 10¾ inches. 315 p. 84 pl.

For more than thirty-five years Dr. Peterson has been interested in the study and identification of immature stages of insects. However, it was only during the past ten years or so that he could devote much time to this interest, and this volume is the long anticipated result.

The importance to agriculture and public health of recognizing many insects in their immature stages is accepted. And insect taxonomists with interests in phylogeny are turning in greater numbers to consult the larval, nymphal, and pupal stages for answers to questions of identity and relationships, which they may be unable to decide from study of adults alone. But the problem of finding keys and illustrations to aid in their identification is often discouraging. The present volume, part I of two parts, will enable the student to get an excellent start toward the recognition of representatives of larvæ, nymphs and pupæ of all the orders of insects in North America except the Zoraptera and Strepsiptera. About 100 illustrations are provided to aid in the recognition of the orders. The volume then considers the Lepidoptera and plant infesting Hymenoptera with emphasis placed upon those species of economic importance.

There is a detailed discussion with more than 100 illustrations of larval structures in nearly all families of Lepidoptera in which larval stages of one or more species are known. The keys to families are first divided into four sections which combine some characters such as size and habits with structure. Following the keys the families are considered in alphabetical order with an indication of the number of known North American species in each, a discussion of the habits of the family, and a description of fully grown larvæ. Once the family is known to which a larva belongs, illustrations with accompanying explanations of figures may be consulted for specific identification. There are separate keys to the species of Pyralidæ injurious to stored food products, and Pyralidæ injurious to corn, sugarcane and related plants. No other keys are provided to the species considered in each family but the illustrations and explanations should enable one to make the identification if the species is among those treated. For each species figured, the scientific and common names are given, length of fully grown larva, color and shape of living specimen, morphological features, food habits, and frequently citations to literature which describe larval stages. More than 220 larvæ have been figured and there are approximately 650 illustrations of entire larvæ or structural details.

The section on plant infesting Hymenoptera follows the pattern used for the Lepidoptera. All the species considered belong to the several families of sawflies and chalcidflies of which over 40 species are figured.

Throughout the book there is considerable supplementary information of value. There are separate lists of some common, important or unusual species of Lepidoptera and Hymenoptera as well as selected bibliographies for the two orders; a selected general bibliography on nymphs and larvæ of insects; and an extensive glossary chiefly of morphological terms found in the published literature on immature stages of insects. A general index includes chiefly the common and scientific names of all insects considered in this volume.—M. W. SANDERSON.

COLOR DISCRIMINATION BY *ERISTALIX TENAX*

In Nature, Vol. 163, p. 255, February 12, 1949, Dora Ilse, reports on her successful training to colors of a solitary insect, *Eristalis tenax,* for the first time, in the Department of Physiology of the Medical School, Hospital Centre in Birmingham. These drone flies were trained to find their food on flower models made of colored papers, offered in a greenhouse. The flies were trained to yellow and in order to determine if they recognized the specific wave-length band reflected by the yellow paper or its special degree of brightness they were offered without any food, models in the training color along with two other shades of yellow, as well as models in various shades of gray, ranging from black to white, all exposed to full sunlight. The behavior of the flies in visiting in abundance the yellow models which varied considerably in reflectance indicated that they were influenced by wave-length rather than brightness. Other experiments indicated that the insects preferred their training color rather than red, green, blue and violet. Incomplete experiments gave promise that the insects could be trained to come to blue.—H.B.W.

INSECTS AND SLANG

To the expressions previously noted in Volume 56, p. 170 and p. 250 of this Journal, Professor Minnie B. Scotland of the New York State College for Teachers, Albany, N. Y., has supplied the following, garnered from her students.

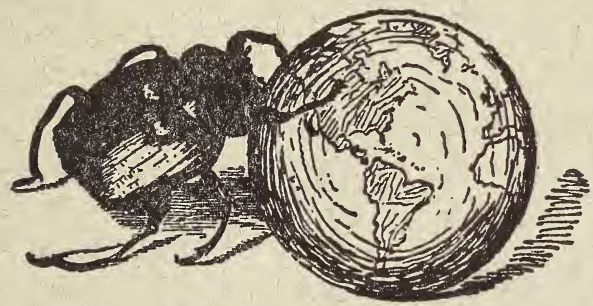
Cootie garage, a hair-roll.
Cute as-a-bug's ear, self-explanatory.
Snug as a bug in a rug, cozy.
Stung, cheated.
Vest ''vulchers,'' moths in clothing.

Vol. LVII No. 3

SEPTEMBER, 1949

Journal
of the
New York Entomological Society

Devoted to Entomology in General



Edited by HARRY B. WEISS

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E. W. TEALE

Subscription $5.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1949

CONTENTS

NOTICE: Volume LVII, Number 2, of the Journal of the New York Entomological Society was published on June 2, 1949.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

Vol. LVII September, 1949 No. 3

STUDIES ON THE FAUNA OF PACIFIC NORTHWEST GREENHOUSES (ISOPODA, COLEOPTERA, DERMAPTERA, ORTHOPTERA, GASTROPODA)

By Melville H. Hatch

The present paper represents a contribution to the knowledge of that interesting assemblage of animals (the synanthropes) that in varying degrees have adapted themselves to conditions provided by man. The author became interested in greenhouse fauna in 1946 in connection with his study of isopods. Myriapods were collected extensively from the first and, it is hoped, will be reported on separately by Mr. Ervin F. Dailey. The Araneida will likewise be reported on later. At the beginning beetles were collected only desultorily and it was not until the 1946 collections were studied that it was realized that they presented features worthy of further investigation. The result was that the 1947 collections were more thorough, though still only Isopoda, Myriapoda, Coleoptera, Araneida, snails, and a few earwigs and crickets were collected. Sixty-seven greenhouses in 45 localities in British Columbia, Washington, Idaho, and Oregon were visited in 1946 and 25 additional greenhouses in 18 additional localities were visited in 1947.

I. ISOPODA

This report is supplemental to a previous one (Hatch 1947: 182–184) in which eleven species of oniscoids were reported from 67 greenhouses in 45 localities in the Pacific Northwest. In 1947, 28 greenhouses (2 in British Columbia, 6 in Washington, 20 in Oregon), 25 of which were not seen the previous year, revealed 9 species of Oniscoidea. Of these 5 contained no oniscoids, as opposed to one out of 67 in 1946. Three of these 5 were in the dry area east of the Cascade Mountains: Ephrata, Wash.; Bend and Klamath Falls, Ore. The other two were in Coos Bay and Waldport, Ore. Of the remaining 25, 4 contained one species; 9, 2 species; 5, 3 species; 3, 4 species; 1, 5 species; and 1, six species. *Trichoniscus* sp. and *Cordioniscus stebbingi* Patience from Corvallis, Ore., *Cylisticus convexus* DeG. from Pullman, and *Trachelipus rathkei* Br. from Seattle, Wash. in 1946 were not taken in 1947. All 13 species of isopods occurring in Pacific Northwest greenhouses may be introduced with the dubious exception of *Trichoniscus demivirgo* Blake and *Porcellio scaber* Latr.

Trichoniscus demivirgo Blake. This species, not found in any greenhouse in 1946, was taken in greenhouses in Seattle, Wash. and North Vancouver, B. C. It was likewise taken immediately outside the greenhouse in the latter locality. This is the first British Columbia record for this species.

Philoscia muscorum Scop. Taken in 2 greenhouses: Kelso and Seattle, Wash.

Oniscus asellus L. Taken in 5 greenhouses, the only new locality being Kelso, Wash.

Porcellionides pruinosus Br. Taken in 5 greenhouses: Langley Prairie, B. C.; Seattle, Wash.; Ashland, Grants Pass, Medford, Ore.

Porcellio lævis Latr. Taken in two greenhouses: Medford and Roseburg, Ore. Not previously recorded from the Pacific Northwest.

Porcellio scaber Latr. Taken in 16 greenhouses, new localities being Ashland, Albany, Canby, Coos Bay, Grants Pass, Myrtle Point, Reedsport, Roseburg, Salem, and Woodburn, Ore.

Porcellio dilatatus Br. Taken in 7 greenhouses: Seattle, Kelso, Ritzvelle, Wash.; Ashland, Albany, Medford, Salem, Ore. Occurred in 54 per cent of the greenhouses visited in 1946. Absent from most of the southwestern Oregon greenhouses. I have recently received specimens taken outdoors near Garden Grove, Cal. in 1948.

Armadillidium nasatum B.-L. Found only at Langley Prairie, B. C., where it has occurred since 1941.

Armadillidium vulgare Latr. Taken in 20 greenhouses, new localities being: Kelso, Wash.; Ashland, Albany, Canby, Coos Bay, Eugene, Grants Pass, Medford, Myrtle Point, Roseburg, Salem, and Woodburn, Ore.

II. COLEOPTERA

In the following list of 61 species of Coleoptera, the 24 species known likewise from Europe are starred and the 6 of these 24 not previously known from North America are double-starred. In nearly every instance European material has been available to help authenticate the identification of the European species, the exceptions being *Platysma* (*Bothriopterus*) *adstrictum* Esch. and *Amara* (s. str.) *anthobia* Vill. The previously recorded distribution of each species is indicated and the species previously undescribed in the American literature are sufficiently described so that it is hoped future students of the Nearctic fauna will be able to recognize them.

The taxonomic interest in this list of beetles derives from its introduction of five or six well-established European species into our fauna. It must be emphasized, however, that the occurrence of these introduced species in greenhouses may be only incidental, since in every instance except that of *Bembidion* (*Metallina*) *lampros* Hbst. the newly reported species is established outdoors, and I have reason to believe that the *Bembidion* will eventually be found outdoors likewise.

Carabidæ

Scaphinotus (*Brennus*) *fulleri* Horn. ORE.: Roseburg. A western Oregon species.

**Carabus granulatus* L. B. C.: Burnaby, Langley Prairie, North Vancouver; WASH.: Lynden. The previous status of this species in America has been traced by Hatch (1933: 117; 1946), Brown (1940: 69), and VanDyke (1945: 92, 128–129). In Eurasia it occurs throughout Europe except the Iberian Peninsula and southern Italy, and across northern Asia to Japan (Apfelbeck 1904: 33; Porta 1923: 58; Jeannel 1941: 115). It is said to be native to the Transcaspian region and

Persia (Schaufuss 1907: 16). Andrewes (1935: 14) points out that the fixation of the type of *Carabus* by Curtis in 1833 as *C. violaceus* L. (= *Megodontus* Solier 1848) has priority over its fixation as *C. granulatus* L. by C. G. Thomson in 1875. Earlier than this (1859: 2) C. G. Thomson had already designated *C. hortensis* L. (= *Euporocarabus* Reitter) as the genеritype. In consequence of the above, I propose the subgenus **Neocarabus** nov. for *C. granulatus* L.

**Carabus* (*Archicarabus*) *nemoralis* Müll. WASH.: Aberdeen, CleElum, Colfax, Ellensburg, Kelso, Port Angeles, Pullman. The status of this species in America is traced by Hatch (1933: 117–118; 1946), Brown (1940: 69), and Van Dyke (1945: 92, 129), and I have specimens taken outdoors previously unrecorded from Port Angeles, Olympia, Montesano, Wenatchee, Cheney, and Vancouver, Wash. and McMinnville, Ore. A native of northern and middle Europe (Jeannel 1941: 126–127).

Notiophilus sylvaticus Esch. ORE.: Coos Bay. Occurs from northern California to south central Alaska (Fall 1906: 89).

**Bembidion* (*Peryphus*) *ustulatum* L. (? *tetracolum* Say). B. C.: Langley Prairie, North Vancouver; WASH.: Everett, Marysville, Seattle. I can detect no difference between North American specimens and examples in my collection from Moravia in central Europe. I have similar specimens taken outdoors from Toronto, Ont.; Calumet, Mich.; North Vancouver, B. C.; Seattle and vicinity (Lake Forest Park, Bothell, Juanita Beach, Renton, Redmond) and from Pacific City and Port Angeles, Wash. In the Old World *ustulatum* occurs throughout nearly the entire Palaearctic region (Jeannel (1941: 509) and I am beginning to suspect it is introduced in North America. If *tetracolum* Say 1823 is really a synonym, its introduction occurred at an early date, but *tetracolum* may refer to a related native species like *substrictum* LeC (= *lucidum* LeC.). My suspicion of *ustulatum's* introduced status in this country is due to its predominance in my experience in and near cities and in cultivated fields and its general absence from "natural" habitats. Hayward's (1897: 80) record of it as "very widely distributed, occurring *locally* throughout the greater part of the region east of the Rocky Mountains'' (italics mine) would fit in with this hypothesis.

Bembidion (*Peryphus*) *substrictum* LeC. (*lucidum* LeC. nec Fald.). WASH.: Ephrata, Ritzville. Occurs from Alaska (Van Dyke 1924: 7) to Newfoundland, Illinois, Mexico, and California (Csiki 1928: 114).

Bembidion (*Peryphus*) *fusicrum* Mots. WASH.: Ritzville. Occurs in Turkestan and Siberia and from Alaska (Csiki 1928: 96) and Quebec (Brown 1930: 232) to New Mexico (Fall and Cockerell 1907: 157) and eastern Washington. It has probably not been introduced into North America by human agency.

***Bembidion* (*Metallina*) *lampros* Hbst. B. C.: Langley Prairie, one specimen taken in 1946, seven in 1947, the latter in the damp dirt on the floor under one of the tables. This European and western Siberian species (Müller 1918: 58) has not previously been recorded from North America.[1]

The subgenus *Metallina* Motsch. has not previously been recognized in America and may be defined as follows: Elytra with marginal line angulate at humerus and attaining the base of the fourth stria, the third interval with two dorsal punctures, the striæ strongly punctate, the discal striæ obsolete towards apex, the eighth stria more deeply impressed and narrowly separated from the glabrous margin; shining metallic; frontal striæ simple, impressed, straight in front, arcuate behind; pronotum strongly cordate, the hind angles rectangular, the base not or scarcely wider than the apex, the marginal seta in front of the middle.

B. lampros Hbst. may be further described as follows:

Shining black, metallic, the legs and first four segments of antennæ more or less rufous; head with frontal striæ single, subparallel in front and sinuate and deeply prolonged behind the anterior supraorbital seta and divergent behind, the eyes large; pronotum strongly cordate, about three-fourths as long as wide, widest just in front of middle, the base about nine-tenths as wide as the apex, the side margins strongly arcuate

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[1] Not to be confused with the *lampros* Horn (1890; Hamilton 1894: 351) *nec* Herbst (= *muscicola* Hayward 1897: 122–123).

in front, strongly constricted in front of the prominent rectangular carinate hind angles, the basal impressions deep and bistriate and connected by a well impressed coarsely punctate transverse impression; elytra with the first and eighth striæ entire and impressed, the second through the sixth striæ feebly impressed, obsolete towards apex, the first through the sixth striæ and the scutellar stria coarsely punctate, the seventh stria obsolete, the eighth distinct from the margin, the third interval with two dorsal punctures distant from the third stria, the marginal line obtusely angulate at the humerus and inwardly prolonged to the base of the fourth stria; mentum with a large entire tooth; length 2.5–4 mm. (3.25–4 in my series).

Belonging likewise to *Metallina* apparently is the *B. dyschirinum* LeC. of Hayward and the related forms described by Casey (*aleneanum, perturbatum, agitabile, atrolucens*). From my extensive series of *dyschirinum, lampros* may be distinguished by its slightly more coarsely punctate elytral striæ, the punctures becoming obsolete behind the middle rather than about at the middle as in *dyschirinum.* Moreover, the pronotum is slightly less cordate in *dyschirinum,* the base being nearly equal to the apex in width, the transverse basal impression smooth and nearly obsolete at the middle.

Bembidion (s. str.) *dubitans* LeC. WASH.: Dayton. Occurs from Alberta and British Columbia (Csiki 1928: 143) to New Mexico (Fall and Cockerell 1907: 157).

**Trechus* (s. str.) *obtusus* Er. WASH.: Everett, Seattle. First reported from North America at Seattle by Hatch (1933: 119), this species has since been taken at Bothell, Renton, Silver Lake (Snohomish Co.), and Tacoma, all in western Washington. It is a native of western Europe from Iceland and southern Scandinavia to Albania, Sicily, Tunis, and Morocco (Jeannel 1927: 303–309). Western Washington specimens are said by Jeannel (1941: 329) to belong to the form *obtusioides* Jeann. from north Africa, Spain, and southern France. It may be described as follows:

Rufo-testaceous, shining, impunctate, the legs flavous; head with frontal sutures well impressed, extending from the clypeus broadly arcuating behind the well developed eyes nearly to the gula; pronotum nearly five-sixths as long as broad, the apex seven-eighths as wide as the base, the sides broadly subevenly arcuate, the basal margin within the hind angles narrowly beaded but not at all flattened, the hind angles obtusely rounded and very minutely prominent, the side margins narrowly reflexed, the basal impressions feebly impressed and separated from the hind angle by a convex undifferentiated extension of the pronotal disc; elytra with eight sparsely evanescently punctate striæ, the first three well impressed, the first with a deeply impressed apical portion recurving to near the apex of the fifth stria, the third with two dorsal punctures and an apical puncture at its confluence with the second, the sixth and seventh striæ evanescent, the eighth evanescent except at its apical third where it is sulciform; length 3.75–4.25 mm.

Distinguished from *chalybœus* Dej. and *ovipennis* Mots., the native Pacific Northwest species of the genus, by the hind angles of the pronotum, which in these species are rectangular or subrectangular with the side margin more or less slightly sinuate in front of the hind angles, the basal impressions larger than in *obtusus,* the basal margin just within the hind angles appreciably but narrowly flattened.

Platysma (*Hypherpes*) *herculaneum* Mann. WASH.: Everett. Occurs from southeastern Alaska to Oregon west of the Cascade Mountains and in northeastern Washington and northern Idaho.

Platysma (*Hypherpes*) *algidum* LeC. WASH.: Everett, Kelso, Port Angeles, Seattle. ORE.: Grants Pass, Roseburg. Occurs from south central Alaska to Oregon west of the Cascade Mountains, the most abundant species of the genus.

Platysma (*Pœcilus*) *occidentale* Dej. ORE.: Grants Pass. A single specimen appears to belong to this southern Californian and Nevadan species. I am not familiar enough with the fauna of southern Oregon to say whether or not it occurs outdoors in that area.

Platysma (*Pœcilus*) *lucublandum* Say. WASH.: Walla Walla, Yakima. This species ranges from Alaska (Csiki 1930: 601) and Quebec (Chagnon 1917: 170) to Oregon, Utah, and District of Columbia (Ulke 1902: 6).

**Platysma* (*Omaseidius*) *vulgare* L. B. C.: Burnaby, Langley Prairie, North Vancouver. WASH.: Ellensburg, Everett, Mt. Vernon, Port Angeles. First reported from North America by Hatch (1933: 120) from various localities in western Washington and northwestern Oregon, this species has since been taken outdoors at the following additional localities: B. C.: Burnaby, North Vancouver, Vancouver, Victoria; W. Wash.: Alpha, Bellingham, Blaine, Bothell, Custer, Friday Harbor, Olympia, Port Townsend, Redmond, Renton, Snoqualmie Falls; E. Wash.: Wenatchee. Jeannel (1942: 785) records this species from central and northern Europe and Siberia. It may be described as follows:

Black, shining, finely alutaceous, the tarsi and palpi piceous; pronotum seven-tenths as long as wide, the apex about ninety-five per cent as wide as the base, the sides arcuate in front of the very briefly prominent bluntly rectangular hind angles, the side margins evidently flattened, the basal impressions well impressed rugoso-punctate bistriate, a prominent convex carina between the outer stria and the side margin, median line fine and entire; elytra with a scutellar and eight discal well impressed sparsely evanescently punctulate striæ, the intervals convex, the third interval with two dorsal punctures adherent to the second stria, the eighth stria with about fifteen ocellate punctures, the humeri rounded and not dentate; venter impunctate, sparsely punctate towards the sides of the meso- and metathorax; male with protarsi dilated and with one anal seta on either side of the last abdominal sternite; female with protarsi narrow and two anal setæ; tarsi with last segment with two or three setæ along the lower margin; length 14–19 mm.

This member of the subgenus *Omaseidius* Jeannel (1942: 781, 782, 784) (generitype *vulgare* L.) (= *Omaseus* auct. nec Steph. —Jeannel 1942: 755) runs to *Lophoglossus* LeC., but is distinguished therefrom by the two or three setæ on the lower surface of the last tarsal segment. It is likewise distinguished by its more roughly sculptured basal pronotal impressions. From *Melanius* Bon. (= *Omaseus* Casey nec Steph.) it is distinguished by the same tarsal character as well as by its more broadly flattened pronotal side margins.

Platysma (*Parargutor*) *atrolucens* Csy. WASH.: Seattle. ORE.: Salem. *Atrolucens* is distinguished from the Californian *lustrans* LeC. by its averagely larger size and its posterior thoracic angles, the side margins curving out almost directly from the hind angles and not perceptibly in front of them, as in *lustrans*. Widely distributed throughout Washington and northern Oregon.

**Platysma* (*Bothriopterus*) *adstrictum* Esch. WASH.: Mt. Vernon, Port Angeles. Many years ago Fall (1926: 135) opined that "nearly all the names under *Bothriopterus* of the Leng list apply to more or less trifling variations of this ubiquitous northern species." The species is nearly circumpolar, is common throughout the Pacific Northwest, and I know of no reason to believe that it is introduced.

Amara (*Curtonotus*) *jacobina* LeC. ORE.: Klamath Falls. Washington and California (Hayward 1908: 22–23) to Idaho, Colorado (Wickham 1902: 236), and Arizona (*Hayward*).

Amara (*Percosia*) *obesa* Say. WASH.: Ellensburg. Widely distributed in Canada and the United States north of Oregon (Horn 1892: 26), Oklahoma, and the District of Columbia (Horn).

Amara (*Celia*) *californica* Dej. WASH.: Port Townsend. ORE.: Eugene, Medford. California and New Mexico (Horn 1892: 27–28) to Washington.

Amara (s. str.) *impuncticollis* Say. WASH.: Walla Walla. ORE.: Grants Pass, Medford, Woodburn. Alaska (Csiki 1929: 418) and Quebec (Chagnon 1917: 171) to Alabama (Löding 1945: 18) and Oregon.

***Amara* (s. str.) *anthobia* Vill. Wash.: Marysville (1946), Seattle (1947). My first two specimens of this European species are dated June 1945 from Lake Forest Park (north of Seattle, collected by Arnie Brown). Additional specimens have been taken at Bothell in 1946 and 1947. This species is distributed throughout southern Europe and Asia Minor (Jeannel 1941: 912) to England (Fowler and Donisthorpe 1913: 7), Netherlands (Everts 1903: 83), and southern Germany (Reitter 1908: 161). It has not previously been reported from North America. My identification is not based on comparison with

European examples, but my specimens fit so perfectly the descriptions of *anthobia* that I am virtually certain of my identification. It may be recognized as follows.

Above æneous, shining, nearly impunctate, very finely and feebly alutaceous; below shining black, nearly impunctate; legs and first three or four antennal segments clear rufo-flavous, the second and third segments not carinate, the outer antennal segments piceous; pronotum about two-thirds as long as broad, broadest at about the basal third in front of which the sides are broadly arcuate to the broadly rounded anterior angles and behind which the sides are just visibly convergent to the narrowly rectangularly rounded posterior angles; pronotum with the apex nearly truncate and about two-fifths as wide as the base, the disc convex and with a finely impressed median line not attaining either apical or basal margins, the side margins and the basal margin at either side finely beaded, the inner basal impression strongly impressed and linear, the outer impression feeble, the side margin with the anterior seta-bearing puncture at apical third, the posterior one in the hind angles closer to the basal than to the lateral margin; elytra with a scutellar and eight discal striæ finely impressed (more strongly impressed at extreme apex) and evanescently punctulate, the scutellar stria more or less interrupted and with a seta-bearing puncture at its base, the intervals nearly flat (convex at extreme apex), the lateral and apical margin with about sixteen seta-bearing punctures, the apical margin sinuate; male with first three protarsal segments dilated, the inner surface of the distal portion of the metatibia pubescent, the prosternum smooth, the last abdominal sternite with a single anal seta on either side; female with the protarsi and metatibiæ unmodified, with two anal setæ; length 5.5–7 mm.

Anthobia runs to *impuncticollis* Say and its allies from which it is distinguished by its smaller size, its uniform rufo-flavous legs, and its nearly truncate pronotal apex.

**Amara* (s. str.) *familiaris* Duft. (*humilis* Csy.). B. C.: Burnaby. WASH.: Enumclaw, Vancouver. ORE.: Woodburn. This widely distributed Palæarctic species was first recorded from North America in 1918 by Casey (1918: 302) under the name *humilis* Csy. on the basis of specimens from Rhode Island and Long Island. According to Mr. L. L. Buchanan, who has been so kind as to look into the matter for me, the Long Island specimens were taken in 1915, the Rhode Island specimens at an undetermined date. Mr. Buchanan likewise reports specimens in the United States National Museum from West Point, N. Y., 1913, and Mt. Vernon and Seattle, Wash., 1943. Darlington (1936: 20) established the true identity of American material, reporting *familiaris* common in eastern Massachusetts and New Hampshire, and Mr. C. A. Frost writes me he has it from eastern Massachusetts from 1919 or before. I collected specimens in central (Onondaga Co., 1923) and northern New York (Cranberry Lake, 1922). The species is common in the Pacific Northwest, my earliest material being a male from Seattle taken in 1913. I have additional males taken since 1928 from Ariel, Auburn, Camano Is., Cedar Mt., Darrington, Evans Creek, Juanita Beach, Kent, Moclips, Mora, Mt. Vernon, North Bend, Oak Harbor, Olympia, Panther Lake (King Co.), Possession, Puyallup, San Juan Is., Seattle, Snoqualmie Falls, and Tacoma, all in western Washington; from Walla Walla (1942) in eastern Washington; and from Cannon Beach (1937) in western Oregon.

***Calathus* (s. str.) *fuscipes* Goeze. B. C.: North Vancouver —a single specimen, 1946. Additional specimens were secured outside the same greenhouse in 1946 (2), May 1947 (2), and July 1947 (2). Mr. G. Stace Smith has two specimens taken in North Vancouver in 1928 (G. H. Larnder collector) and there are seven additional specimens in the Ralph Hopping collection, same place, same year, same collector. This European-Mediterranean species (Schaufuss 1908: 96; Jeannel 1941: 850) has not previously been reported from North America. It may be recognized as follows.

Black, shining, finely alutaceous, the elytra somewhat more alutaceous and less shining (male) or opaquely alutaceous (female); legs, mouthparts, and antennæ piceous to rufous, the basal antennal segment frequently evidently paler; pronotum about four-fifths as long as wide, very feebly deplanate at sides, more strongly so towards the hind angles which are variably slightly punctate in the position of the "outer" and "inner" basal impressions which are feebly impressed, the apex emarginate and about seven-tenths as wide as the base, the sides broadly arcuate in front, nearly parallel to very slightly convergent behind the basal half or third, the posterior angles rounded, the base feebly broadly emarginate at middle, the disc with impressed median line not attaining either margin; elytra with finely impressed finely punctate scutellar and nine discal striæ, the scutellar stria with an ocellate puncture at its base, the second (especially behind), third, fifth, and eighth striæ set with numerous larger seta-bearing punctures; length 10–14 mm. (10.5–12 mm. in my material).

This species is distinguished from the previously known North American species of *Calathus* by the series of punctures on the second, third, and fifth elytral striæ.

**Lœmostenus* (s. str.) *complanatus* Dej. WASH.: Enumclaw. ORE.: Canby. The World and American status of this Mediterranean species has been detailed by Gray and Hatch (1941: 13–14) and Hatch (1942: 1211). It is a subcosmopolitan predator said to be associated primarily with stored grain, but its occurrence in two greenhouses may suggest other associations as well.

Agonum (*Melanagonum*) *fossigerum* Dej. WASH.: Chehalis. ID.: Moscow. California to Washington, along stream margins.

Chlœnius tricolor Dej. WASH.: Dayton. This is one of a group of species represented likewise by *Harpalus caliginosus* F. (which does not, however, get beyond the extreme eastern margin of Washington) and *H. pennsylvanicus* DeG., which, extending all the way to the Atlantic Ocean, do not in Washington surpass the barrier of the Cascade Mountains.

Harpalus (*Megapangus*) *caliginosus* F. WASH.: Rosalia—a single dead specimen. My only other Northwestern specimens are from Almota, Wash. and Homestead, Ore.

Harpalus (*Harpalomerus*) *amputatus* Say. WASH.: Pullman. Occurs from South Dakota and British Columbia east of the Cascade Mountains to Wyoming and Arizona.

Harpalus (*Pardileus*) *pennsylvanicus* DeG. WASH.: Clarkston, Kennewick, Sunnyside, Wenatchee. ORE.: Grants Pass, Medford. See note under *Chlœnius tricolor* Dej.

Harpalus cautus Dej. WASH.: Seattle. ORE.: Salem. The commonest species of the genus west of the Cascade Mountains.

Harpalus sp. WASH.: Prosser, Sunnyside.

Harpalus fraternus LeC. WASH.: Ephrata. British Columbia to northern California and Wyoming (Casey 1914: 118).

Anisodactylus consobrinus LeC. ORE.: Ashland. Northern California (Casey 1914: 187) to eastern Washington.

Anisodactylus californicus Dej. WASH.: Chehalis, Clarkston, Seattle, Wenatchee. ORE.: Dayton, Eugene, Grants Pass, Reedsport, Roseburg. Middle California (Casey 1914: 189) to British Columbia and Idaho. The commonest species of the genus in the Pacific Northwest.

Anisodactylus semipunctatus LeC. ID.: Moscow. Northern California (Casey 1914: 186) to Washington and Idaho.

*******Anisodactylus binotatus*** F. B. C.: Burnaby (1946), Langley Prairie (1946). This widely distributed common Palæarctic species has not previously been reported from America. My first specimens were taken by Mr. M. J. Forsell in 1944 at Seattle, Bothell, Redmond, Mt. Vernon, and Conway, all in western Washington (Apr. 30–Aug. 19, 19 specimens). I have two specimens from Seattle taken in 1946 and one taken in 1947, and two specimens from Bothell taken in 1947. It may be described as follows.

Black, a transverse rufous spot between the eyes, the first two and one-half segments of the antennæ conspicuously paler; head shining, minutely punctulate; pronotum nearly two-thirds as long as wide, widest just before middle, apex emarginate and five-sixths as wide as base; sides of pronotum broadly arcuate, oblique before the minutely prominent hind angles; disc of pronotum shining, minutely punctulate, slightly more coarsely punctate along apical margin, the sides, and the base, the basal impressions conspicuously punctato-rugose; elytra shining, alutaceous (more opaquely so in female), obscurely punctate (more obscurely so in female), the scutellar and nine discal striæ entire, impressed, impunctate, the intervals feebly convex, the third interval with a single dorsal puncture behind the middle at or near the second stria, the two outer intervals and the apical third or fourth (female) or sixth or seventh (male) with minute seta-bearing punctures; venter shining minutely alutaceous, the metepisterna punctate, the sterna and first two abdominal sternites pubescent especially towards their median portions, the male with the median portion of the metasternum in front of the antecoxal piece and of the first two abdominal sternites glabrous; male with the first four segments of the pro- and mesotarsi dilated and spongy pubescent beneath; length 10–11.5 mm.

Distinguished from the other American species of *Anisodactylus* s. str. known to me by its conspicuously paler two and one-half basal antennal segments, the other species having only the basal segment paler. From all our species except *semipunctatus* LeC. and related forms it is distinguished by its pubescent lateral and apical elytral margins. From *semipunctatus* it is distinguished by its slightly smaller size, nearly flat elytral intervals, and the fact that in *semipunctatus* the pronotum is throughout more or less uniformly punctate rugose and the median portions of the sterna and first two abdominal sternites are pubescent in both sexes.

Stenocellus nubicollis Csy. WASH.: Dayton. ORE.: Eugene, Grants Pass. California (Casey 1914: 253) to Washington. *Nubicollis* differs from such eastern species as *rupestris* Say and *debilipes* Say by the very much less, almost evanescent, minutely prominent pronotal angles.

Stenolophus conjunctus Say. ORE.: Grants Pass. Rhode Island to California (Casey 1914: 281) and Washington.

Silphidæ

Necrophilus hydrophiloides Mann. B. C.: North Vancouver. Southeastern Alaska to central California west of the Cascade Mountains.

Staphylinidæ

Lathrotropis jacobina LeC. ORE.: Roseburg. Southern California and Nevada (Casey 1905: 116) to Washington.

Gyrohypnus hamatus Say. WASH.: Seattle. Rhode Island and California (Casey 1906: 39) to Washington.

***Xantholinus linearis* Oliv. ID.: Lewiston. This generally distributed Palæarctic species has not previously been reported from America. My first specimen was taken in Seattle in 1931, from which locality I have 21 other specimens dated from 1932 to 1941. Additional specimens are from McDonald Lake, Bothell, and Cedar Mt. in King Co., and from Tacoma, Wash., and from Portland and Cornelius, Ore. (1934). It may be described as follows:

Black, shining; legs, mouthparts, and antennæ reddish brown; head and pronotum sometimes somewhat microstrigulate; elytra frequently brownish; head quadrate, about five-sixths as broad as long, slightly wider before the arcuate hind angles where it is subequal to the apex of the pronotum in width, the frontal punctures about as distant from each other as from the eyes, which are circular and separated from the neck by about four times their diameter; surface of head shining, smooth along mid-dorsal line, punctate towards either side and below, the sides evenly rounded with an irregularly delimited smooth area extending back from the eye, the gular sutures confluent behind middle; maxillary palpi with the fourth segment nearly as long as the third, pointed at apex, obviously narrower than third segment at base; neck three-sevenths as wide as head; pronotum seven-tenths as wide as long, obliquely narrowed behind, the angles broadly rounded, the disc with a series of about 12 to 14 punctures on either side of the median line with scattered punctures laterally, especially towards the front angles; elytra together about four-fifths as wide as long, the surface with seta-bearing punctures some of which are faintly linear in arrangement; abdomen finely sparsely punctulate and pubescent; length 5–8.5 mm.

Distinguished from *Xantholinus picipennis* LeC. of Casey by the evenly rounded not densely opaquely punctate lateral surface of the head.

**Philonthus fuscipennis* Mann. ORE.: Woodburn. This Palæarctic species (Ganglbauer 1895: 447) was first reported from America from North Carolina by Horn (1884: 186) under the name of *politus* F. Horn had not seen any specimens. Leech (1947: 23) reported it from southern British Columbia, 1931 to 1938. My Seattle records go back to 1910. It is one of our common species and I have specimens from: Ballinger L. (Snohomish Co.), Bellingham, Bothell, Duvall, Elwa, Evans Cr. (King Co.), Montesano, Mora, Mt. Vernon, Point Roberts, Port Townsend, Renton, Richmond Beach, Tacoma, Tokeland, Vashon, Washougal River, all in western Washington; Walla Walla and Yakima Co., eastern Washington; Harrison Hot Springs and Ocean Falls, B. C.; Dayton and Lostine, Ore.

Philonthus hepaticus Er. WASH.: Bellingham—a single female. Widely distributed throughout the Nearctic region (Horn 1884: 189).

**Philonthus sordidus* Grav. ORE.: Bend. Holarctic (Horn 1884: 209), Chile (Ganglbauer 1895: 451). At present I believe it is impossible to say whether or not this species has been introduced into North America through human agency.

**Philonthus nigritulus* Grav. WASH.: Ephrata. ORE.: Bend, Corvallis, Waldport. Females, possibly of this species, from B. C.: Langley Prairie; WASH.: Kelso; ORE.: Eugene. Europe, Mediterranean, Siberia, Chile, Australia (Ganglbauer 1895: 460); New England to Arizona and British Columbia (Horn 1884: 216). It is impossible to say whether or not this species has been introduced into North America through human agency.

**Staphylinus* (*Ocypus*) *globulifer* Fourc. B. C.: Burnaby. WASH.: Seattle. This widely distributed Palæarctic species (Ganglbauer 1895: 436) was first recorded in North America from Montreal, Que. by Chagnon (1936: 116) from three specimens taken in 1935. In addition to the two specimens from greenhouses, I have 16 specimens from western Washington: North Creek near Bothell (1925), Vashon (1930), Seattle (1932–1946), Bothell (1938); also one specimen from Burns, Ore. (1938). Chagnon has given a short description. It is placed in the subgenus *Ocypus* in Ganglbauer's table by its slender mandible without a tooth on the inner margin.

Staphylinus (*Tasgius*) *nigrellus* Horn. ORE.: Canby. Northern California (Horn (1879: 188) to Washington. I have used Ganglbauer's table (1895: 424) in assigning this species to the subg. *Tasgius* Steph., in which the mandibles have a single large tooth along the inner margin.

**Staphylinus* (*Tasgius*) *ater* Grav. (*Ocypus* auct.). WASH.: Bellingham, Chehalis, Dayton, Port Townsend, Walla Walla. ORE.: Dayton. This Holarctic species (Ganglbauer 1895: 435) is said to be rare in Eurasia. Such is hardly true in North America. I have specimens from New York, Michigan, and Utah. From western Washington I have taken outdoors 164 specimens from 32 localities as well as specimens from Walla Walla in eastern Washington and Corvallis and Dayton in western Oregon. It is especially common on but not confined to salt water beaches in western Washington, and I know of no particular reason for regarding it as introduced into North America through human agency. It was first reported in this country by Say in 1834 (p. 452).

***Quedius* (s. str.) *fuliginosus* Grav. WASH.: Seattle—2 specimens, 1947. This European and Mediterranean species (Ganglbauer 1895: 403) has not previously been reported from North America. In addition to the two specimens from greenhouses, I have eight specimens from Seattle taken in 1939, 1941, 1942, and 1946, and a single specimen from near Renton, just south of Seattle taken in 1946. The species may be described as follows.

Black, shining, the antennæ, palpi, tibiæ, and tarsi rufopiceous, the abdomen iridescent; head above with a puncture at base of antennæ, a pair of frontal punctures on either side in line with the anterior ocular puncture, two punctures along the posterior margin of the eye, and one or two punctures obliquely between the inner posterior ocular puncture and the distinct nuchial line; labrum broadly arcuate; eyes separated from nuchial line by less than one-third their length; head below with well developed subocular carina, the posterio-ventral margin of the eye with three large punctures behind which are a number of small bristle-bearing punctures; pronotum nearly as long as wide, broadly arcuate at sides and behind; the anterior portion of pronotal disc with 2 to 4 (usually 3) punctures on either side of the median line lateral to which are about 6 discal punctures, some of which may be lateral or sublateral, the extreme margins with sparse smaller punctures; scutellum impunctate, finely alutaceous; elytra and abdomen moderately densely punctato-pubescent; male with fifth ventral abdominal segment feebly and the sixth deeply broadly emarginate behind, the emarginations bordered by crescent shaped flattened impunctate areas; length 10–16 mm.

Distinguished from the other European and Nearctic species of the subgenus by the impunctate scutellum.

Quedius (*Distichalius*) *marginalis* Makl. (*brunneipennis* Mann. of Casey). ORE.: Dayton. Alaska (Casey 1915: 406) to Oregon, west of the Cascade Mountains.

Quedius (*Microsaurus*) *limbifer* Horn. WASH.: CleElum. Vancouver Is. to California (Casey 1915: 406).

**Quedius* (*Microsaurus*) *mesomelinus* Marsh. (*groenlandicus* Zett.). WASH.: Seattle. ORE.: Ashland. Europe, Peru, Australia, New Zealand (Ganglbauer 1895: 400); New York, Iowa, California, British Columbia (Casey 1915: 411); Washington (Seattle).

**Quedius* (*Microsaurus*) *fulgidus* F. (*iracundus* Say of Casey). WASH.: Ephrata. Europe, Mediterranean Region, Atlantic Islands, India, Australia, New Zealand (Ganglbauer 1895: 399); Iowa, Indiana (Casey 1915: 411); eastern and western Washington. I am unable to follow Casey (pp. 411, 416) in separating *iracundus* from *fulgidus*. American specimens match very closely European specimens in my collection from Austria and Moravia. *Fulgidus* may be distinguished from *mesomelinus* by its reddish elytra as pointed out by Horn (1878: 159) and Casey, but the difference in chætotaxy mentioned by Ganglbauer (1895: 394) is somewhat more satisfactory. In *mesomelinus* the group of thoracic punctures laterad to the submedian series of 3 punctures is anterior to the level of the large sublateral puncture; in *fulgidus* these punctures extend to behind the level of the large sublateral puncture. At present it is impossible to say whether or not *mesomelinus* and *fulgidus* are introduced in North America. My Washington specimens were taken under conditions which make me feel they may possibly be introduced.

Elateridæ

Drasterius dorsalis Say. ORE.: Grants Pass. A widely distributed Nearctic species.

Tenebrionidæ

Eleodes (*Blapylis*) *nunemacheri* var. *verrucula* Blais. WASH.: Kennewick, Sunnyside. Widely distributed in the Pacific Northwest east of the Cascade Mountains.

Scarabaeidæ

**Pleurophorus cæsus* Creutz. ORE.: Grants Pass. The distribution and present status in North America of this probably native European species is given by Hatch (1946a: 80). It occurs outdoors in eastern Washington and western Oregon.

Curculionidæ

**Brachyrhinus* (*Normotianus*) *sulcatus* F. WASH.: Sunnyside. ORE.: Canby—a single specimen from each locality. This species is reported as injurious in greenhouses in Pennsylvania, especially to cyclamen (Smith 1932). Its general status is discussed by Smith (1932), Essig (1931: 187–192), and Wilcox et al. (1934: 72–76). Essig opines that "this weevil was early introduced into North America, probably upon potted plant material from Europe.[2]

**Brachyrhinus* (*Zustalestus*) *rugosostriatus* Goeze (*rugifrons* LeC. et Horn nec Gyll.). WASH.: Centralia. The status of this species in North America has been discussed by Essig (1931: 184–187) and Wilcox et al. (1934: 63–71). Its discontinuous distribution in North America is partial evidence in favor of its introduction by human agency.

III. DERMAPTERA

Both the following species are introduced.

Anisolabris annulipes Lucas. ORE.: Medford. Well established and numerous in a greenhouse near Medford. The Ne-

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[2] Eleven species constitute the entire Nearctic fauna of *Brachyrhinus* in contrast with more than a thousand species in Europe. All these eleven species are likewise found in Europe. It is extremely probable, therefore, that all of the Nearctic species are migrants from the Palæarctic region. The only question, therefore, is whether they arrived before or after the advent of European man. Downes (1922) suggests that the presence of *B. ovatus* L. in British Columbia "on rocky islands away from settlements where it could not possibly have been introduced artificially" is evidence against the introduced status of at least this one species.

arctic status of this "cosmopolitan" species is given by Blatchley (1920: 47–48) and Buckell (1929: 16–17). In the Pacific Northwest the species has been previously known only from a colony established since 1927 in the gardens of the Empress Hotel in Victoria.

Forficula auricularia L. ORE.: Grants Pass, Klamath Falls, Medford, Woodburn. Probably elsewhere, but not collected. The American status of this native western Palæarctic species is given by Crumb et al. (1941: 2–3). It is generally distributed throughout the Pacific Northwest.

IV. ORTHOPTERA

Tettigoniidæ

Both the following species are native.

Ceuthophilus agassizii Scudder. ORE.: Salem. Central British Columbia and northern Idaho to middle Oregon (Hubbell 1936: 135).

Stenopelmatus longispina Bruner. ORE.: Roseburg. British Columbia and Wyoming to New Mexico, Mexico and California (Essig 1926: 97).

V. GASTROPODA

Oxychilus draparnaldi Beck. B. C.: Langley Prairie, North Vancouver. WASH.: Dayton, Seattle, Walla Walla, Wenatchee. ORE.: Coos Bay, Klamath Falls, Medford, Salem. Taken outside greenhouses in North Vancouver, B. C. and Seattle, Wash. This species is a native of Europe, western Asia, and north Africa, but is widely distributed in the United States where it was introduced before 1850 (Pilsbry 1946: 251). I am indebted to Mr. Charles B. Wurtz of the Academy of Natural Sciences of Philadelphia for naming my material.

VI. DISCUSSION

About 92 Pacific Northwest greenhouses were visited. The greenhouse species that are the subject of the present report constitute 13 species of Isopoda, 61 species of Coleoptera, two species each of Demaptera and Orthoptera, and one species of Gastropoda. Of these only 5 species of Isopoda can be considered as in any sense common greenhouse inhabitants: *Arma-*

dillidium vulgare taken in 74 greenhouses, *Porcellio scaber* in 52, *Porcellio dilatatus* in 43, *Porcellionides pruinosus* in 20, and *Oniscus asellus* in 17. Of the other species eight (*Oxychilus draparnaldi* in 10; *Anisodactylus californicus* in 9; *Carabus nemoralis* and *Platysma vulgare* in 7; *Platysma algidum, Harpalus pennsylvanicus,* and *Staphylinus ater* in 6; *Bembidion ustulatum* in 5) occurred in from 5 to 9 greenhouses, 6 in 4, 3 in 3, 18 in 2, and 43 in a single greenhouse.

Noteworthy is the preponderance of beetles in three carabid genera (*Amara, Harpalus,* and *Anisodactylus*) which are unusually phytophagous in their habits for carabids. Perhaps this is correlated with an abundance of plant food in the greenhouse habitat.

From another point of view, the species may be classified as follows:

(1) Species peculiar to the greenhouse: *Porcellio dilatatus, Cordioniscus stebbingi, Trichoniscus* sp., *Armadillidium nasatum*. *Bembidion lampros* has been taken so far only in a single greenhouse in British Columbia. The general biology of the species indicates, however, that it probably likewise occurs or will occur outdoors in our region. *Porcellio lævis* and *Platysma occidentale* are Californian species that have been taken in the Northwest only in greenhouses in southern Oregon. They may be, but probably are not, confined to greenhouses in that region. Only more extensive collecting in southern Oregon can decide. *Anisolabris annulipes* would fall in this same first category, except that it occurs outdoors at Victoria, B. C.

(2) Species living both in greenhouses and outdoors: all the rest.

A peculiarity of the greenhouse fauna is the high percentage of introduced species, by which is meant species introduced into the United States and Canada by human agency. These include all or nearly all of the 13 Isopoda, over a third of the 61 Coleoptra, both the Dermaptera, and the single gastropod. The explanation of this preponderance of European species in Northwestern greenhouses is, I believe, to be understood in terms of the somewhat similar conditions prevailing in and around greenhouses in the two regions, and the lines of communication open between the greenhouses in the two areas. It is simply a special case of the more general question as to why a preponderance of introduced species are synanthropic (associated with man) rather than otherwise. Since man is the agency for the spread of such species, it is only natural that most of the species so distributed should be closely associated with some phase of his activity. If analogous channels of dispersal were open to carrion-inhabiting, stream-side, carvernicolous, aquatic, or alpine species such as are open to the synanthropic ones, we might well witness a similar influx of foreign species into such situations.

There are three ways in which a greenhouse may become inhabited: directly from the surrounding outdoor habitats, through the introduction of plant materials or soil from some distant location, or through the introduction of similar materials from another greenhouse.

Porcellio dilatatus demonstrates the great facility with which a properly adapted species can spread from greenhouse to greenhouse without being able to live in the surrounding situations. This species has been taken in 46 per cent of the greenhouses visited and does not occur outdoors in our area. Therefore, it secures entry to a greenhouse only on materials from another greenhouse or from a region like middle or southern California where it lives outdoors. *Porcellio dilatatus* also suggests a manner in which greenhouse species that are able to live outdoors as well may be spread.

The greater portion of the Northwest greenhouse fauna, however, consists of species living in adjacent outdoor habitats. The city lot, the nursery, or the cultivated field where the greenhouse is located provide the inhabitants, some of whom find the greenhouse a suitable abode. And, *vice versa,* some of the greenhouse forms find their way into the surrounding environment.

To the extent to which greenhouse species are introduced, it is probable that the shipment of nursery stock and other plant materials have played an important if not exclusive role in their dispersal. And some of these species may first have found their way into this country through the medium of greenhouse shipments.

In this connection it may be noted that in the genera *Platysma, Harpalus,* and *Anisodactylus* the commonest of the native species in western Washington (*P. algidum, H. cautus, A. californicus*) in each case is involved in the greenhouse list, and the first and last of them are among the commonest of the greenhouse beetles. Species are common in part by virtue of their ability to adapt to varying conditions. It is possible that some of these species are in the course of becoming synanthropes and may eventually be carried elsewhere by commerce just as foreign species have been carried here.

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PRE–COLUMBIAN AZTEC GRASSHOPPER

In a note in Isis, (No. 86, Vol. XXXII (2), June, 1949), Dr. George Sarton, calls attention to a gigantic, monumental representation of a grasshopper, of red stone, weighing 48½ pounds, Aztec style (XIV–XVth cent.), that was borrowed from the Museo Nacional of Mexico City for the Exhibition of Pre-Columbian Art, arranged by the Peabody and Fogg Museums of Harvard University (Jan.–Feb. 1940). He supposes that it had a religious significance and his note is accompanied by a photograph of it. In the same note he mentions the enormous scarab of Amenophis III (1411–1375) which he saw in November, 1931 near the Sacred Lake of Karnak. This granite scarab was of considerable weight. Another Egyptian scarab of monumental size, in the British Museum, is of green granite, 5 feet long and 3 feet high, and weighs about 43 cwt.—H. B. W.

THE EFFECT OF SUMMER RAINFALL ON JAPANESE BEETLE POPULATIONS

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The amount of rainfall during the summer is an important cause of year-to-year fluctuations in the abundance of the Japanese beetle (*Popillia japonica* Newm.). Such fluctuations are often independent of long-time trends, which may be brought about, in part at least, by the action of biotic factors, such as pathogenic microorganisms (9)*, insect parasites and predators, and nematodes. Hawley and Dobbins (7) have given a comprehensive account of changes in beetle abundance from 1935 through 1943; the reducing effect of summer droughts on beetle populations and the increase in numbers resulting from unusually favorable rainfall conditions are also discussed.

In the large eastern section of the country now infested by the Japanese beetle, summer rainfall is sufficient in average years to ensure survival and, in most places, to permit an increase in the number of beetles. When precipitation is deficient, however, the soil may become so dry that certain of the soil-inhabiting stages are killed. As pointed out by Fox (1), summer rainfall has such an important effect on Japanese beetle populations that this insect would not be expected to survive in certain parts of the western United States if accidentally carried there.

STAGES OF THE JAPANESE BEETLE SUSCEPTIBLE TO DESICCATION

According to Ludwig (2), Japanese beetle eggs increase in weight during the incubation period from about 0.86 to 2.4 milligrams, chiefly by the absorption of moisture through the egg shell from the surrounding soil. If there is not sufficient moisture, the eggs will not complete their embryological development, but will perish. A dry soil condition is also unfavorable to the newly hatched larvæ. According to Fox (1), the body wall of the newly hatched larva is only lightly chitinized and not

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* Numbers in parentheses refer to Literature Cited.

adapted to conserve moisture. Furthermore, the soft-bodied small grub is unable to dig long distances through the soil to find food to replenish its body moisture.

Older larvæ of the Japanese beetle are resistant to desiccation under conditions of low soil moisture. As Ludwig (3) has shown, larvæ in all three instars may be reduced to about 50 per cent of their initial weight and still survive if returned to a favorable soil moisture condition. The prepupæ and pupæ are also able to stand considerable desiccation.

SEASONAL OCCURRENCE OF STAGES AFFECTED BY LOW SOIL MOISTURE CONDITIONS

In an average year in the Philadelphia area, soil surveys have indicated that eggs and first instars of the Japanese beetle occur in the soil from July 1 through September 30. Data on these surveys, which consisted of 13,413 square-foot diggings made in turf between June 21 and September 30 during an 11-year period, are given in table 1.

TABLE 1

FREQUENCY DISTRIBUTION OF ALL EGGS AND FIRST INSTARS OF JAPANESE BEETLES FOUND IN SOIL SURVEYS IN THE PHILADELPHIA AREA, 1926 TO 1936, INCLUSIVE

Period	Eggs (per cent)	First instars (per cent)
June 21–30	1.2	0.0
July 1–10	14.1	0.5
11–20	38.0	3.4
21–31	30.2	19.7
Aug. 1–10	11.8	30.9
11–20	3.1	24.3
21–31	1.2	13.6
Sept. 1–10	0.4	5.2
11–20	0.1–	1.7
21–30	0.0	0.5

All the viable eggs were found in the period shown in the table. First instars were found throughout the year, but 99.7 per cent of them occurred between July 1 and September 30.

The data in table 1 apply only to conditions in the Philadelphia area. South of this point, events in the seasonal cycle occur earlier, and at points further north, later. At Richmond, Va., the beetle season normally begins about 10 days earlier than at Philadelphia; at Washington, D. C., 3 days earlier; at New York City, 5 days later; and at New Haven, Conn., Boston, Mass., and Cleveland, Ohio, 10 to 12 days later than at Philadelphia. At the extreme northern range of the insect in New Hampshire, beetles and eggs often continue to be found late in the fall (5). For this reason, a severe drought in late summer or fall would have more of an adverse effect on beetle populations in New Hampshire than it would further south.

RAINFALL DEFICIENCIES AND THEIR EFFECT ON JAPANESE BEETLE POPULATIONS

The Japanese beetle was first found near Philadelphia in 1916 (4), and for 15 years or more the general infestation was restricted to a comparatively small area having much the same climatic conditions. In determining the effect of rainfall deficiencies on the beetle in this area, the records of the Philadelphia office of the United States Weather Bureau have been used. During a 75-year period, rainfall has averaged 12.01 inches at this station for the three summer months of June, July, and August. In 11 of the 30 years since 1916, summer rainfall was below 10 inches, as may be seen from table 2. The rainfall for July alone is also given since this is the month when rainfall has the greatest influence on egg survival in that area as is evident from table 1.

Rainfall in the summer of 1916, the year beetles were first found, and 1918 (table 2), was considerably below normal. If these years had been more favorable for the survival of eggs and small larvæ, the Japanese beetle would probably have built up more rapidly at the time that it was becoming established in the United States. The summer of 1929 has been mentioned as one in which rainfall was markedly deficient in the Philadelphia area (1). From July 1 through August 10, the critical period for eggs, the rainfall was only 2.29 inches. Since 94 per cent of all eggs are usually found in this period, the marked reduction in the beetle population in 1930 was not surprising.

Summer rainfall from 1932 through 1937 (table 2), was generally unfavorable for the survival of eggs and small larvæ of the Japanese beetle, since in all but two of these years there had been less than 10 inches of rain. In addition, the winter of 1935–36 was the only one, since the beetle first became established in this country, in which larval mortality is known to have been high (6). As a result of the action of these unfavorable conditions, the beetle population in the Philadelphia area by 1937 had fallen far below that in the summer of 1932. In soil surveys made near Philadelphia in the spring of 1937, larvæ averaged only 1.7 per square foot as compared with 16.0 per square foot in 1932. The beetles continued to be present in reduced numbers in this area until 1946, but the continued low population was probably due as much to the action of biotic agents as to climatic influences.

TABLE 2

Years With Less than 10 Inches of Summer Rainfall, 1916–45, Philadelphia, Pa.

Year	Rainfall June, July, August (inches)	Rainfall July alone (inches)
1916	7.17	3.40
1918	7.96	2.43
1923	8.42	3.51
1925	8.16	4.99
1929	7.49	1.53
1932	8.71	2.25
1934	9.69	2.18
1936	9.86	2.60
1937	8.77	1.16
1943	8.06	4.26
1944	5.27	0.73

The drought of 1944 was general throughout most of the continuously infested area, which by this time extended from Massachusetts to Virginia, but the greatest rainfall deficiency was in the area running from eastern Massachusetts through Rhode Island and southern Connecticut to the New York City area.

In this latter area rainfall was especially deficient on Long Island and in northern New Jersey. Rainfall was also markedly reduced in eastern Pennsylvania, southern New Jersey, northern Delaware and parts of Maryland, and at some points in the Middle West. The severity of the drought is apparent when summer rainfall in 1944 is compared with the normal summer precipitation for various places in the beetle infested area; this comparison for a few selected locations is as follows: Boston, Mass., 47.8 per cent of the normal amount; Providence, R. I., 34.0 per cent; New Haven, Conn., 23.7 per cent; Setauket, N. Y., 48.9 per cent; New Brunswick, N. J., 44.6 per cent; Moorestown, N. J., 52.3 per cent; Cape May, N. J., 44.0 per cent; Coatesville, Pa., 45.0 per cent; Millsboro, Del., 51.0 per cent; Elkton, Md., 58.0 per cent; Frederick, Md., 60.6 per cent; Salisbury, Md., 52.1 per cent; and Indianapolis, Ind., 61.2 per cent. The deficiency was less pronounced in central Delaware and in the adjoining part of Maryland than elsewhere in the southern part of the area of general distribution. Rainfall was normal only at certain inland points in New England, in the upper Hudson River Valley, at some points in Lancaster and York Counties in Pennsylvania, and at isolated colony sites in Virginia and North Carolina.

At most places in the 1944 area of low rainfall fewer beetles were found in 1945. A marked drop in beetle populations occurred in Rhode Island, southern Connecticut, on Long Island, in New Jersey, eastern Pennsylvania, most of Delaware, and in parts of Maryland, all of which are in the zone where rainfall was most deficient in 1944. Less marked reductions were observed at other points. The only parts of the infested area that maintained their previous population densities, or where numbers increased in 1945, were those already mentioned where rainfall was close to the normal or higher. In some places, such as the Berkshire section of Massachusetts, rainfall was far above normal, and the beetles greatly increased in numbers.

THE EFFECT OF RAINFALL DEFICIENCIES ON GRUB POPULATIONS

Variations in the abundance of the Japanese beetle from year to year may be estimated in several ways. The degree of brown-ing of favored food plants (8) may be used to judge the density of beetle populations, but the most accurate method is to make a series of soil surveys to determine the abundance of the soil-inhabiting stages. If a large number of scattered diggings are made at the same time and place each year, an accurate indication of population trends may be obtained.

In a few specific locations reductions in grub populations could be traced to the deficient rainfall in 1929 and 1932. On a golf course at Merchantville, N. J., soil surveys showed that the larval population per square foot decreased from 17.1 in the spring of 1929 to 2.0 in the spring of 1930 (5), and at Moorestown, N. J., from 9.4 to 1.9 in the same period. On a golf course at Jenkintown, Pa., there was a drop from 24.9 larvæ per square foot in 1932 to 8.9 in 1933. The evidence of reductions elsewhere as determined by soil surveys was not always so clear as in these cases, owing perhaps to local variations in rainfall that did not show up in the records of Weather Bureau stations, or to the action of other influences.

THE EFFECT OF ABUNDANT RAINFALL ON BEETLE POPULATIONS

Just as a deficiency in summer rainfall brings about a reduction in beetle populations so an excess of precipitation usually results in a marked increase in numbers. The importance of summer rainfall is especially apparent when two or more favorable years fall in succession. Beetles apparently reached their peak of abundance in the Philadelphia area about 1929, following three years with summer rainfalls of 15.54, 17.84, and 14.88 inches. This suggests that the normal summer rainfall for Philadelphia, about 12 inches, may be slightly below the optimum for the insect.

Summer rainfall was normal, or above, at most points in the infested area in both 1945 and 1946. The precipitation at nine key stations of the United States Weather Bureau in the heavily infested area averaged 25.5 per cent above normal in 1945, and 14.3 per cent above in 1946. In 1945 the variation was from 1.2 per cent below normal to 54.6 per cent above, and in 1946, from 19.1 per cent below normal to 51.8 per cent above at these nine stations. The high rainfall in these two years brought about increased beetle populations in 1947 in most parts of the infested area. This was true where the insect was already abundant, as well as where it had become reduced in numbers, as in the long-infested area about Philadelphia. Soil surveys in the Philadelphia area in the fall of 1947 showed from 10 to 20 larvæ per square foot where the count had been 2 or less prior to 1946. The trend was the same in most of the infested area and numerous counts of 30 or more grubs per square foot were found in the fall of 1947. It should be noted that the increasingly high grub populations favor the activity of milky disease organisms and other parasitic forms, and that these factors will, in turn, operate to reduce soil populations before emergence starts in 1948.

DISCUSSION

It has been pointed out that the normal summer rainfall is about 12 inches at Philadelphia. It is also close to this amount in much of the beetle-infested area in southern New England, southeastern New York, the eastern half of Pennsylvania, New Jersey, Delaware, and Maryland. At points in the Central States, such as Saint Louis, Mo., Chicago, Ill., and Indianapolis, Ind., the normal summer rainfall is about 10 inches, and at Cleveland, Ohio, it is only 9.5 inches. An infestation of the Japanese beetle in Cleveland has been under observation by entomologists of the Ohio Agricultural Experiment Station since 1939, and large increases in numbers had occurred there by 1944, following two years in which the summer rainfall was 11.68 and 11.89 inches; in both of these years it was plentiful during the critical month of July. Rainfall in 1944, 1945, and 1946 was below normal, the totals for these three years being 8.01, 9.13 and 8.11 inches. The 1947 beetle populations were greatly reduced.

It has been suggested that, because of the low summer rainfall, the Japanese beetle will never become so serious a pest in the Central States as it has in the Eastern States (1). It is obvious that years with less than 10 inches of summer rainfall occur more frequently in the Central States. The beetle infestations in this area are still relatively new and small, but population trends at Cleveland in recent years indicate that summer rainfall may have a most important influence on population trends in that area.

In July 1943 rainfall at Philadelphia totaled 4.26 inches, but only 0.62 of an inch in August and 1.18 inches in September. The soil became so dry that the grass turned brown and some plants wilted. At the time of the drought most of the larvæ had developed to a point where they were resistant to desiccation (3) and probably few were killed, though many appeared shrunken and stunted. Except in certain northern areas, where beetles and eggs are commonly found in the fall months, droughts of this type are less critical to the Japanese beetle than those in mid-summer.

At some nearby points in eastern Pennsylvania, there was less rainfall in 1932 than at Philadelphia. The records of eighteen United States Weather Bureau Stations show that at six of these points the summer rainfall was lower than at the Philadelphia city office, and at eleven locations it was higher. At twelve stations the summer rainfall was below 10 inches. There was a variation of from 5.56 inches at Marcus Hook southwest of the city to 14.02 inches at Neshaminy Falls north of Philadelphia. In July 1932 alone, the rainfall ranged from 1.25 inches at Marcus Hook to 4.04 inches at Conshohocken northwest of the city. These variations in rainfall are often due to local thunderstorms, but differences as large as those experienced at Philadelphia in 1932 are unusual. Such variations result in wide differences in beetle populations in relatively small sections of the infested area, with increases in numbers at some points and reductions at others. It is evident that to correctly interpret the action of rainfall deficiencies on beetle populations, it is necessary to have an exact knowledge of the precipitation at numerous points throughout an area.

CONCLUSIONS

Soil surveys carried out over a period of years have shown that in dry summers the beetles tend to congregate their egg laying in low places with favorable soil moisture where entrance into the soil is comparatively easy. A concentration of larvæ in these moist areas and low populations in the drier places is the result. In years with abundant evenly-spaced precipitation, the eggs are more generally distributed and the larval populations are more uniform. When this condition prevails, the number of larvæ per square foot will be lower in the locations favored in dry years, even though there may be more larvæ in the area as a whole.

The distribution of summer rainfall is important. Moderate amounts of rain evenly distributed are more favorable for the survival of the Japanese beetle than several heavy showers close together. In the latter case, much of the water runs off and, beyond certain limits, contributes little to wetting the soil where the immature stages occur.

Although summer rainfall is important, several other factors are now acting to bring about changes in beetle abundance and these must be considered in evaluating changes in numbers. The effectiveness of the milky disease organisms in destroying larvæ is generally recognized and other biotic factors are known to operate in restricted areas. The high grub populations of 1947 will aid in the distribution and build up of the milky diseases, so that a favorable rainfall condition has a bearing on the action of this and other biotic control factors.

The area infested by the Japanese beetle is now so large that the amounts of summer rainfall will vary widely and populations will differ accordingly. As the beetle spreads into new areas, it will encounter new rainfall conditions and differences in ecological influences, such as soil type, food plants and the nature of breeding areas, as well as new combinations of biotic factors. All of these factors working together will determine whether the insect will build up and become a serious pest, or whether it will only persist in small numbers and cause little damage.

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A NEW SPECIES OF CAMPONOTUS, SUBG. COLOBOPSIS FROM MEXICO (HYMENOPTERA: FORMICIDÆ)

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Ants of the genus *Camponotus,* subgenus *Colobopsis* Mayr, occur in all zoogeographical regions of the world except possibly the Ethiopian. They form small colonies of a few dozen to several hundred individuals, nesting in culms of sedges, stalks of plants, branches of trees and shrubs, insect galls, hollow nuts and acorns, and crevices of wood. Some forms, if not all, may be polydomous. Although most of them are diurnal, there are also some that are nocturnal. Their food seems to be largely honeydew and the flesh of arthropods.

In the species of this group there are dimorphic or feebly polymorphic workers, the largest individuals of which are known as soldiers and are easily recognized by the peculiarly shaped subcylindrical head, the anterior portion of which is truncated and very often concave. The head is well adapted for blocking the small, circular openings of the nest to keep out intruders. Although the soldier and female can be readily distinguished from other forms of *Camponotus,* the worker and male are not so easily recognized.

Camponotus (*Colobopsis*) *mathildeæ* is, so far as I am aware, the second species to be described from Mexico, Emery having described *cerberulus* from a female collected in the State of Michoacan (1920, Bol. Soc. Ent. Ital. 52: 34). Wheeler (1934, Bul. Mus. Comp. Zool. 77: 214) described the soldier and male of what he believes to be *cerberulus.* If Wheeler's interpretation is correct, *mathildeæ* cannot possibly be synonymous with *cerberulus.*

There is no described form of *Camponotus,* subgenus *Colobopsis,* known to me which has even a near affinity to *mathildeæ.* This new species has so many excellent and easily recognizable characters that one should have no difficulty in identifying it in future collections. Since it has been intercepted on at least three occasions on orchids originating in Mexico, it does not appear to be an especially rare form.

Camponotus (Colobopsis) mathildeæ, new species

Soldier.—Length 5.75 mm. (Fig. 2, anterior view of head; Fig. 3, profile of body).

Head subcylindrical, longer than broad, widest anteriorly; posterior border almost imperceptibly emarginate. Antenna 12-segmented; scape flattened, narrowest at the base, widening apically, the apex distinctly surpassing the posterior corner of the head; funiculus widening apically but not forming a well defined club. Eye oblong, moderately convex, with numerous facets; situated less than its length from the posterior corner of the head. Frontal carinæ distant from each other, divergent posteriorly. Clypeus viewed from above, more than two and one-half times as wide as long, with sharp, bimarginate anterior border. In profile, the truncated surface of the head sloping anteroventrally; viewed anteriorly, the truncated surface subcylindrical, slightly wider than high, and concave, with sharply carinate lateral borders. Clypeus somewhat wedge-shaped, narrowest ventrally, with sharply carinate, uneven lateral borders; divided longitudinally, by a sharp, uneven carina. Mandible with 4 apical teeth and an edentate basal portion. In profile, the posterior part of the prothorax and much of the mesothorax moderately convex and almost on the same plane. Mesoepinotal impression distinct but not noticeably wide or deep. Base of epinotum meeting the declivity in an obtuse angle. From above, the posterior portion of the pronotum and epinotum with a distinct but not deep, longitudinal impression. Legs moderately long, with somewhat incrassated femora and tibiæ, the femora of the anterior pair of legs more noticeably incrassated than those of the other legs. Petiole, in profile, with a subrectangular node; the node, from above, wider dorsally than ventrally and with a distinct but not deep impression.

Anterior two-thirds or more of the head subopaque, more or less coarsely rugose-reticulate with punctate interrugal spaces; the coarse sculpturing extending on the dorsal surface of the head as far posteriorly as the termination of the frontal carinæ; remainder of head and body finely shagreened.

Hairs on the head yellowish, short, erect, obtuse, absent on the truncated surface, extending on the sides almost to the eyes and on the dorsal surface almost to the posterior border. The hairs slightly longer and less obtuse on the front and vertex of the head. Antennal scape with a few, short, erect hairs. Gaster with scattered, erect hairs in addition to the transverse row of hairs near the posterior border of each segment; hairs on the venter and at the apex longer than elsewhere.

Anterior two-thirds or more of the head light brown or yellowish brown; borders of the mandibles, sides of the truncated surface, and clypeal carinæ darker; remainder of head, body and appendages blackish to black, with the exception of the tarsi.

WORKER.—Length 5.37 mm. (Fig. 1, profile of body)

Head longer than broad, narrowest anteriorly, with rounded posterior border and moderately convex sides. Eye of approximately the same shape and position as that of the soldier. Scape proportionally longer than that of the soldier exceeding by approximately one-fourth its length, the posterior border of the head. Frontal carinæ well separated, posteriorly divergent, not as long as the greatest width between them; with a distinct but not strongly developed frontal furrow extending their full length. Clypeus subrectangular, approximately as wide as long, with a median carina extending its full length. In profile, the thorax is highest where the anterior face of the prothorax meets the dorsal surface of the pronotum. Mesoepinotal impression extraordinarily deep and broad, with a distinct and very protuberant spiracle on each side. Base of epinotum highest at the point where it meets the declivous surface in a prominent angle. From above, both pronotum and epinotum with a distinct but not deep, longitudinal impression, which in some aspects, at least, gives the epinotum a somewhat bicarinate appearance. Legs, petiole, and gaster not materially different from that of the soldier.

Anterior part of head not sculptured as in the soldier but with a few small punctures on the mandibles, clypeus and cheeks; remainder of body and appendages shagreened as in the soldier.

Hairs on head yellowish, fairly short and erect; confined to mandibles, clypeus, front and vertex; lacking on the sides and ventral surface of the head. Antennal scape with a few short, erect hairs. Gaster with hairs similar to those on gaster of the soldier.

Color somewhat lighter than that of the soldier, with head, thorax, and petiole dark brown, and the gaster blackish. Mandibles and tarsi an even lighter brown.

Type locality—Mexico (D. F.)

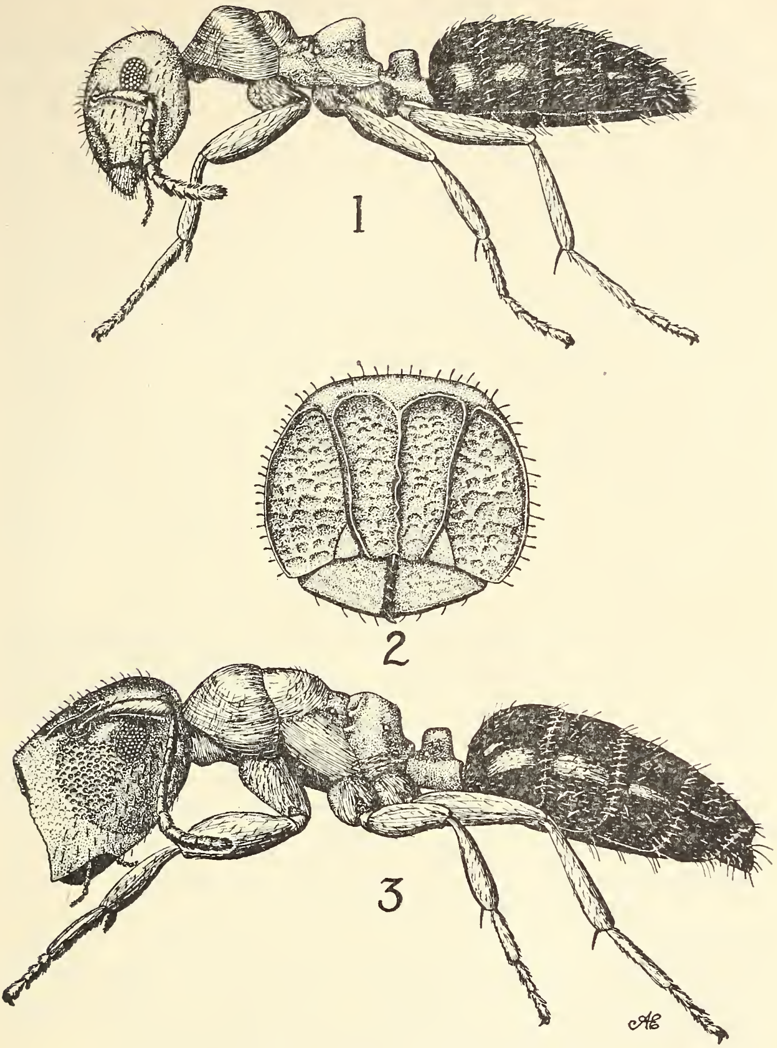
Described from a holotype soldier, a paratype soldier, and 14 paratype workers collected from orchids at Laredo, Texas on Jan. 28, 1948 by H. R. Cary of the Division of Foreign Plant Quarantines, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture. These specimens bear Laredo Interception No. 46044. All have been placed in the United States National Museum under U.S.N.M. No. 59300. There are two other collections which I consider to be this same species: one made at Laredo by the same collector and on the same date as the type series, from orchids originating in the type locality, and recorded under Laredo Interception No. 46043; and the other made on July 31, 1948 by T. P. Chapman at Laredo, from orchids originating in Tamazunchale, San Luis Potosi, Mexico, recorded under Laredo Interception No. 46986. Except for the fact that the ants were collected on orchids, nothing is known concerning their habits.

Paratype workers show considerable variation in the width and depth of the mesoepinotal constriction, and also in the height and acuteness of the angle formed by the base and declivity of the epinotum. The erect hairs on the antennal scape vary in number from none to five or six. Workers under Laredo Interception No. 46043 are much darker (almost black) than the paratypes and also have the basal surface of the epinotum almost horizontal instead of ascending to meet the declivity.

The soldier can be distinguished from that of other species by the shape of its head which is much widened anteriorly; the concave truncated surface with sharp lateral borders, the wedge-shaped clypeus with sharp lateral borders and a sharp, longitudinal carina dividing it into two equal parts, and by the distinct, longitudinal impression on the posterior part of the pronotum and epinotum.

The worker can be distinguished by an impression on the pronotum and epinotum similar to that of the soldier, by the wide and deep mesoepinotal impression with a prominent spiracle on each side, and by the basal surface of the epinotum meeting the declivity in a high and prominent angle. The thorax of the worker bears a striking similarity to that of some of the ants of *Camponotus,* subg. *Myrmocladœcus.*

I take pleasure in naming this ant for Miss Mathilde M. Carpenter, the very efficient and courteous librarian of the Division of Insects, U. S. National Museum.



Camponotus (Colobopsis) mathildeæ, new species. Fig. 1, body of worker in profile. Fig. 2, anterior view of head of soldier. Fig. 3, body of soldier in profile. (Illustrations by Miss Addie Egbert.)

BOOK NOTICE

The Insect World of J. Henri Fabre. With Introduction and Interpretive Comments by Edwin Way Teale. Dodd, Mead and Company, New York, 1949. 8½ × 5¾ inches, xvi + 333 p. $3.50.

After a lapse of many years Dodd, Mead and Company have added another volume to the series of Fabre's works which they published from 1912 to 1923. In the present, well-printed and attractively bound volume, Edwin Way Teale, the well-known naturalist, author and photographer, has brought together forty of the best known of Fabre's studies and has prefaced them with a concise and appreciative summary of Fabre's life and observations. Mr. Teale has followed Alexander Teixeira de Mattos' original translation into English and Fabre's accounts will always retain their original charm and interest. Although students of animal behavior now operate on a different level, frequently with complex laboratory apparatus, they are all indebted to the facts harvested by Fabre and embedded in his "Souvenirs Entomologiques", after years of patient observation.

The works of Fabre need not be recommended to entomologists. His basic observations are familiar to all of us, and it is likely that all entomologists, at one time or other, have taken inspiration from them. His experiments are classics of simplicity. As an observer he was a genius. If we do not agree with his interpretation of all his experiments, they are nevertheless always interesting and worthy of study. Though many of his experiments were conducted in the late years of his long life, they were pursued with the vigor and application of a crusader. For he was one, who wanted his insects studied and understood, so that they might be loved. His views on natural history education, which caused him considerable embarrassment, have only recently become established in our schools. Perhaps he could be called the father of the "field trip" and the "summer camp."

This book provides a generous and a very well chosen sample of the prodigious work of a man who did much to establish the entomological profession, and whose timeless accounts and lucid prose will always be read and enjoyed by people who recognize insects as living creatures of infinite interest.—F.A.S.

THE OLD WORLD MEMBRACIDÆ

By Frederic W. Goding

(Continued from Vol. XLVII, p. 349)

Key to Species

1(4). Suprahumerals inclined more or less forward, slightly elevated above the scutellum then impinging upon margins of tegmina.

2(3). Suprahumerals porrect, short, posterior process sinuate; tegmina subhyaline, costal margin and tips black; reddish brown; 5 × 3 mm. .... **badius**

3(2). Suprahumerals slightly inclined forward, twice as long as the intervening space; tegmina pale tawny hyaline, base tawny; ferruginous, yellow pubescent; 7 mm. .... **invarius**

4(1). Suprahumerals transversely oblique or horizontal.

5(22). Posterior process extended beyond apex of clavus; median carina percurrent.

6(17). Suprahumerals more or less oblique.

7(16). Suprahumerals at least as long as the intervening space.

8(13). Suprahumerals strongly oblique, distinctly longer than the space between bases.

9(12). Posterior process sinuate, scarcely separated from the scutellum, tips recurved; tawny or brown, pubescent.

10(11). Posterior process unicarinate, suprahumerals slender; tegmina pale testaceous hyaline, base ochraceous; 6–7 × 3.5 mm. **oneratus**

11(10). Posterior process tricarinate, suprahumerals moderately broad; tegmina semihyaline, base narrowly piceous; 5–6 × 3.5 mm. **elongatus**

12(9). Posterior process straight, tricarinate, slightly elevated above scutellum, suprahumerals broad, straight; castaneous, legs ochraceous; tegmina pale bronze brown, apical margins darker; 7 × 4.5 mm. .... **albosignatus**

13(8). Suprahumerals weakly oblique, about as long as space between bases, posterior process slightly elevated above scutellum.

14(15). Fuscous brown, pilose; suprahumerals broad at base, tips obtuse, posterior process unicarinate, robust, narrowed beyond middle; tegmina pale hyaline, basal area fuscous; 5 × 3 mm. .... **doddi**

15(14). Black, legs brown; suprahumerals hardly long as intervening space, tips acute, posterior process tricarinate, slightly curved at base, tip just passing apex of clavus; tegmina bronze ochraceous, basal area, costal apical margin and first apical cell black, costal margin narrowly testaceous; 7 × 3 mm. .... **cavendus**

16(7). Suprahumerals very short, long as one-fourth the intervening space; pronotum black, posterior process brown, sinuate, unicarinate, slightly separated from scutellum; legs ochraceous; tegmina dull subhyaline, base black; 5–5.5 × 2 mm. ...... **brevicornis**
17(6). Suprahumerals horizontal or subhorizontal.
18(21). Apex of posterior process extended far beyond apex of clavus; entirely brown.
19(20). Posterior process straight, hardly separated from scutellum, suprahumerals half as long as the intervening space; tegmina dense brown, veins indistinct; 9 × 4 mm. ...... **midas**
20(19). Posterior process slightly sinuate, tricarinate, slightly separated from scutellum, suprahumerals slightly longer than half the intervening space; tegmina pale shining ochraceous, base broadly black enclosing large white spot, costal and inner apical margins narrowly black; 8 × 4 mm. ...... **mimicus**
21(18). Apex of posterior process slightly passing apex of clavus, sinuate, tricarinate, one-half ochraceous, tip black, suprahumerals slender, straight; pronotum fuscous brown; tegmina subhyaline, basal angular area ochraceous; 4 × 2 mm. ...... **transversus**
22(5). Posterior extended to not passing apex of clavus.
23(30). Suprahumerals horizontal or subhorizontal; median carina percurrent.
24(29). Black or piceous black; suprahumerals long as intervening space, posterior process sinuate, slightly elevated above scutellum.
25(28). Tegmina pale bronze, destitute of a basal white spot.
26(27). Suprahumerals substraight, narrow; base of tegmina and legs black; 7–8 × 4 mm. ...... **ammon**
27(26). Suprahumerals strongly recurved; base of tegmina black with a subbasal pale transverse area; legs pale ochraceous, tips of tibiæ and tarsi black; 6 × 3–3.5 mm. ...... **karenianus**
28(25). Tegmina shining ochraceous, basal angle and narrow costal margin black, a large subbasal white spot; suprahumerals short; legs pale brown, tips of tibiæ and tarsi black; 5.5 mm. **albomaculatus**
29(24). Testaceous red, pilose; suprahumerals moderately long, tips and tip of posterior process piceous; tegmina pale bronze ochraceous, base narrowly piceous; 6 × 4–4.5 mm. ...... **rufescens**
30(23). Suprahumerals short, weakly oblique, posterior process straight, tricarinate, slightly separated from scutellum; pronotum fuscous brown; tegmina dull brown ochraceous, veins hirsute, two ochraceous basal spots; 9 mm. ...... **campbelli**

LIST OF SPECIES

badius Distant, Faun. Brit. Ind. vi, App. p. 158. (1916). Nilgiri Hills, India.

invarius Walker, List Hom. B. M. p. 621. (1851). ? China.

oneratus Walker, Ins. Saund. Hom. p. 78. (1858); Distant, Faun. Brit. Ind. iv, p. 40. (1908). Common all over India.

lignicola Buckton, Mon. Memb. p. 224, pl. 49, fig. 6. (1903). Raniseram, Ceylon.

pallescens Distant, Faun. Brit. Ind. iv, p. 41. (1908). Mainpura, Bangalore, Bombay, India.

elongatus Distant, Faun. Brit. Ind. iv, p. 41. (1908). Calcutta, Mysore, Trivandrum, Travancore, India.

albosignatus Distant, Faun. Brit. Ind. vi, App. p. 159. (1916). Nilgiri Hills, India.

doddi Distant, Ann. Mag. N. H. xviii, p. 40. (1916). N. Queensland, Australia.

cavendus Distant, Faun. Brit. Ind. vi, App. p. 153, fig. 111. (1916). Nilgiri Hills, India.

brevicornis Distant, Faun. Brit. Ind. vi, App. p. 160, fig. 118. (1916). Dehra Dun, Lahore, Punjab, India.

midas Buckton, Mon. Memb. p. 233, pl. 52, fig. 8. (1903). Perak, Sumatra.

mimicus Distant, Faun. Brit. Ind. vi, App. p. 159, fig. 117. (1916). Nilgiri Hills, India.

transversus Distant, Faun. Brit. Ind. vi, App. p. 161. (1916). Lahore, Punjab, India.

ammon Buckton, Mon. Memb. p. 233, pl. 52, fig. 6. (1903); Distant, Faun. Brit. Ind. iv, p. 39, fig. 32. (1908). Nilgiri Hills, India.

karenianus Distant, Ann. Mag. N. H. xiv, p. 332. (1914). nom. nov.

pallipes Distant, Faun. Brit. Ind. iv, p. 40. (1908). Karen Hills, Burma.

albomaculatus Distant, Faun. Brit. Ind. vi, App. p. 159. (1916). Nilgiri Hills, India.

rufescens Distant, Faun. Brit. Ind. iv, p. 40. (1908). Tenasserim, Myitta, India; Burma.

campbelli Distant, Faun. Brit. Ind. vi, App. p. 158. (1916). Nilgiri Hills, India.

Eufrenchia

Goding, Mon. Aust. Memb. p. 24. (May 5, 1903); *Ibiceps* Buckton, Mon. Memb. p. 239. (1903).

Key to Species

1(2). Robust, piceous brown; suprahumerals with apical fourth strongly curved outward and lightly downward, extreme tips excavated, posterior process strongly arcuate; 7–9 × 6 mm. .... **falcata**

2(1). Slender, dark ferruginous, head and basal area of metopidium black; suprahumerals with tips briefly curved outward, roundly truncate, minutely acute at middle, posterior process nearly straight, middle and apex lightly depressed; 6 × 3 mm. .... **leæ**

LIST OF SPECIES

falcata Walker, List Hom. B. M. p. 622. (1851); Buckton, Mon. Memb. p. 239, pl. 54, fig. 6. (1903). Tasmania; Murray Bridge, S. Australia.

biturris Walker, List Hom. B. M. Suppl. p. 164. (1958). New Hebrides, Victoria, Australia. (Label in Walker's handwriting).

curvicornis Stål, Bid. Memb. K. p. 287. (1869). Adelaide, S. Australia.

leæ Goding, Mon. Aust. Memb. p. 26, pl. 1, fig. 5. (1903). West Australia.

Cebes

Distant, Ann. Mag. N. H. xviii, p. 39. (1916).

KEY TO SPECIES

1(4). Apex of posterior process passing tips of tegmina, substraight; reddish testaceous, venation of tegmina testaceous.

2(3). Suprahumerals robust, obtusely narrowed at tips; tegmina subhyaline; 6 × 4 mm. .... **godingi**

3(2). Suprahumerals short, acuminate, tips and marginal carinæ piceous, posterior process lightly arcuate and piceous on dorsum to tip, piceous spot each side of chest; tegmina colorless hyaline; 6 × 3 mm. .... **tenuis**

4(1). Apex of posterior process extended to tip of abdomen; tegmina clear hyaline.

5(6). Pronotum piceous or dark ferruginous, suprahumerals paler, legs ferruginous; venation toward base and surrounding third apical cell, and spot beyond clavus piceous; tip of posterior process decurved; 7 × 4 mm. .... **transiens**

6(5). Pronotum ferruginous, legs yellowish, suprahumerals less diverging, slender, sharp, compressed; 6 mm. .... **paria**

LIST OF SPECIES

godingi Distant, Ann. Mag. N. H. xviii, p. 39. (1916). Australia.

rubridorsi Distant, supra p. 40. nom. nud.

tenuis Goding, Jour. N. Y. Ent. Soc. xxxiv, p. 245. (1926). Homebush, N. S. W.; S. Australia; Victoria, Australia.

transiens Walker, List Hom. B. M. p. 624. (1851). Unknown.

bicolor Walker, List Hom. B. M. p. 625. (1851). Unknown.

arolatus Goding, Mon. Aust. Memb. p. 23, pl. 1, fig. 3. (1903). Queanbeyan, Braidwood, N. S. W.; Victoria; S. Australia.

paria Fairmaire, *Rev. Memb. p. 513. (1846). East Indies.

Lubra

Goding, Mon. Aust. Memb. p. 28. (1903).

KEY TO SPECIES

1(2). Tips of suprahumerals acuminate and curved inwardly on apical area and contiguous, short spine exteriorly; 7 × 4 mm. .... **regalis**

2(1). Tips of suprahumerals gibbous approaching but not contiguous, short spine exteriorly; 8 × 3 mm. .... **spinicornis**

* Judging from the description by Fairmaire this species can be included in no other modern genus.

LIST OF SPECIES

regalis Goding, Mon. Aust. Memb. p. 30, pl. 4, figs. 4, 9. (1903). Brisbane, Queensland, Australia.

spinicornis Walker, Jour. Ent. i, p. 316. (1862); Goding, Mon. Aust. Memb. p. 29, pl. 1, fig. 22. (1903). Moreton Bay, Queensland; Tweed and Clarence Rivers, N. S. W., Australia.

Sarantus

Stål, Tr. Ent. Soc. Lond. (3), i, p. 592. (1863).

KEY TO SPECIES

1(4). Basal half of tegmina black or fuscous, apical half hyaline; pronotum black, legs brown, suprahumerals at least 3 mm. long.

2(3). Tips of suprahumerals slightly recurved; tegmina fuscous, apical area vitreous, tips fuscous; 10 mm. .... **wallacei**

3(2). Tips of suprahumerals slightly curved outwardly, central carina on upper surface; tegmina black, opaque, apical third vinaceous hyaline; 10 mm. .... **similis**

4(1). Tegmina black or reddish brown, opaque, apical half paler semi-opaque, apical margins partly hyaline; brown.

5(6). Black; tegmina black, apical half blackish brown, hyaline spot on exterior apical margin; suprahumerals 1.5 mm. long, tips slightly elevated, central carina on upper surface, posterior process lightly sinuate; 8 mm. .... **marginalis**

6(5). Brown, head black; tegmina reddish brown, opaque, paler subopaque apically, inner apical margins hyaline; suprahumerals 4 mm. long, apical half curved upwardly; posterior process straight; 9.5 mm. **apicalis**

LIST OF SPECIES

wallacei Stål, Tr. Ent. Soc. Lond. (3), i, p. 592. (1863); Walker, Jour. Linn. Soc. x, p. 193, pl. 3, fig. 12. (1868). Waigiu Is., New Guinea.

similis Schmidt, Soc. Ent. xl, p. 16. (1925). Kapaor, New Guinea.

marginalis Schmidt, Soc. Ent. xl, p. 15. (1925). Purari, New Guinea.

apicalis Schmidt, Soc. Ent. xl, p. 15. (1925). Wokan, Aru Is.; Andai, New Guinea.

Godingella

Distant, Ann. Mag. N. H. xviii, p. 31. (1916).

KEY TO SPECIES

1(4). Posterior process distinctly longer than tegmina, suprahumerals 2.5 mm. long.
2(3). Shining purplish black; tegmina colorless hyaline with a broad longitudinal percurrent reddish stripe; 10 mm. .... **australensis**
3(2). Piceous, body and legs ferruginous; tegmina pale vinaceous hyaline; 10 mm. .... **nobilis**
4(1). Posterior process extended to tips of tegmina, suprahumerals 4 mm. long, brown; tegmina pale bronze brown, apical third purplish brown; piceous, legs ochraceous; 9–10 mm. **queenslandensis**

LIST OF SPECIES

australensis Goding, Jour. N. Y. Ent. Soc. xxxiv, p. 208. (1926). Brisbane, Queensland, Australia.
nobilis Kirkaldy, Rept. Exp. Sta. Haw. Sug. Pl. Assoc. p. 374. (1906). Cairns, Queensland, Australia.
queenslandensis Distant, Ann. Mag. N. H. xviii, p. 32. (1916). North Queensland, Australia.

Otinotoides

Distant, Ann. Mag. N. H. xvii, p. 321. (1916); *Gondopharnes* Distant, Ann. Mag. N. H. xvii, p. 321. (1916)

KEY TO SPECIES

1(22). Suprahumerals more or less oblique, posterior process tricarinate, median carina percurrent.
2.(9). Suprahumerals distinctly oblique, well elevated.
3(8). Tegmina brown, or piceous, translucent, base and costal area darker, opaque.
4(7). Suprahumerals long as width of pronotum, acute, posterior process decurved; wings vitreous.
5(6). Pronotum shining purplish black, legs dark brown, tarsi paler; suprahumerals straight; tegmina brown, small decolored spot just behind apex of clavus; 7 × 4 mm. .... **acuticornis**
6(5). Pronotum and legs black, knees ochraceous, tips of suprahumerals recurved; tegmina purplish brown; 5.5 × 4 mm. .... **solomonensis**
7(4). Suprahumerals much longer than width of pronotum, posterior process straight; pronotum and chest piceous, abdomen and legs pale luteus; tegmina piceous, wings blackish; 7 mm. **contractus**

8(3). Tegmina subhyaline, base and costal margin testaceous brown; pronotum, body and legs testaceous brown; suprahumerals long as width of pronotum, tips recurved; posterior process decurved; 5 × 3 mm. .... **intermedius**

9(2). Suprahumerals weakly oblique, lightly elevated, posterior process tricarinate, median carina percurrent.

10(19). Tegmina yellowish hyaline.

11(18). Costal margin and base of tegmina black or brown.

12(17). Apical margin of tegmina more or less black or brown.

13(16). Pronotum black.

14(15). Suprahumerals long as width between bases, posterior process weakly undulate, hind legs testaceous; tegmina lurid; 4.5 mm. **semilucidus**

15(14). Suprahumerals one-third as long as the intervening space, posterior process decurved, tarsi tawny; tegmina cinereous; 4.5 mm. .... **albidus**

16(13). Pronotum and legs brownish ochraceous, suprahumerals black long as width between bases, posterior process black except base, decurved; tegmina pale stramineous; 5 × 3 mm. .... **australis**

17(12). Apical margin of tegmina concolorous yellow hyaline; entirely piceous; suprahumerals long as half the width of pronotum, posterior process decurved; 5 mm. .... **brevivitta**

18(11). Costal margin and base of tegmina with pronotum and legs pale brown, densely pubescent; suprahumerals long as width between bases, posterior process heavy, decurved; 5.6 × 3.8 mm. **pubescens**

19(10). Tegmina brown or piceous.

20(21). Entirely fuscous brown including tegmina; suprahumerals long as width between bases, recurved, posterior process decurved; 6 × 4 mm. .... **spicatus**

21(20). Piceous, head, metopidium and abdomen black, legs red; suprahumerals shorter than the intervening space, posterior process straight with median gray band; tegmina piceous, incomplete median and subapical bands and tips hyaline; 4 mm. ...... **piceus**

22(1). Suprahumerals horizontal.

23(28). Tegmina lurid hyaline, base and costal margin black, two discoidal cells.

24(27). Apical margin of tegmina more or less black.

25(26). Posterior process decurved, suprahumerals straight about half as long as width of pronotum; black, legs pale yellow; 5–6 mm. **pallipes**

26(25). Posterior process undulate, suprahumerals lightly curved much longer than width between bases, tips recurved; black or dark yellowish brown, hind legs testaceous; tegmina with transverse subapical brown fascia from costal margin; 8–10 × 5–6 mm. **strigatus**

27(24). Apical margin of tegmina concolorous hyaline; suprahumerals short, posterior process undulate; piceous, legs pale yellow; 5 mm. .... **subflavipes**

28(23). Tegmina mottled brown, subopaque, base and costal margin dark brown, three discoidal cells; suprahumerals long as space between bases, posterior process heavy, much decurved, apical two-thirds slender; 6.8 × 5 mm. .... **brunneus**

List of Species

acuticornis Goding, Jour. N. Y. Ent. Soc. xxxiv, p. 244. (1926). Kuranda, Queensland, Australia.

solomonensis Distant, Ann. Mag. N. H. xviii, p. 41. (1916). Solomon Is.

contractus Walker, Jour. Linn. Soc. x, p. 188. (1868). Aru Is., New Guinea.

intermedius Distant, Ann. Mag. N. H. xviii, p. 41. (1916). Large Bay, N. S. W.; Gayndah, Peak Downs, Queensland, Australia.

semilucidus Walker, Jour. Linn. Soc. x, p. 186. (1868). Waigiou Is., New Guinea.

tibialis Buckton, Mon. Memb. p. 238, pl. 54, fig. 3. (1903). Dory, New Guinea.

albidus Walker, Jour. Linn. Soc. x, p. 188. (1868). Mysol Is., New Guinea.

australis Distant, Ann. Mag. N. H. xviii, p. 40. (1916). Queensland, Australia.

brevivitta Walker, Jour. Linn. Soc. x, p. 189. (1868). New Guinea.

pubescens Funkhouser, Phil. Jour. Sci. xl, p. 115, pl. 1, fig. 7. (1929). Amboina Is., Moluccas.

spicatus Distant, Ann. Mag. N. H. xviii, p. 42. (1916). Queensland, Australia.

piceus Walker, Jour. Linn. Soc. x, p. 187. (1868). Batchian Is., Moluccas.

pallipes Walker, Jour. Linn. Soc. x, p. 185. (1868); Buckton, Mon. Memb. p. 232, pl. 52, fig. 4. (1903). Batchian Is., Myson Is., New Guinea.

tibialis Walker, Jour. Linn. Soc. x, p. 188. (1868). New Guinea.

ramivitta Distant, nom. nud; *semilusus* Distant, Nom. nud.

strigatus Walker, Jour. Linn. Soc. x, p. 184. (1868). New Guinea.

curvicornis Buckton, Mon. Memb. p. 250, pl. 57, fig. 3. (1903). Stephansort, German New Guinea.

subflavipes Walker, Jour. Linn. Soc. x, p. 189. (1868). New Guinea.

brunneus Funkhouser, Rec. Aust. Mus. xv, p. 309, pl. 26, figs. 11, 12. (1927). Lavoro Plantation, Guadalcanar Is., Solomon group.

Elegius

Distant, Ann. Mag. N. H. xvii, p. 152. (1916).

Key to Species

One black species with body and legs piceous, tegmina bronze brown, the costal cell black; 7 mm. .... **merinjakensis**

LIST OF SPECIES

merinjakensis Distant, Ann. Mag. N. H. xvii, p. 153. (1916) Mt. Merinjak, Borneo.

Ceraon

Buckton, Mon. Memb. p. 228. (1903); *Daunus* Stål, Hemip. Afric. iv, p. 87. (1866); *Zanophara* Kirkaldy, Entom. xxxvii, p. 279. (1904).

KEY TO SPECIES

1(4). Posterior process long as tegmina, slightly sinuate, suprahumerals slightly diverging.

2(3). Tegmina with central longitudinal brown stripe sometimes forked at tip; piceous or ferruginous, suprahumerals twisted, rarely slightly inclined forward; 6 × 3 mm. .... **vitta**

3(2). Tegmina piceous toward base, without brown stripe; piceous, suprahumerals twisted, tips dilated; 7 mm. .... **contractus**

4(1). Posterior process shorter than tegmina, straight.

5(8). Suprahumerals broadly diverging, tips not dilated.

6(7). Tegmina ferruginous, suboqaque; ferruginous yellow, median carina concolorous; 8 × 3 mm. .... **succisus**

7(6). Tegmina hyaline; fusco-ferruginous, suprahumerals darker, median carina reddish; 8 × 3 mm. .... **rubridorsatum**

8(5). Suprahumerals subparallel, tips slightly dilated; ferruginous brown to black, legs reddish ferruginous; tegmina ferruginous, apical area subhyaline; 8–9 mm. .... **tasmaniæ**

LIST OF SPECIES

vitta Walker, List Hom. B. M. p. 626. (1851); Goding, Mon. Aust. Memb. p. 32, pl. 1, fig. 25. (1903). Camden Haven, Penrith, Sydney, Queanbeyan, Bungadore, N. S. W.; South Australia; Tasmania.

contorta Walker, Ins. Saund. Hom. p. 66. (1858). Tasmania.

albovitta Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. 111, p. 96. (1907). Bundaberg, Queensland, Australia.

contractus Walker, List Hom. B. M. p. 622. (1851). New Holland, Australia.

succisus Buckton, Mon. Memb. p. 226, pl. 50, fig. 3. (1903). Adelaide, S. Australia.

rubridorsatum Buckton, Mon. Memb. p. 230, pl. 51, fig. 6 (1903). Adelaide, South Australia.

tasmaniæ Fairmaire, Rev. Memb. p. 513, pl. 3, fig. 15. (1846); Goding, Mon. Aust. Memb. p. 31, pl. 1, figs. 6, 20. (1903); Buckton, Mon. Memb. p. 227, pl. 50, fig. 6. (1903). Hobart, Tasmania; Melbourne, Gisbourne, Victoria; Brisbane, Queensland; New Holland, Australia.

truncaticornis Walker, Ins. Saund. Hom. p. 81. (1858). Melbourne, Victoria, Australia.

tumescens Buckton, Mon. Memb. p. 229, pl. 51, fig. 1. (1903). Tasmania.

contortum Buckton, Mon. Memb. p. 229, pl. 51, fig. 2. (1903). Tasmania.

leda Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. 111, p. 90. (1907). Mittagong, N. S. W., Australia.

Emphusis

Buckton, Mon. Memb. p. 256. (1903).

KEY TO SPECIES

1(4). Posterior process long as tegmina, lightly sinuate, dorsum altitude gradually decreasing.

2(3). Tegmina with base and costal cell black, central area hyaline, apical fourth red with brown margin; metopidium slightly advanced upwardly without median carina; 8–10.5 × 7–8.6 mm. **bakeri**

3(2). Tegmina entirely colorless hyaline; metopidium vertical, weakly carinate; 6.5–9 × 4.5 mm. .... **occidentalis**

4(1). Posterior process shorter than tegmina.

5(10). Tegmina brown, translucent or opaque, base and costal margin black or brown or concolorous.

6(9). Pronotum obtusely elevated, concave posteriorly, seen from front coarctate; suprahumerals moderately long, and slender, posterior process moderately thick; tegmina with two discoidal cells; ocelli equidistant.

7(8). Pronotum purplish brown, seen from front lengthily coarctate two vertical tomentose fasciæ each side; tegmina purplish brown, base darker; 9–10 × 6 mm. .... **ansatus**

8(7). Pronotum black, rugose, seen from front gradually narrowed to just below suprahumerals with one tomentose fascia each side; tegmina bronze brown, base and costal cell black, hyaline spot near apex of clavus; 9 × 5.5 mm. .... **rugosus**

9(6). Pronotum elevated in an enormous globular swelling inclined forward, including basal half of posterior process, dark purplish brown, reticulate, seen from front broadened from base to the short suprahumerals, apical half of posterior process slender; tegmina bronze, three discoidal cells; ocelli nearer to eyes; 7 × 5, alt. 5 mm. .... **globosus**

10(5). Tegmina hyaline with brown or black markings.

11(18). Pronotum moderately elevated, seen from front the inferior margins of suprahumerals very little elevated above the eyes.

12(15). Suprahumerals acuminate, tips acute.

13(14). Dark purplish brown, median carina percurrent, suprahumerals recurved, posterior process slightly separated from scutellum; tegmina ochraceous, base and costal cell purplish brown, apical area tinged with brown; 10 × 6 mm. .... **agnatus**

(To be continued)

PROCEEDINGS OF THE NEW YORK ENTOMOLOGICAL SOCIETY

Meeting of January 6, 1948

The annual meeting of the New York Entomological Society was held January 6, 1948 in the American Museum of Natural History. President Doctor Hagan called the meeting to order at 8 P.M.

Mr. Comstock reported as the delegate to the New York Academy of Sciences. He said that the Academy is anxious to obtain new quarters and that a drive for $3,000,000 for this purpose has been initiated. He reported there had been no other action by the Academy during the year that would affect the Society.

The secretary read a letter of thanks to the membership from the Brooklyn Entomological Society in response to the letter from this Society on the occasion of their 75th anniversary.

A second letter was read concerning the increase of 20 per cent in the cost of printing the Journal.

The nominating committee submitted the following slate of officers for 1948.

President	Dr. Harold R. Hagen
Vice President	Dr. Mont A. Cazier
Secretary	Mr. Frank A. Soraci
Assistant Secretary	Mrs. Patricia Vaurie
Treasurer	Dr. James C. King
Assistant Treasurer	Mr. Leonard H. Sandford
Editor	Mr. Harry B. Weiss
Trustees	Dr. James C. King
	Dr. Mont A. Cazier
	Dr. H. T. Spieth
	Dr. Harold R. Hagan
	Mr. E .W. Teale
Publication Committee	Mr. Harry B. Weiss
	Dr. Charles D. Michener
	Mr. John D. Sherman, Jr.
Delegate to the N. Y. Academy of Sciences	Mr. William P. Comstock

The entire slate was duly elected.

There being no further business, Dr. Hagan, the speaker of the evening, presented his paper on "Viviparity in Insects." The following four types of viviparity were described and discussed: 1, Ovoviviparity 2, Adenotrophic viviparity 3, Metagonadic viviparity 4, Pseudoplacental viviparity. His paper was published in the Journal, vol. LVI, p. 63.

Frank A. Soraci, *Secretary.*

Meeting of January 20, 1948

A regular meeting of the New York Entomological Society was held January 20, 1948 in the American Museum of Natural History; President Dr. Hagan in the chair. There were 10 members and 9 visitors present.

Dr. Lucy Clausen reported for the field committee that one field trip was held during 1947.

The treasurer, Dr. King, gave his annual report.

The program and field committees were then appointed by the president, as follows:

Program Committee	Field Committee
Dr. James Forbes	E. W. Teale
Albro T. Gaul	Chris E. Olsen
Dr. Lucy W. Clausen	Dr. Lucy W. Clausen

Dr. Albert Hartzell then proceeded with the paper of the evening, titled, "DDT, Its Proper Use as an Insecticide."

He traced the history of this insecticide from the time it was first synthesized in 1874, by Othmar Zeidler, a young chemistry student at Strasbourg, Germany, to its appearance as a miracle drug during the recent war. The insecticide reached this country through the Geigy Company which offered it to the U. S. Army after rediscovering and proving it in Switzerland in 1938 and later. The remarkable insecticidal properties of the material were proved by the U. S. Department of Agriculture and army authorities here, and its effectiveness against lice was, in large part, responsible for the abatement of the typhus epidemic of late 1943 and early 1944 in Italy. Since then it has been used successfully in combating the insect vectors of cholera, malaria, and other diseases in many parts of the world.

Dr. Hartzell spoke of the pharmacology of DDT, and of the precautions which need to be taken in using this insecticide. He stated that cold blooded animals are more susceptible than warm blooded animals to its effects.

Mention was made of the use for DDT in the garden and on ornamental material. Some plants are injured by direct applications of DDT, while others do not fare well in soil which has been heavily dosed. Far from being a cure-all, DDT has proven valueless against some insects.

Frank A. Soraci, *Secretary.*

Meeting of February 3, 1948

A regular meeting of the New York Entomological Society was held February 3, 1948, in the American Museum of Natural History; President Dr. Hagan in the chair. There were 17 members and 13 visitors present.

Mr. Leon Siroto of the Hoboken Inspection House, U. S. Bureau of Entomology and Plant Quarantine, was proposed for membership by Dr. Swain.

Dr. King, the treasurer, announced that there had been four resignations within the last few weeks and that one member, Mr. Alfred Fenton, of Texas had died.

There being no further business, the paper of the evening was given. Mr. Albro T. Gaul spoke on "Economy and Labor in the Vespine Society."

The observations of Mr. Gaul were made on a number of species of hornets, notably *Dolichovespula arenaria* and *Vespula maculifrons,* whose nests he had transferred indoors. He described in detail 8 categories of labor in the colonies, the production of eggs, foraging for food, brood nursing, nest construction, nest sanitation, the tending of tenerals, or not fully mature queens, defense of the colony, and water collecting. Excellent colored slides of a number of nests were shown.

Mr. Gaul's original observations and interesting topic provoked many questions and a long discussion followed.

PATRICIA VAURIE, *Assistant Secretary.*

MEETING OF FEBURARY 17, 1948

The regular meeting of the New York Entomological Society was held Feb. 17, 1948 in the American Museum of Natural History, President Dr. Hagan in the chair. There were 12 members and 5 visitors present.

Mr. Leon Siroto of 40–71 Elbertson St., Elmhurst, L. I., N. Y. was elected to active membership.

Mr. Jack Colvard Jones of the Department of Entomology and Zoology of the Agricultural Experiment Station at Auburn, Alabama was proposed for membership.

The speaker of the evening Dr. Nellie Payne then gave her talk on "The Yearly Round of Insect Pests in a Suburban Garden."

On a garden plot of 60′ × 30′, surrounded by brambles and sod, she studied horizontal and vertical migrations of insects. She found that a cold wet spring results in the influx of large numbers of cut worms, Japanese beetle grubs, Asiatic beetle grubs and native white grubs from the surrounding land through a 2′ cleared strip around the garden, into the garden plot. In dry years migration across the strip into the garden does not take place.

With regard to vertical migration, Dr. Payne observed that in bare soil the greatest concentration of grubs occurs just below the frost line. Largest numbers occurred in the 2 foot strip, between the sod and the garden.

Population studies in the garden plot were made on a number of insects. Dr. Payne observed that the first annual appearance of some forms could be accurately forecast. Certain ground beetles, flea beetles, millipedes and sowbugs were given as examples of this. The following succession had been observed in her garden plot. The cabbage aphid was present and active on broccoli during the months of Dec., Jan. and Feb. From March 15 to the 26 millipedes and sowbugs appear. In April the flea beetles appear. In May and June, the various grubs were noticed. The adult Japanese beetles, and Asiatic beetles are abundant in July. Then in August and September an enormous increase in the population of various aphids occurs. Finally, in late Sept. the garden reverts back to the millipedes and sowbugs.

Various types of population build-up were then described. Examples given were:

(1) The cabbage aphid. There are 3 to 5 of these insects per broccoli head throughout the winter months. Then a slow increase with a spectacular build-up to 25,000 or so aphids per head during Sept. In October the population decreases just as spectacularly to its spring level.

(2) Other aphids such as the potato aphid are not as predictable. With this aphid a dry August means a build-up of the population. Otherwise the population might remain more or less constant.

(3) The Mexican bean beetle. This population starts out with 2–5 beetles per leaf on the first crop of beans. On the 2nd crop of beans, 5–10 beetles are common. The third crop is the vanished crop for the population has eaten itself out of food.

(4) The Japanese beetle. The downward trend in numbers during the past 5 years indicates a secular swing.

(5) A wooly bear. This insect seems to build up to 5 per bean plant; then stops. The population studies indicated that for this garden there were 3 general patterns. (1) the constant population, (2) the population with predictable fluctuations, (3) the population with unpredictable fluctuations.

There was considerable discussion of Dr. Payne's paper. The meeting adjourned at 9:45 P. M.

FRANK A. SORACI, *Secretary.*

MEETING OF MARCH 2, 1948

A regular meeting of the New York Entomological Society was held March 2, 1948, in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8:00 P. M. There were 11 members and 17 guests present. Mr. Pallister introduced to the SOCIETY Miss John lecturer in Zoology of Andra Christian College of India. Miss John spoke briefly of her connection with that Lutheran institution and of the fine progress which is being made in India along educational lines. She expressed her gratitude for the fine spirit with which she has been received in her tour of the various institutions in this country.

Mr. Jack Colvard Jones of the Alabama Agricultural Experiment Station was elected to active membership.

There were three proposals for membership, as follows:

Barnard D. Burks, associate taxonomist, Illinois Natural History Survey.
A. C. Miller, Pittsburgh, Pa.
John P. Barrett, Armour and Company in Chicago.

A committee of Mr. William P. Comstock and John C. Pallister was appointed to draw up a formal resolution appointing C. F. dos Passos to serve as the representative of this Society at the 13th International Congress of Zoology in Paris and the 8th International Congress of Entomology in Sweden, both to be held during the coming summer.

There being no further business, Dr. Brayton Eddy, curator of insects at the Bronx Zoological Gardens presented the paper of the evening titled ''Insects Alive.'' He spoke of the dependency of man upon insects for the food he eats; of the estimate that only 1/2 of 1 percent of insects are injurious to man, and that many insects are kept in check through the efforts of other insects, i. e., the predators, parasites and scavengers.

Motion pictures of some of the live insects exhibits which he maintained at a Rhode Island public park were shown. He also presented a group of excellent color slides of popular interest.

After a discussion of Dr. Eddy's talk the meeting was adjourned at 9:30.

FRANK A. SORACI, *Secretary.*

MEETING OF MARCH 16, 1948

A regular meeting of the New York Entomological Society was held March 16, in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8:00 P. M. There were 16 members and 18 visitors present.

The following new members were elected:

A. C. Miller, P. O. Drawer 2038, Pittsburgh, Pa.

John P. Barrett, Armour & Co., Chemical Research & Development Department, Union Stock Yards, Chicago 9, Ill.

Barnard D. Burks, Assoc. Taxonomist, State Natural History Survey Division, Urbana, Ill.

The following were proposed for membership:

Prof. Osmond P. Breland, Assoc. Professor of Zoology, Department of Zoology, University of Texas, Austin 12, Texas.

Esmond B. Martin, 465 East 57th Street, New York 22, N. Y.

Mr. Chris Olsen offered the use of his home for the society field trip during May. The president thanked him for this kind offer and expressed the hope that many of the members might be able to partake of the Olsen hospitality on that occasion.

There being no further business, Mr. Roman Vishniac speaker of the evening proceeded with his talk on ''Photographing Insects.'' He spoke of the many mysteries of the insect world, and of the fact that interest in insects is growing. This growth is more than matched by the growth of the insecticide industry, but he feels it would be a most desolate world if the insecticides ever actually catch up with the insects. Of greatest interest to Mr. Vishniac was the development of the insect from the egg through the various stages, often unrecognizable one to the other, to the adult form.

In his photography, Mr. Vishniac has always made it his primary objective to picture the free insect. In captivity these animals do not perform naturally and, when dead, they are a poor substitute for the real thing.

Mr. Vishniac then showed an excellent collection of slides in color, and black and white, which were outstanding for their depiction of insect faces, and especially eyes. He also showed some fine colored moving pictures of insects in action.

FRANK A. SORACI, *Secretary.*

MEETING OF APRIL 6, 1948

The regular meeting of the New York Entomological Society was held April 6 in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8:00 P. M. There were 12 members and 16 visitors present. The following men were elected to active membership, Prof. Osmond P. Breland, Department of Zoology, University of Texas, Austin, and Dr. Esmond B. Martin, 465 East 57th Street, New York.

The following were proposed for membership.

Prof. C. L. Fluke, Department of Entomology, University of Wisconsin, College of Agriculture, Madison 6, Wisconsin.

Dr. Norman S. Easton, 458 High Street, Fall River, Massachusetts.

Mr. Chris Olsen offered the use of his grounds at West Nyack, N. Y. for a SOCIETY field trip. His invitation was accepted for June 6.

Dr. Hagan welcomed Dr. Schneirla on his return from Panama. Dr. Schneirla promised to talk to the society on his experiences at an early date.

Prof. Virgil N. Argo presented the talk of the evening titled "Ramblings of a Biologist in Mexico." He related his many interesting experiences in traveling by automobile from Laredo south to Mexico City and Vera Cruz. His excellent photographs were of wide general interest.

FRANK A. SORACI, *Secretary.*

MEETING OF APRIL 20, 1948

A regular meeting of the New York Entomological Society was held April 20, 1948, at the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8: 00 P. M. There were 18 members and 38 visitors present.

The following men were elected to active membership:

Prof. C. L. Fluke, Dept. of Entomology, University of Wisconsin, College of Agriculture, Madison, Wisconsin.

Dr. Norman S. Easton, 458 High Street, Fall River, Massachusetts.

The following was proposed for membership:

Dr. H. I. Wechsler, Dept. of Biology, Fordham University.

Mr. E. W. Teale offered the use of his grounds at Baldwin, L. I., for a SOCIETY outing during August. His kind offer was accepted and the Field Committee agreed to send proper announcements to the membership at a later date.

There being no further business, Mr. Leon Siroto presented his talk on "An Amateur Naturalist on the Amazon River." Mr. Siroto made this trip to satisfy his desire to see the jungle for himself. He also hoped to track down the so-called "bush dog" of the Amazon. His interest in insects was limited to the collection of the large, spectacular forms, primarily beetles. Equipped only with those things which could be carried he proceeded by boat to Belem, at the mouth of the Amazon river. He discarded his plan of hiking from there to Rio de Janeiro when he found his map was in error, in showing the presence of a road. Mr. Siroto finally settled for a trip up the Amazon. He boated to Manaus in the state of Amazonas, and then up to Fonte Boa by small boat. The speaker mentioned his difficulty in obtaining food and his stay was not as long as he had planned for he found he was not well adapted to starving. He was impressed with the many birds, and in the Upper Amazon the birds of prey were especially abundant and interesting. He was able to collect some Buprestidæ and Cerambycidæ at Fonte Boa, but his mission, as it concerned the bush dog, was a failure. The trip from Fonte Boa back to Manaus was made by plane, and the return to this country by boat. Mr. Siroto hopes that he might be able to revisit the Amazon, avoiding the many pitfalls that beset the explorer on his first trip to the jungle.

FRANK A. SORACI, *Secretary.*

MEETING OF MAY 4, 1948

A regular meeting of the New York Entomological Society was held May 4, 1948 in the American Museum of Natural History. President Dr. Hagan called the meeting to order at 8:00 P.M. There was 20 members and 17 guests present.

Dr. Salvador de la Torre y Caldejas of Playa 75½ Matanzas, Cuba was proposed for membership.

Dr. Harry I. Wechsler, 85 Central Avenue, White Plains, New York was elected to active membership.

Miss Hoffman, daughter of Prof. Hoffman of Mexico City was introduced. She spoke of her interest in ticks and chiggers and was appreciative of the help extended her by various members of the museum staff.

Mr. John D. Sherman, Jr., read a note, prepared by Dr. Herbert Ruckes concerning the death on May 2, 1948 of Jose Rollin de la Torre Bueno at Tucson, Arizona. This note was spread on the minutes of the society and the secretary was directed to mail a copy to the family.

There being no further business, Mr. Jay T. Fox of Seaford, Long Island, proceeded with the paper of the evening titled ''Entomological Photomacrography and Photomicrography.''

He stressed the importance of photography in depicting man's activities, then spoke briefly on the history of black and white and color photography. The 3-color subtractive process of color photography was invented by Dr. Fisher in Germany in 1914, and almost exactly duplicated by two Russian musicians in 1921. The Eastman Kodak Company hired the musicians and in 1936 Kodachrome appeared on the market. There has been considerable improvement in color, so that slides in Mr. Fox's collection which were made some 8 years ago, show practically no fading at this time. Mr. Fox spoke of the need for accurate exposures in color work and of the need for proper adjustments for color temperature. In his work he corrects his exposures to a half stop. He then showed a series of insect pictures, most of which were taken from the collections of the American Museum of Natural History. His equipment was set up for this work in such manner that photographs of the specimens could be taken quickly and accurately.

NOTE ON TORRE-BUENO

Jose Rollin de la Torre-Bueno died at his home in Tucson, Arizona, on Sunday, May 2nd, 1948, at the age of 76. By his passing American Entomology has lost one of its outstanding personalities and leaders. A goodly part of his life, prior to retirement to Arizona, was spent as Assistant to the President of the General Chemical Company, but early in his career he found time to become interested in the biology of the Hemiptera. He soon established for himself an enviable reputation for his amateur standing in entomology and it was not long before the now familiar initials J-R-T-B. were universally recognized wherever Hemipterists gathered. Bueno's earlier studies centered on the aquatic hemiptera in which he became a specialist. Kirkaldy thought so highly of his work that he erected the genus *Buenoa* in honor of our late confrére.

Torre-Bueno's aristocratic heritage dating from the time of the Spanish Conquistadores marked him as one who had the courage of his convictions and who strove to be a perfectionist in all his undertakings. Not all entomologists were his friends, however, for he was a severe and bitter critic to all who stepped beyond the bounds of accepted procedure. His caustic editorials in the Brooklyn Bulletin and his sharp comments in other entomological journals are classics, and frequently were the cause for pause to reconsider the validity of one's own decision. He was, on the other hand, a helping friend and adviser to many. The greatest aim of his entomological career was to make available to all interested as much of the general knowledge of the systematics of Hemiptera as possible. Thus in his later life he undertook the herculean task of preparing and publishing his *Synopsis* of the families of Hemiptera of North America, a work that now is incomplete and interrupted by his death.

Torre-Bueno's indefatigable energy, his devotion to his entomological studies and his unselfish contribution of time and effort toward the editorial work of the Bulletin of the Brooklyn Entomological Society and Entomologica Americana, have marked him as a man to be admired and to whom we all owe a debt of gratitude. Another monumental contribution, his *Glossary,* is the accepted hand book of all workers in our science.

In recognition of his achievements and his faithful service to them, the members of the Brooklyn Entomological Society elected him Honorary President of their association.

Now that he has passed to his reward, we salute Torre-Bueno and say that whoever made his acquaintance was a better man for having known him.

HERBERT RUCKES
FRANK A. SORACI, *Secretary.*

MEETING OF MAY 18, 1948

A regular meeting of the New York Entomological Society was held May 18, 1948 in the American Museum of Natural History. President Doctor Hagan called the meeting to order at 8: 00 P. M. There were 15 members and 11 visitors present.

Mr. E. W. Teale gave notice of the field trip which would be held on his grounds on August 22.

Doctor Caldejas was elected to membership.

There being no further business, Mr. Herbert T. Schwarz, speaker of the evening, gave a talk on "The Stingless Bees of the Western Hemisphere."

Some of the information presented in his recently issued Stingless Bees (Meliponidæ) of the Western Hemisphere was covered by Mr. Schwarz. He pointed out that these bees belong to the small minority among the Apoidea (perhaps only about 5 per cent)that are social in habit. Although they live in colonies, they have, however, retained the technique, characteristic of the solitary bees, of stocking a cell with provisions (the task of the workers), of laying an egg thereon (the task of the queen), and then of sealing the cell, with the result that the larva that emerges from the egg is shut off from contact with the world until it issues from the cell as a winged insect.

The speaker made some reference to the wide diversity—of size as well as structure—among the different species of stingless bees, which range from insects larger than the honeybee to creatures so tiny that they sometimes get caught in the human eye when visiting it to lap its moisture. He also spoke of the different components of the hive and pointed out that the stingless bee queen, like the honeybee queen, has undergone structural degeneration concomitant with her relinquishment of certain of the functions performed by the female in the case of the solitary bees.

Mr. Schwarz noted that stingless bees occur in the tropical parts of the Old World as well as the New but that their distribution is discontinuous, with a wide area unoccupied by them in the Pacific eastward of the Solomon Islands, their last known outpost, until the west coast of South America is reached. Stingless bees are known from all the states of South America with the possible exception of Chile, and from all the Central American states and Mexico, but they fail to reach even the southern limits of the United States (although they have recently been artifically introduced into Louisiana) and are absent from many of the West Indian islands.

Another phase of the subject was the nest and its structure, with emphasis not only on the architecture but also on the choice of nest sites, to the inclusion of arboreal as well as subterranean nests, as well as nests erected in the structures of other creatures, termites, ants, wasps, and even birds. While many of the nests are of the standard pattern, horizontal story built above horizontal story, other nests, more primitive in type, have the brood cells arranged in clusters. As many as 35 or 40 stories may occur in nests where this kind of architecture prevails. Honey and pollen are stored in jars irregularly clustered.

Due to limitations of time many phases of stingless bee biology had to be omitted but brief reference was made to the many enemies of stingless bees, including among the invertebrates especially bees, ants, wasps, cockroaches, and saltidid spiders and among the vertebrates, in addition to man, many mammals, birds, and reptiles. Against these enemies the bees have developed defenses, partly architectural (for a stingless bee nest is a citadel as well as a habitation) but largely individual. Acting in concert the individual bees of a colony are capable of effective defense. Deprived of a sting, they nevertheless resort to biting; some of them (*Oxytrigona*) discharge caustic fluids; a few species have been observed gluing up small intruders of the nest with a sticky substance, rendering them utterly impotent.

Frank A. Soraci, *Secretary.*

AN EARLY NEW JERSEY INSECT COLLECTION

In 1831 Professor Benedict Jaeger, a native of Austria, visited the United States and was engaged in 1832 by the College of New Jersey, now Princeton University, to put the Zoological Museum in good order. Later in that year he was appointed curator of the Museum and Lecturer on Natural History at a salary of $200 per year. He also taught German, Italian, and French, probably for additional remuneration. In 1839 he offered his private cabinet of natural history including 2,000 specimens of insects to the College, provided his salary was paid in advance. The Board of Trustees agreed to this but he resigned in September 1841 and his account with the College was left in confusion and it was not until 1846 that a committee of the Board was appointed to settle the controversy. The Princeton University Library has a copy of his manuscript ''Museum Neo-Caesariensis'' dated 1832, which is a catalogue of the natural history specimens in the college museum. The insects included 252 species in the Coleoptera, Hemiptera, Lepidoptera, Neuroptera, Hymenoptera, Diptera and Aptera, all collected at Princeton. Nothing remains of this collection of insects. If any escaped the first fire in Nassau Hall, they must have been destroyed by the second fire of March 10, 1855, when the entire interior was demolished.—H.B.W.

Vol. LVII No. 4

DECEMBER, 1949

Journal
of the
New York Entomological Society

Devoted to Entomology in General

Edited by HARRY B. WEISS

Publication Committee

HARRY B. WEISS JOHN D. SHERMAN, Jr.
E. W. TEALE

Subscription $5.00 per Year

Published Quarterly by the Society
N. QUEEN ST. AND McGOVERN AVE.
LANCASTER, PA.
NEW YORK, N. Y.

1949

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NOTICE: Volume LVII, Number 3, of the Journal of the New York Entomological Society was published on September 12, 1949.

Entered as second class matter July 7, 1925, at the post office at Lancaster, Pa., under the Act of August 24, 1912.
Acceptance for mailing at special rate of postage provided for in Section 1103. Act of October 3, 1917, authorized March 27, 1924.

JOURNAL

OF THE

New York Entomological Society

VOL. LVII DECEMBER, 1949 No. 4

THE ACTIVITIES OF HOUSE FLIES[1]

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INTRODUCTION

The observations that are described herein were undertaken to obtain a better understanding of the activities of house flies. It was desired to keep a given fly under continuous observation for periods of several hours at a time. Since it was impossible to make such observations using free flies out-of-doors, it was necessary to confine them in a cage small enough to enable the constant, desired observations to be made.

DESCRIPTION OF PROCEDURE

Pairs of flies of known age and of normal size were confined in a cage, each inside dimension of which was 12 inches, or which was of one cubic foot capacity. The cage was constructed so that it could be taken apart quickly to facilitate cleaning. The two sides, the bottom and the back were of unpainted plywood; the top was of wire screening of 16 mesh, and the front was of glass. When in use the cage was placed on a table about four feet below a light consisting of two GE Mazda Daylight Fluorescent

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[1] Journal Series paper of the New Jersey Agricultural Experiment Station, Rutgers University, Department of Entomology. Research carried out with funds provided by the Office of the Quartermaster General, Department of the Army.

bulbs. The temperature was about 75° F. Two workers cooperated, one who watched a fly continuously, using a stop-watch to time the various activities observed, and dictated the observations to a second worker who entered the information on prepared forms. The activity of one fly of a pair was observed and recorded in this way for continuous periods ranging from 30 minutes to three hours. Information applicable to 22 females and 16 males was obtained and will be described in the following sections.

AGE OF FLIES AND LENGTH OF TIME OBSERVED

The flies of each sex, that were observed, ranged in age from newly emerged individuals to those that had emerged 11 days before. Although each observation was scheduled for a particular length of time, it was never possible to account for exactly the planned interval because short periods were unavoidably gained or lost at each change of activity of a fly which, during the course of one experiment, might result in several hundred separate observations to be entered on the data sheets. A compilation of the data applicable to each fly gave the exact time for which observations were obtained, and these totals served as a basis for the calculations given herein.

TIME SPENT IN SIX CATEGORIES OF ACTIVITY

Prior observations of flies under the conditions of the experiments showed that their activity could be divided into six categories. They spent much time in resting; intermittently they cleaned their feet, head, mouth parts, wings or abdomen; they sought food with the proboscis extended; they fed; they regurgitated the food—which evidently is a part of digestion, and they walked or flew about without reference to food-seeking and, in the males, this often consisted of advances to the female. Therefore all the activities of the flies were classified under the following categories:—1, walking or flying; 2, searching for food; 3, feeding; 4, regurgitating; 5, resting; and 6, cleaning. A summary showing the percentages of time observed that was spent by each fly in each of these activities is given in table 1.

TABLE 1

COMPARISON OF THE TIME SPENT BY HOUSE FLIES IN EACH OF SIX CATEGORIES INTO WHICH THEIR ACTIVITY WAS DIVIDED

Age in days	Time spent by individual flies in the following activities					
	Walking or flying	Searching for food	Feeding	Regurgitating	Resting	Cleaning
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
			FEMALES			
0	0.1	....	....	....	68.2	31.7
0	2.8	10.6	20.1	51.2	5.2	10.1
0	1.1	....	....	....	82.4	16.5
1	2.3	10.0	4.4	76.1	....	7.2
1	1.0	7.7	5.9	45.1	12.5	27.8
1	0.2	0.8	....	....	90.5	8.5
1	0.8	27.9	3.2	19.5	6.3	42.3
1	3.7	7.3	2.0	78.1	0.7	8.2
1	....	....	....	....	94.1	5.9
2	1.7	1.7	2.2	....	89.6	4.8
3	6.0	1.3	....	4.9	74.3	13.5
3	2.6	1.3	1.4	23.3	57.2	14.2
4	5.0	7.4	1.2	66.9	8.3	11.2
5	1.6	....	....	....	83.7	14.7
6	0.4	37.1	3.2	35.0	6.9	17.4
6	4.6	36.4	....	....	43.6	15.4
7	10.4	14.7	....	....	63.3	11.6
9	15.3	0.2	2.8	34.0	26.1	21.5
11	4.8	5.0	3.1	57.6	13.5	16.0
11	4.4	3.0	....	54.0	29.0	9.6
?	29.9	....	....	10.9	40.9	18.3
Average	4.3	8.4	2.5	29.7	40.6	14.5
			MALES			
0	2.7	3.2	1.5	30.8	38.1	23.7
0	....	5.4	....	....	83.0	11.6
2	1.0	11.0	14.0	56.4	4.1	13.5
2	6.7	0.5	6.5	60.9	11.5	13.9
2	1.2	20.3	10.9	49.6	5.8	12.2
2	4.8	36.5	2.5	....	36.7	19.5
2	0.2	15.8	2.8	56.6	0.2	24.4
2	1.8	1.0	....	....	88.6	8.6
3	43.3	5.2	3.2	11.2	10.7	26.3
4	45.9	0.5	....	....	2.7	50.9
5	14.9	7.7	5.4	21.8	23.3	26.9
7	53.8	3.5	0.3	....	30.3	12.1
8	37.5	4.2	1.0	12.4	20.1	24.8
10	26.0	0.9	4.1	....	27.6	41.4
10	5.8	0.2	9.9	59.1	5.7	19.3
11	8.7	....	0.1	....	64.6	26.6
Average	16.2	8.1	4.1	23.0	27.9	20.7

CHOICE OF RESTING PLACES

In the cage that has been described there was a choice of three types of surfaces on which the flies could rest, including resting during regurgitation. Observations showed that they preferred to rest on the plywood and wire screening, but avoided the glass. When cleaning the middle legs were used less often than the others, and one middle leg rested on the surface at all times. The tarsi of these legs were observed to slip on the vertical glass surface indicating that it did not afford a secure foothold for the flies and that they avoided it for this reason.

The avoidance of glass surfaces has been shown also by the choice of resting places by flies in small rectangular cages in which the sides, bottom and top were of glass, and the two ends were of cloth. In these cages the flies carried on most of their activities on the cloth, leaving it only to search for food or when they were disturbed. In these cages this choice by the flies was shown by the occurrence of excrement specks, which were found much more abundantly on the cloth than on the glass. It was indicated, therefore, that the relative smoothness of surfaces was a factor in the choice of resting places by the flies and that they avoided very smooth surfaces on which their foothold was insecure.

FINDING OF FOOD AND THE DURATION OF FEEDING

In these experiments the food provided for paired flies consisted of milk on cotton in 10 cc. beakers placed in the center of the bottom of a cage. The observations failed to show that the flies were attracted to this food by odor. They seemed to find it rather accidentally after searching for a shorter or longer period. The length of time that previously unfed flies searched before finding the food was, for 8 males from 8 seconds to 46 minutes, 37 seconds; and for 7 females from 2 minutes, 28 seconds to 139 minutes, 15 seconds. The average searching time for the males was 11 minutes, 14 seconds, and it was 31 minutes, 44 seconds for the females. After the food was found the males fed for periods ranging from 66 seconds to 3 minutes, 10 seconds, or an average of 1 minute, 39 seconds, and the females fed for periods ranging from 40 seconds to 6 minutes, 55 seconds, or an average of 2 minutes, 15 seconds.

REGURGITATION

Heretofore it has been known that house flies regurgitated food, but the details of the regurgitation and the probable reason for this activity has been little understood. Regurgitation began soon after feeding and continued for some time, probably depending on the amount of food that had been taken. When milk was colored with red stain the regurgitated droplets at first were colored identical with the colored milk, but as the process continued the color gradually became less intense until the droplets were colorless. It was indicated, therefore, that regurgitation is a process of digestion during which the food is brought up from the crop bit by bit and is mixed with saliva before being passed on to the digestive tract. Of the 679 regurgitated droplets observed only one was dropped, indicating that fly specks consist almost entirely of excrement.

The duration in time of individual exposed droplets at the end of the proboscis varied from less than 15 seconds to more than 3 minutes for both males and females, as shown in table 2. The average duration of droplets by male flies was 73.3 seconds and for female flies it was 76.5 seconds. The total number of droplets regurgitated by individual flies, which were observed for varying lengths of time, ranged from 6 to 53, or an average of 32 for the males and from 1 to 76, or an average of 32.6, for the females.

The length of time droplets were exposed ranged from 33.3 to 139.7 seconds for the females and from 34.3 to 188.8 seconds for the males. For male flies 61.1 per cent of the droplets were exposed for one minute or less, 21.2 per cent for from 1 to 2 minutes, 10.8 per cent for from 2 to 3 minutes, and 6.9 per cent for more than 3 minutes. For female flies 56 per cent of the droplets were exposed for one minute or less, 25.6 per cent for from 1 to 2 minutes, 10.5 per cent for from 2 to 3 minutes, and 7.9 per cent for more than 3 minutes.

In the case of female flies the duration of regurgitated droplets of flies one day old was much greater than was the case with older

TABLE 2

Comparison of the Length of Exposure in Seconds of Droplets Regurgitated by House Flies

Sex	Percentage of droplets that were exposed for the following periods in seconds												
	0–15	16–30	31–45	46–60	61–75	76–90	91–105	106–120	121–135	136–150	151–165	166–180	Over 180
Females	9.7	16.9	19.4	10.0	9.5	7.9	4.9	3.3	2.3	4.1	2.3	1.8	7.9
Males	12.2	20.1	15.3	13.5	8.0	5.6	4.9	2.8	3.5	4.5	1.7	1.0	6.9

flies. The average number of droplets regurgitated by female flies one day old was 46.5 and the average length of time they were exposed was 99.2 seconds. For female flies from 3 to 6 days old these figures were 24.5 droplets and 66.6 seconds, and for female flies from 9 to 11 days old they were 21 droplets and 34.9 seconds. Since a similar correlation was not observed in the case of male flies it is probable that the observations noted as being applicable to the females were related to the development of eggs by the young females.

The process of regurgitation was frequently interrupted by movements of the fly or by cleaning without other movement. It occurred after the flies had moved away from the food and were resting in any position on parts of the cage. Male flies regurgitated from 1 to 18 droplets without movement and female flies regurgitated from 1 to 32 droplets without movement. On an average the male flies regurgitated 4.5 droplets without movement and the females regurgitated 5.4 droplets.

CLEANING

Flies of each sex cleaned themselves intermittently, particularly the males, which spent an average of 20.7 per cent of their time in this way whereas the females spent an average of 14.6 per cent of their time in this activity. As in other respects the flies were quite individualistic in their cleaning activities as may be seen from the data given in table 3.

In this table the insect parts involved in cleaning are represented by symbols which are described in the table. The various combinations of symbols show when the flies used the indicated parts in one cleaning operation. A total of 18 of these combinations were represented in the data, and the table shows the percentage of the time devoted to cleaning when each combination of parts was used.

The fore-legs were used with or without the middle legs to clean the head and mouth parts, and the rear legs were used to clean the wings and abdomen. The middle legs were used for cleaning much less than either of the others and in no case was more than one of them removed at a time from the surface on which a fly rested. More time was devoted to cleaning the head

TABLE 3

Comparison of the Time Spent by House Flies in Cleaning Their Several Parts

Age in days	Percentages of the time spent in cleaning that was devoted to cleaning the following body parts																			Time spent in cleaning
	F	FB	FH	FHB	FM	FMH	FMB	FMHB	FMR	M	MR	MRW	MRA	MRAW	R	RA	RW	RWA	Undetermined	
										FEMALES										
0	9.8	5.8	15.6	22.6	0.7	6.9	......	22.6	......	......	......	......	3.4	......	1.1	4.0	......	7.5	......	31.7
0	15.6	9.3	31.3	2.0	5.6	2.0	......	......	......	......	......	18.2	......	......	3.0	5.5	7.5	......	......	10.1
0	14.3	29.1	37.7	0.8	......	......	......	......	......	5.2	......	......	......	......	2.4	......	1.8	8.6	......	16.5
1	15.0	14.5	7.2	......	10.8	15.4	23.0	......	......	......	......	......	......	......	6.5	......	......	7.6	......	7.2
1	18.5	4.5	19.7	2.9	3.2	10.5	......	6.0	......	......	......	......	10.2	......	10.4	......	12.2	1.9	......	27.8
1	11.6	......	20.0	......	19.3	35.5	......	......	......	......	......	......	......	......	3.9	......	9.7	......	......	8.5
1	24.3	9.7	0.2	9.8	12.5	12.1	......	12.1	......	......	......	3.7	......	......	2.8	......	8.6	4.2	......	42.3
1	19.1	......	9.2	5.7	2.7	5.2	1.4	......	......	......	......	......	......	......	4.3	......	52.4	......	......	8.2
1	6.8	......	39.2	12.0	......	9.9	......	......	......	......	3.2	......	......	......	3.0	......	25.9	......	......	5.9
2	22.6	......	6.5	......	28.6	......	......	......	......	......	......	......	......	......	......	......	42.3	......	......	4.8
3	48.2	......	15.1	......	6.8	......	......	......	......	......	......	......	......	......	......	......	25.9	......	......	13.5
3	3.8	14.8	8.9	23.4	1.5	......	......	......	......	......	4.0	......	......	......	0.5	......	27.5	......	......	14.2
4	7.1	6.5	7.2	2.3	4.6	1.9	4.0	15.6	......	......	......	......	......	......	7.4	12.5	20.3	1.5	......	11.2
5	12.1	7.9	1.1	22.9	5.8	......	12.7	13.9		0.3	1.8	......	......	......	3.3	......	43.1	......	......	14.7
6	10.6	8.5	4.4	5.0	3.8	......	......	3.8	......	......	......	......	......	......	24.5	......	13.3	7.2	......	17.4
6	26.8	......	10.0	......	6.3	21.4	11.8	10.9	......	......	......	......	......	......	7.5	......	14.8	8.5	......	15.4
7	10.8	1.7	10.0	10.4	3.0	5.5	4.7	......	......	......	......	......	......	......	0.8	1.2	25.2	7.6	......	11.6
9	11.6	2.2	7.1	2.0	4.5	9.4	10.2	12.7	......	0.9	......	......	......	......	9.1	2.0	23.1	......	......	21.5
11	5.3	4.5	6.4	15.7	......	......	......	11.8	0.7	......	2.3	4.9	......	9.3	0.7	......	......	34.4	......	16.0
11	2.6	......	32.7	......	9.2	14.6	......	33.0	......	......	......	......	......	......	2.3	......	......	22.3	......	9.6
?	12.2	......	......	......	3.3	3.8	......	......	......	......	......	......	......	16.3	11.3	......	40.2	......	29.2	18.3
Average	15.6	6.3	11.5	8.0	5.3	6.6	3.3	8.6	0.1	0.2	0.6	1.2	1.4	0.8	5.6	1.3	18.3	4.3	1.0	14.6

TABLE 3 (*Continued*)

Age in days	Percentages of the time spent in cleaning that was devoted to cleaning the following body parts																			Time spent in cleaning
	F	FB	FH	FHB	FM	FMH	FMB	FMHB	FMR	M	MR	MRW	MRA	MRAW	R	RA	RW	RWA	Undetermined	
									MALES											
0	52.8	3.6	16.5	1.8	7.8	....	....	....	....	....	....	....	....	....	16.6	0.9	....	....	....	23.7
0	21.9	....	26.5	11.2	16.7	....	....	....	....	....	....	9.8	....	....	2.3	....	2.8	8.8	....	11.6
2	14.9	2.1	11.7	13.9	8.6	8.1	9.6	16.8	....	....	....	....	....	....	8.7	....	3.8	1.8	....	13.5
2	11.4	16.1	7.6	16.2	....	14.5	8.2	4.1	....	....	2.9	....	....	....	9.6	....	6.6	2.8	....	13.9
2	17.7	17.9	12.4	....	11.4	8.2	10.3	....	....	....	....	....	....	....	19.1	....	3.0	....	....	12.2
2	13.7	16.9	11.1	7.4	2.0	6.5	5.2	....	....	1.4	3.2	7.9	....	2.9	3.1	0.4	10.5	7.8	....	19.5
2	4.2	5.2	1.3	13.2	7.3	....	....	4.7	....	....	....	....	....	....	42.5	....	15.3	6.3	....	24.4
2	7.9	....	30.7	....	....	3.4	....	10.5	....	....	4.2	....	....	....	2.5	....	16.5	24.3	....	8.6
3	34.9	12.3	14.0	12.2	1.1	4.4	....	5.4	....	....	....	....	....	....	8.9	....	6.8	....	....	26.3
4	24.0	....	....	....	3.1	....	....	....	....	....	....	6.9	....	....	....	....	32.3	....	33.7	51.0
5	9.9	7.9	8.1	7.1	5.1	....	3.8	3.5	....	0.9	....	12.3	....	....	1.3	....	40.1	....	....	26.9
7	32.6	....	4.3	4.0	3.7	3.0	4.8	4.4	....	....	1.0	1.3	....	....	2.3	....	35.4	3.2	....	12.1
8	39.8	....	10.9	....	3.4	....	....	....	2.8	....	3.7	1.5	....	....	6.0	....	27.7	4.2	....	24.8
10	9.6	0.8	10.0	3.1	7.9	9.3	6.7	13.4	....	....	....	10.2	1.8	....	1.5	....	14.0	11.7	....	41.4
10	52.8	3.6	16.5	1.8	7.8	....	....	....	....	....	....	....	....	....	16.6	0.9	....	....	....	23.7
11	12.2	9.7	4.8	....	....	3.8	26.4	....	....	....	5.7	16.9	....	....	1.4	....	19.1	....	....	26.6
Average	20.0	6.5	10.1	6.4	5.1	4.0	4.7	4.7	0.1	0.2	1.1	4.8	0.2	1.0	8.0	0.1	17.1	4.3	1.5	20.7

The symbols are:

F—front legs
M—middle legs
R—rear legs

H—head
B—mouth parts
A—abdomen

W—wings

and proboscis and fore legs than other parts, as shown in the following summary:

COMPARISON OF THE AVERAGE TIME SPENT BY HOUSE FLIES IN CLEANING PARTS OF THEIR BODIES

Parts cleaned	Percentage of time devoted to cleaning that involved the use of the stated parts	
	Males	Females
Fore legs, head and mouth parts	42.97	41.30
Fore and middle legs, head and mouth parts	18.56	23.86
Involving the middle and rear legs	7.42	5.28
Rear legs, wings and abdomen	29.50	29.55
Undetermined parts	1.53	

Cleaning involving the use of the fore legs, the mouth parts and head and the rear legs, wings and abdomen accounted for 91 per cent of the time devoted to cleaning by the males and 94.7 per cent by females. The time devoted to cleaning by male flies ranged from 8.6 to 50.9 per cent of the time they were observed, and for female flies this range was from 4.8 to 42.3 per cent.

ADVANCES BY THE MALES

The males were much more excitable than the females, as was indicated by their much greater activity in walking and flying, and after the first few days following emergence they made frequent advances to the females, but they were usually rejected. The data show that the males did not become interested in the females until the second or third day after emergence. Their interest became less from the 4th to the 6th day after emergence, but it increased on the 7th to the 11th day.

During the course of the observations mating was seen in the case of one pair of flies. A female that was one day old was observed in copulation at 8:30 A.M. on July 18, and mating continued until about 9:50, thus lasting for about one hour, 20 minutes.

DEFENCE

The observations showed that the females were quite capable of resisting the advances by the males, and that any fly was well equipped for competition for food or mates with other flies.

In cages where the mass of food was small in proportion to the number of flies, there were frequent clashes for feeding positions about the food. These engagements were carried out by using one or the other of the middle legs as weapons of defense or offense. The appendage was raised high into the air where it was poised until the encroaching fly was close: then it lashed out. A well-placed blow could break several legs or tear a wing to shreds.

A similar action was observed when a single male and female were confined in a cage. After the female had become gravid she fended off the approaches of the male by using one of her middle legs in a similar way. By the fifth or sixth day the male often was crippled in legs or wings or both. It had been noted often that the males died sooner than the females, and that after a few days they were much battered with frayed wings. It appeared that much of this early mortality might be caused by the females when resisting the rather frequent advances by the males. Less frequently the female disturbed the male while he was feeding or regurgitating, in which case he protected himself by the same method.

SUMMARY

Pairs of house flies were confined in a cage in which milk was provided as food. Each was watched continuously for varying lengths of time; their successive activities were observed and timed by use of a stop watch and the observations were entered on forms.

Their activity was divided into six categories: walking or flying, searching for food, feeding, regurgitating, resting, and cleaning. There was much variation in the proportion of time spent by individual flies in each of these activities. The males spent more time in walking, flying and cleaning, and the females spent more time in resting.

After feeding the flies spent much time in regurgitating the food drop by drop. The first-exposed droplets were colored identical with the food, but the color gradually disappeared and the last exposed droplets were a clear liquid. From the observations it appeared that regurgitation was a process of digestion

wherein the food was brought up from the crop and mixed with saliva before passing on to the intestines.

The fore legs were used with or without the middle legs to clean the head and proboscis, and the rear legs were used to clean the wings and abdomen. The middle legs were used for cleaning much less than either of the others and in no case was more than one of them removed at a time from the surface on which the fly rested. More time was devoted to cleaning the head and mouth parts than any other parts.

ARMY-ANT BEHAVIOR

The American Museum of Natural History has just published the results of Dr. T. C. Schneirla's behavior studies entitled "Army-Ant Life and Behavior Under Dry-Season Conditions, 3 The Course of Reproduction and Colony Behavior" (Bull. Amer. Mus. Nat. Hist., Vol. 94, Article 1, p. 1–82, 1949). The observations on which the study is based extended over a period of four and a half months in the dry season on Barro Colorado Island in the Canal Zone and involved the species *Eciton hamatum* and *Eciton burchelli.* The purpose was to determine if the general activities of army ants are materially affected by seasonal dry conditions. Detailed observations of particular colonies for a period of four months are presented together with records of other colonies for shorter periods of time, the whole being followed by an informative and interesting discussion of the variations in different phases of the behavior pattern of these ants. Dr. Schneirla concludes that the cyclic system of events making up the behavior pattern persists during both the rainy and dry seasons and that such differences as occur during the dry season are secondary and do not materially damage the orderly persistence of the events. Dr. Schneirla's present paper is another in his series of authentic and erudite contributions, dealing with the behavior of army ants, over many years.—H. B. W.

THE CHLORIDE ION IN THE HEMOLYMPH OF THE LARGE MILKWEED BUG, ONCOPELTUS FASCIATUS (DALLAS)[1, 2]

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Although the literature revealed some figures on the chloride ion content of the hemolymph of a few insects, only one adult insect, *Dytiscus marginalis* L., has been so studied. Most workers bled a great many insects to obtain a sufficiently large sample or chose a larva or pupa of a species with complete metamorphosis relatively rich in hemolymph. The following table indicates the species, life stage, chloride in milligrams per 100 ml. and the investigator for all such references:

TABLE 1

Chloride Determinations in Hemolymph from the Literature

Species of Insect	Stage	Cl^- mg./ 100 ml.	Investigator
Prodenia eridania (Cramer)	larva	119.8	Babers (1938)
Apis mellifera Linné	larva	117.0	Bishop, Briggs, and Ronzoni (1925)
Sphinx pinastri Linné	pupa	65.9 ♂ 58.1 ♀	Brecher (1929)
Deilephila euphorbiæ Linné	larva	48.6	Heller and Moklowska (1930)
Dytiscus marginalis Linné	adult	224.0	Portier and Duval (1927)
Saturnia carpini Schiffner	larva	42.5	Portier and Duval (1927)
Cossus cossus Linné	larva	6.69	Portier and Duval (1927)
Bombyx mori Linné	larva	51.6	Portier and Duval (1927)
Bombyx rubi Fabricius	larva	89.8	Portier and Duval (1927)
Sphinx ligustri Linné	pupa	53.4	Portier and Duval (1927)
Saturnia pyri Schiffner	pupa	62.5	Portier and Duval (1927)
Aedes ægypti (Linné)	larva	182.0	Wigglesworth (1938)
Culex pipiens Linné	larva	170.0	Wigglesworth (1938)

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[1] A portion of a thesis submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Entomology in the Graduate College of the University of Illinois, 1948.

[2] This work was completed under a fellowship from the Graduate College of Illinois. The work was directed by Professor William P. Hayes to whom I wish to extend my thanks.

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Of the six papers treating of an analysis of insect hemolymph for chloride, two, Heller and Moklowska (1930) and Portier and Duval (1927) did not give the method of analysis. The rest, including Wigglesworth's (1937), were all special modifications of the Volhard determination of chlorides, a method dependent on a colorimetric end point.

The method used involved a potentiometric determination of the end point. Basically this method was first proposed by Cunningham, Kirk, and Brooks (1941). In this present study there were several modifications of the original methods, the most important being the substitution of a vacuum-tube voltmeter for the potentiometer.

APPARATUS AND TECHNIQUES

1. ELECTRODES. A potentiometric method utilizing a bimetallic system of electrodes was used. One electrode was of Number 23 silver wire soldered to a piece of Number 14 copper wire to afford a good connection with the electrode holder. This electrode was the indicator electrode. A small bulb was fashioned in the end which dipped into the solution to furnish a good surface for contact with the solution. The other electrode, which was of Number 23 tungsten wire, served merely to complete the circuit. Both electrodes were thoroughly cleaned with fine emery paper at the beginning of a series of titrations to remove any deposit of silver chloride. It was found that this had the same effect on the silver electrode as dipping it in a solution of nitric acid with a small amount of sodium nitrite added until effervescence occurred as recommended by Cunningham, Kirk, and Brooks (1941).

2. VACUUM-TUBE VOLTMETER. An instrument of this kind was found to be more convenient than a potentiometer in determining the difference in potential across the electrodes, because once set there is no manipulation needed to determine the individual readings, because the latter are read directly from a meter. Furthermore, the titration curve can be obtained more accurately in a shorter period of time than by the use of a potentiometer, because after each addition of silver nitrate a shorter or longer period of

time elapses before equilibrium is reached. On a vacuum-tube the needle continues to swing back and forth slowly until an equilibrium for that addition of silver nitrate is reached.

The vacuum-tube voltmeter was constructed from a diagram given in "Radio Test Instruments" by R. P. Turner. The only change which was made was the use of a d'Arsonval galvanometer instead of the 0–1 D. C. milliammeter suggested. The latter is not sensitive enough to record the end point satisfactorily in all titrations, since the magnitude of the break in potential may be greater or lesser in several titrations, the important point being that it corresponds with the equivalence point.

3. Burette. The burette, manufactured by Microchemical Specialties in Berkeley, California, had a total capacity of 0–1 ml. which was divided into 350 divisions. Therefore, additions could be made as small as 0.286 microliters without estimations. Readings could be estimated to tenths of each division. The burette was calibrated by the company and was similar to the one described by Cunningham, Kirk, and Brooks (1941).

4. Stirrer. The solution being titrated was stirred rapidly by means of a fine glass rod cemented by rosin to a copper wire which in turn was soldered to the vibrator of an electric buzzer. The speed of vibration was controlled by a rheostat inserted into the circuit, the speed being cut down to the point where it did not cause splashing of the solution.

5. Collecting of hemolymph. Although some workers have stated that the hemolymph may be easily collected by cutting the legs or by making a dorsal incision and allowing the hemolymph to drip into a test tube, I have not found this to be true with the large milkweed bug. A small droplet of hemolymph did appear when an incision was made. However, this did not "drip" of its own accord. It was necessary to touch the edge of the vessel to the droplet in order to secure the hemolymph. A microvial which is generally used in taxonomic studies, was employed to collect the fluid. Since the hemolymph of the milkweed bug does not clot, the insect did not have to be first dipped in hot water or treated with acetic acid. In all cases the legs were cut off approximately midway along the femur and the slightly yellow clear drops of

hemolymph which formed were touched with the collecting vial. A small amount of pressure was placed on the abdomen to force out an additional amount of hemolymph. However, care was exercised in forebearing from collecting any fluid which appeared turbid or in any way contaminated with another tissue. Precautions were also taken to avoid contaminating the collected hemolymph with sodium chloride from the hands. The collecting vial was washed in distilled water and dried inside and out with fresh cotton before use and handled only with forceps. When actually in use, it was inserted into a glass tube filled almost to the top with paraffin. In this way one could hold the glass tube instead of attempting to maintain the proper tension with forceps. About five adults, sometimes one or two more for males and sometimes one or two less for females were needed to collect an adequate amount to furnish a sample of 7.58 microliters. Approximately eight nymphs of the fifth instar and fifteen nymphs of the fourth instar were required to obtain a volume of the same size. In order to obtain 3.98 microliters in the neighborhood of twenty-five to thirty individuals of the third, second and first instar had to be bled. About ten minutes were required to bleed the adults; approximately twenty minutes to bleed the fifth and fourth instars, and over thirty minutes for the third, second and first. When a suitable amount was obtained, the hemolymph was taken up with a calibrated pipette. The pipette could not be used directly without the use of the collecting vial, because air tended to be introduced with a subsequent misconception of volume.

6. Pipettes. The pipettes were made of soft glass with a fine point on one end to insert into the collecting vial, a rounded bulb to contain the bulk of the sample, and a constricted area where the capacity mark was made with a diamond marking pencil. This was similar to an ordinary pipette except that it was made on a smaller scale and it was in this respect that it differed from the pipette employed by Cunningham, Kirk, and Brooks (1941) from whose work the remainder of the pipette was designed. After the constriction, the glass widened out. Into this area a Number 27 syringe needle was inserted and glued by means of rosin. A 0.1 ml. syringe was then inserted into the needle of this pipette to

force hemolymph in and out of the measuring chamber. When a syringe having a larger bore was used, the vacuum created was too great and the hemolymph was moved past the capacity mark into the needle of the syringe.

The pipettes were calibrated by weighing the amount of mercury delivered on an analytical balance.

KNOWN CONCENTRATIONS OF CHLORIDE

The method was tested for accuracy by titrating various concentrations of silver nitrate against known amounts of sodium chloride solutions, calculating on the basis of chloride ion content rather than on the salt concentration. Using analytical grade chemicals a 0.1 M solution of sodium chloride and a 0.1 M solution of silver nitrate were made up as primary standards by the use of approved methods. Just before use these were carefully diluted to the necessary concentration. Table 2 shows the titrations of various concentrations of sodium chloride with various concentrations of silver nitrate together with the accuracy thereof.

In order to determine the applicability of the method to hemolymph two samples of adult hemolymph were taken. One was analyzed directly in the described manner. To the other a small quantity of sodium bicarbonate was added. The sample was then ashed. The ash was taken up in 40 microliters of distilled water and subjected to analysis in the same manner as the first sample. The results of the two determinations were practically the same.

HEMOLYMPH OF ONCOPELTUS FASCIATUS (DALLAS)

Adults of various ages, males, and females, and all five instars of the nymphs were analyzed for chloride content of the hemolymph. The molarity of the silver nitrate used for the adults through the fourth instar nymphs was 0.005; for the first three instars, 0.001. The results are shown in Table 3. The plasma of adults and of the fifth instar nymphs was also analyzed, the results also appearing in Table 3.

TABLE 2

TITRATIONS OF KNOWN CONCENTRATIONS OF CHLORIDE

Concentration Cl- Micrograms/ Microliter	Molarity $AgNO_3$	Units $AgNO_3$ Required	Amt. Cl- Calculated (Micrograms)	Amt. Cl- Found (Micrograms)	Deviation (Micrograms)	Mean Deviation	Per Cent Error	Mean Recovery Per Cent	Standard Deviation (0′)	Standard Error of Standard Deviation
0.7092	0.1M	3.24	35.46	35.39	0.07					
		3.25		35.49	0.03					
		3.25		35.49	0.03					
		3.24		35.39	0.07					
		3.25		35.49	0.03	± 0.046	± 0.13	99.97	0.559	0.174
0.7092	0.05	6.54	35.46	35.48	0.02					
		6.53		35.42	0.04					
		6.53		35.42	0.04					
		6.52		35.37	0.09					
		6.55		35.53	0.07	± 0.052	± 0.15	99.94	0.644	0.204
0.7092	0.01	33.79	35.46	35.47	0.01					
		33.78		35.46	0.00					
		33.77		35.45	0.01					
		33.78		35.46	0.00					
		33.76		35.44	0.02	± 0.008	± 0.023	100.00	0.122	0.0386
0.3546	0.05	3.25	17.73	17.74	0.01					
		3.26		17.80	0.07					
		3.24		17.69	0.04					
		3.24		17.69	0.04					
		3.25		17.74	0.01	± 0.034	± 0.19	100.00	0.455	0.144
0.3546	0.01	16.56	17.73	17.73	0.00					
		16.55		17.72	0.01					
		16.56		17.73	0.00					
		16.54		17.71	0.02					
		16.55		17.72	0.01	± 0.008	± 0.045	99.94	0.122	0.0386
0.3546	0.005	33.79	17.73	17.73	0.00					
		33.81		17.74	0.01					
		33.78		17.73	0.00					

TABLE 2 (*Continued*)

Concentration Cl- Micrograms/ Microliter	Molarity $AgNO_3$	Units $AgNO_3$ Required	Amt. Cl- Calculated (Micrograms)	Amt. Cl- Found (Micrograms)	Deviation (Micrograms)	Mean Deviation	Per Cent Error	Mean Recovery Per Cent	Standard Deviation (0′)	Standard Error of Standard Deviation
0.07092	0.01	3.26	3.546	3.560	0.014					
		3.25		3.549	0.003					
		3.24		3.539	0.007					
		3.24		3.539	0.007					
		3.25		3.549	0.003	± 0.0068	± 0.19	100.03	0.279	0.0883
0.07092	0.005	6.54	3.546	3.548	0.002					
		6.56		3.559	0.013					
		6.53		3.542	0.004					
		6.55		3.553	0.007					
		6.53		3.542	0.004	± 0.006	± 0.17	100.08	0.252	0.0797
0.07092	0.001	33.77	3.546	3.545	0.001					
		33.79		3.547	0.001					
		33.78		3.546	0.000					
		33.80		3.548	0.002					
		33.76		3.544	0.002	± 0.0008	± 0.023	100.00	0.050	0.0158
0.03546	0.001	16.56	1.773	1.773	0.000					
		16.53		1.770	0.003					
		16.57		1.774	00.01					
		16.54		1.771	0.002					
		16.53		1.770	0.003	± 0.0018	± 0.10	99.94	0.0758	0.0237
0.03546	0.0005	33.75	1.773	1.771	0.002					
		33.73		1.770	0.003					
		33.82		1.774	0.001					
		33.85		1.776	0.003					
		33.73		1.770	0.003	± 0.0024	± 0.14	99.94	0.0894	0.0283

TABLE 3

	No. of Samples	Mean Amt. Cl - Milli-grams/ 100 Ml.	Mean Deviation	Standard Deviation	Standard Error of Standard Deviation
Chloride in Whole Hemolymph of Adults—Male and Female	25	91.4	± 0.114	0.0689	0.00975
Chloride in Whole Hemolymph of Male Adults	10	91.2	± 0.007	0.138	0.0309
Chloride in Whole Hemolymph of Female Adults	10	91.1	± 0.012	0.141	0.0315
Chloride in Whole Hemolymph of Fifth Instar Nymphs	10	91.5	± 0.026	0.332	0.0743
Chloride in Whole Hemolymph of Fourth Instar Nymphs	10	91.5	± 0.027	0.336	0.0751
Chloride in Whole Hemolymph of Third Instar Nymphs	10	91.4	± 0.009	0.257	0.0575
Chloride in Whole Hemolymph of Second Instar Nymphs	10	91.2	± 0.008	0.367	0.0821
Chloride in Whole Hemolymph of First Instar Nymphs	10	91.2	± 0.007	0.202	0.0452
Chloride in Plasma of Adults	10	142.9	± 0.008	0.494	0.111
Chloride in Plasma of Fifth Instar Nymphs	10	143.0	± 0.009	0.496	0.111

CONCLUSIONS

1. A potentiometric method, utilizing a bimetallic system of electrodes and a vacuum-tube voltmeter was established for measuring the chloride ion content of a microsample of hemolymph with an error of not more than 0.2 per cent down to 0.03546 micrograms of chloride per microliter.

2. The chloride ion content of the hemolymph of the large milkweed bug, *Oncopeltus fasciatus* (Dallas), was found to be 6.93

micrograms per 7.58 microliters or 91.4 milligrams per 100 milliliters.

3. No difference was determined in the chloride content of the hemolymph between the sexes or between the adults and any one of the five instars of nymphs.

4. The chloride ion content of the plasma alone was found to be 10.83 micrograms per 7.58 microliters or 143 milligrams per 100 milliliters.

5. There was no difference in the chloride content of the plasma between the adults and fifth instar nymphs.

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BOOK NOTICE

American Spiders by Willis J. Gertsch, Ph.D. D. Van Nostrand Company, Inc., Toronto, New York, London, 1949. 8½ × 5½ inches. xiii + 285 p. 32 col. pl. 32 black and white pl., 6 text figs. $6.95.

Many entomologists know nothing about spiders although it is virtually impossible to collect insects without coming into contact with spiders. When I think of the hundreds of these interesting creatures that I allowed to escape, unmolested, from my sweep-net in the past, I am amazed at my neglect of this astonishing group, whose predaceous activities, in enormous numbers, are barely appreciated. However it is still possible for me to read the extraordinary accounts of the life histories, habits, morphology and peculiarities of these animals, of which Doctor Gertsch has written, in fascinating detail, from his abundant knowledge and studies.

His book which is admirably planned and executed begins with statements about spiders in general, legendary beliefs, and their place in nature. These are followed by a chapter on the life of the spider which includes ballooning; egg laying; egg sacs; early development; molting; longevity; its ability to drop an appendage, its habit of sucking the juice from the dropped appendage, and the subsequent regeneration of the appendage. There are chapters on silk spinning, courtship, the evolution of spiders, the tarantulas, the cribellate spiders, the aerial web spinners and the hunting spiders together with accounts of their economic and medical importance, the spider fauna of North America, a glossary, and a brief bibliography.

Although the book does not deal with identification, its excellent colored and black and white illustrations, together with textual statements, enable the reader to identify the most common species. Doctor Gertsch's book should do much to remove the unwarranted enmity with which spiders are regarded by most persons and its entertaining and informative text should provide many with a new approach toward the study of this comparatively neglected group. Everyone interested in natural history, specialist and non-specialist will enjoy Doctor Gertsch's skillful presentation and his authentic and extensive insight into araneology.—H. B. W.

INSECTS COLLECTED IN THE DUNDAS MARSH, HAMILTON, ONTARIO, 1947–48[1]

By W. W. Judd[2]

INTRODUCTION

In a previous paper (Judd, 1949) the writer reported upon collections of insects made in the Dundas Marsh during the summers of 1946 and 1947 and upon studies of the times of appearance of adults of aquatic insects emerging from the waters of the marsh in 1947. During 1948 collections of insects on the marsh were continued and they are reported upon herewith, together with additional records from 1947. Some of the insects were collected by sweeping the vegetation around the borders of the marsh, some were collected from leaves and flowers of aquatic plants and some were reached by canoe, being swept from their resting places on the broad leaves of water lilies (*Nymphæa odorata* Ait. and *Nuphar advena* Ait.) and the extensive mats of duckweed (*Lemna minor* L. and *Spirodela polyrhiza* (L.) Scheld.) which formed in quiet stretches of the marsh. As reported in the previous paper, insects emerging from the water during 1947 were trapped in five cages set out at various locations. Cage 1 was about twenty feet from shore in a growth of cat-tail, *Typha latifolia* L., cage 2 was set out over a growth of submerged plants among which the bladderwort, *Utricularia vulgaris* var. *americana* Gray predominated, cages 3 and 5 were placed over submerged plants, mainly coontail, *Ceratophyllum demersum* L. and cage 4 was over a growth of the white water lily *Nymphæa odorata* Ait. A fuller account of the plants occurring in the cages is given in the previous paper.

INSECTS COLLECTED

PLECOPTERA

Nemouridæ

Nemoura vallicularia Wu

Thirteen stoneflies were captured in flight or on the trunks of trees about an inlet of the marsh on April 17, 1948. Of these,

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[1] Contribution from the Department of Zoology, McMaster University; part of a project supported by funds from the Research Council of Ontario.

[2] Assistant Professor of Zoology, McMaster University.

two males and one female are deposited in the collection of Dr. W. E. Ricker, Indiana University.

NEUROPTERA

Hemerobiidæ

Micromus posticus (Walker)

One specimen captured in flight along border of marsh, May 13, 1947.

Hemerobius humulinus L.

Three specimens captured in flight along border of marsh, April 29, May 15, July 28, 1947.

COLEOPTERA

Chrysomelidæ

Donacia subtilis Kunze

Larvæ and cocoons of the beetle were found on a plant of the bur-reed, *Sparganium eurycarpum* Englm. growing in two feet of water about fifty feet from shore. Seven brown cocoons were stuck to the leaves, the ones highest up on the plant being about two inches below the surface of the water and the others ranging downward to the tops of the roots. Four of the cocoons contained white pupæ and the other three contained fully formed adults. Seven larvæ were found with their ends stuck into the tissues of the plant, below the surface of the water, some being attached to the outside of the leaves and others being lodged between the bases of the leaves. Hoffman (1939) reports the occurrence of larvæ and eggs on various species of *Sparganium* and other aquatic plants.

HOMOPTERA

Aphidæ

Rhopalosiphum nymphecæ L.

Specimens were collected on November 5 and 8, 1948 from plants of *Typha latifolia* L. close to the edge of the marsh. These were the winged sexes of this species which was previously reported from leaves of the water lily *Nymphæa odorata* Ait. (Judd, 1949). They were found among the bases of the dead leaves of the cat-tail and were interspersed with numerous cast-off skins. Although the leaves were frozen together and the bases of the plants were surrounded with frost the insects moved sluggishly when removed from the leaves.

DIPTERA

Orthorrhapha

Nemocera

Trichoceridæ

Trichocera garretti Alex.

A single specimen was captured in flight on March 14, 1948 when the marsh was still frozen over and covered with snow and the flowers of skunk cabbage were in bloom and producing pollen.

Tipulidæ

Erioptera (Symplecta) cana (Walker)

One specimen was trapped in cage 1, July 31, 1947 when the water depth was 32 inches, and another was captured in flight April 15, 1948.

Mycetophilidæ

Mycetophila punctata Meigen

Two flies were swept from vegetation at the border of the marsh, May 13, 1947.

Brachycera

Stratiomyidæ

Odontomyia vertebrata Say

Five adults of this fly emerged in the cages during 1947. Four of these appeared in cage 1: July 17 (water depth—34 inches), Aug. 1 (water depth—33 inches), Aug. 4 (water depth—33 inches) and Aug. 5 (water depth—33 inches). The fifth appeared in cage 5 on July 29 (water depth—55 inches). These records indicate that the adults emerge in the latter half of July and the first part of August and that the larvæ inhabit the shallower weed-choked waters as at cage 1, but can be found in deeper, more open water as at cage 5.

Tabanidæ

Chrysops aberrans Phil.

One fly was captured on Aug. 3, 1947 and three were captured on July 16, 1948. They were collected while settling on the skin of workers on the marsh.

Dolichopidæ

Sympycnus lineatus Lw.

Seven adults were swept from vegetation around the marsh during 1947: May 5 (1), May 6 (1), May 13 (4), Aug. 11 (1).

Pelastoneurus vagans Lw.

One specimen was trapped in cage 4 (water depth—58 inches), July 17, 1947.

Cyclorrhapha

Syrphidæ

Platycheirus quadratus Say

Two adults were swept from vegetation, May 22, 1947.

Drosophilidæ

Chymomyza amœna (Lw.)

Two adults were swept from vegetation, May 13, 1947.

Chloropidæ

Elachiptera bilineata Ad.

Flies were swept from vegetation on April 26 (2), April 29 (3), April 30 (5), May 21 (1), 1947.

Ephydridæ

Discocerina obscurella (Fln.)

Three adults were swept from vegetation: June 28 (2), and Aug. 11 (1), 1947.

Dichæta caudata (Fln.)

Three adults were swept from vegetation: April 28 (2), and May 6 (1), 1947.

Pelina truncatus Lw.

Four adults were swept from vegetation: April 24, April 26, April 29 (2) and one was collected from leaves of the water lily, *Nymphæa odorata* Ait., June 25, 1947.

Sectacera atrovirens (Lw.)

Six flies were swept from vegetation Aug. 11, 1947.

Hydrellia griseola var. *scapularis* (Lw.)

Five flies were swept from vegetation on May 6 (1) and June 25 (4), and one from lily pads, Aug. 11, 1947.

Diopsidæ

Sphyracephala brevicornis Say

One adult was swept from a growth of skunk cabbage, *Symplocarpus fœtidus* (L.) Nutt, April 30, 1947 and four were captured in flight about an inlet of the marsh on March 21, 1948.

Borboridæ

Leptocera (Scotophilella) mirabilis (Coll.)

Two flies were swept from leaves of the lily, *Nymphæa odorata* Ait., July 25, 1947. One specimen is deposited in the Canadian National Collection, Ottawa.

Leptocera (Opacifrons) wheeleri Spul.

One fly was swept from vegetation June 28, 1947. The specimen is deposited in the Canadian National Collection, Ottawa.

Tetanoceridæ

Sepedon fuscipennis Lw.

Adults of this species appeared in large numbers in the vegetation around the border of the marsh in the spring of 1947 and the following specimens were captured: April 24 (4), April 26 (4), April 28 (2), April 29 (1). One was captured later on Aug. 11, 1947. One appeared in cage 1 on Sept. 11, 1947 (water depth—26 inches, and one in cage 5 on July 19, 1947 (water depth—55 inches). Pupæ have been reported by Johannsen (1935) from the margin of a pond.

Elgiva rufa (Pz.)

This species occurred in company with *Sepedon fuscipennis* in the vegetation about the marsh in 1947, the following specimens being captured: Apr. 6 (7), April 28 (12), April 29 (5), April 30 (6), May 5 (2), May 6 (3). One specimen emerged in cage 5, Oct. 25, 1947 (water depth—36 inches).

Melina schœnherri Fln.

Three flies were swept from vegetation, April 28 (2), May 5 (1), 1947. One specimen is deposited in the Canadian National Collection.

Cordyluridæ

Pyropa furcata Say

Adults were found in company with *Sepedon fuscipennis* and

Elgiva rufa in vegetation about the Marsh in 1947, the following specimens being captured: April 26 (2), April 28 (5), April 30 (2).

Muscidæ

Lispe albitarsus Stn.

Adults appeared in cages during 1947 as follows: cage 3—July 17 (1) (water depth—51 inches); cage 4—July 16 (1) (water depth—59 inches), July 17 (1) (water depth—58 inches), July 22 (1) (water depth—57 inches); cage 5—July 5 (1) (water depth—55 inches), July 15 (1) (water depth—57 inches). These records indicate that this species emerges during July from deeper waters away from the shore.

Scopeuma stercoraria (L.)

One adult was captured from vegetation, May 22, 1947.

Helina rufitibia Stn.

One adult was captured on vegetation, April 26, 1947.

ACKNOWLEDGEMENTS

The writer is grateful to Professor A. E. Warren, in charge of the Marsh Research Project of McMaster University, for advice and encouragement during the course of this work. I wish to express my thanks to the staff of the Marsh Research Project who have co-operated, and especially to Miss Mary Inksetter and Mr. Arthur Rayner who aided daily, during the summers of 1947 and 1948 respectively, in collecting insects and recording data. I am deeply obliged to the following specialists in the taxonomy of various groups for their kindness in making and checking the indentifications of insects: Dr. W. E. Ricker, Indiana University (Plecoptera), Dr. F. M. Carpenter, Museum of Comparative Zoology, Harvard University (Neuroptera), Dr. A. A. Granovsky, University of Minnesota (Aphidae), Mr. G. E. Shewell, Division of Entomology, Department of Agriculture, Ottawa (Diptera), and Dr. C. P. Alexander, University of Massachusetts (Trichoceridæ, Tipulidæ).

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BOOK NOTICE

The Life of William T. Davis. By Mabel Abbott. Cornell University Press, Ithaca, N. Y. 1949. $9\frac{1}{2} \times 6$ inches. xv + 321 p. 26 illus. $3.50.

This is a book to be read, rather than written about. Following an appreciative introduction by Edwin Way Teale, Miss Abbott, in 20 chapters, presents a sincere, full length portrait of William T. Davis. Most entomologists are unfortunate in their biographers, if they have any at all and only rarely is the human side of the subject presented. But this is not true of Miss Abbott's book which begins with the background and boyhood of Mr. Davis and continues through his long life. Included therein are chapters on his youthful reading habits, his numerous friendships and correspondents, his helpfulness to many persons, his continuous interest in cicadas and the natural history of Staten Island, his travels, his financial worries, his diet, of which he had to be careful, and his long active interest in the Staten Island Institute of Arts and Sciences, and other cultural bodies of the Island.

In her account Miss Abbott has included many extracts from Mr. Davis' ''Natural History Notes'' a manuscript record, which he kept for 56 years, of his observations, thoughts, and bits of reflections, all indicating his philosophy and attitude toward life. Although Mr. Davis, a lifelong resident of Staten Island, was an authority on the Cicadidæ and a student of the fauna and flora of the Island, and of its history, his scientific and historical contributions are not unduly stressed. Instead there emerges a faithful portrait of Mr. Davis himself, his mild disposition, his quiet humor, his unfailing kindliness, his long and fast companionships, his abounding and tireless interest in natural history, his pleasure in the behavior of creatures of the field and woods, and in little happenings which most of us fail to notice, his appreciation of warm sunshine, the song of a chickadee, and a crow he saw from a ferryboat. Mr. Davis was continually aware of the ceaseless and varied animal and plant life that went on all about him, from which he took much satisfaction and which filled his life.

This is a biography of Mr. Davis as he lived, thought and worked, a gentle, all-around naturalist, kindly disposed toward everything, except perhaps the despoilation of his beloved Island by so-called improvements. Miss Abbott has reproduced the quiet flow of his life, interrupted at times by sadness and worries, but continuing as before bright and unruffled with no deviation from his self-appointed tasks. Mr. Davis was fortunate in his biographer. Excellent taste is evident in the format of this biography which includes a list of Mr. Davis' writings and an index.—H. B. W.

POISONOUS PASTE

In the "South Carolina Gazette" of September 11, 1762, Richard Bird, upholsterer from London informed the ladies and gentlemen of Charles-Town that he hung paper "with a paste that has a peculiar quality of destroying all vermin in walls." About the same time John Webster in Philadelphia another upholsterer from London advertised in the "Pennsylvania Journal," August 20, 1767 that he sold Webster's Liquor "for entirely destroying that offensive and destructive vermin called Buggs."—H. B. W.

NOTES ON THE DISTRIBUTION, HABITS, AND HABITATS OF SOME PANAMA CULICINES (DIPTERA: CULICIDÆ)

By Ross H. Arnett, Jr.
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(Continued from Vol. 56, p. 193)

In the second part of this paper I discussed the distribution, habits and habitats of some Panama *Uranotænia, Megarhinus, Culex,* and *Deinocerites.* I am continuing with the Panama Culicines, *Mansonia* through the Sabethini.

PART III

Culicini (Cont.)

Mansonia Blanchard

Mansonia titillans (Walker)

Culex titillans Walker, Cat. Brit. Mus., Dipt., 1: 5, 1848.

Distribution.—Alejuela (Busck); Miraflores, Ancon, Paraiso, Camp Perdun, Frijoles, Gatun, Monte Lirio, Caño, Bas Obispo, Darien (Zetek); Culebra (Dunn); Rio Grande, France Field, Quarry Heights (Zetek); Cativa, Empire, Margarita, Comacho (Shropshire); Fort Clayton (Baker); Rio Trinidad (Busck); Gatuneita River (Zetek); Colon (Chidester); Pital, Chiriqui (Dunn); Empire, Lake Gatun; La Chorrera, La Joya, Chilibre, Nuevo Chagres, Piña, Lagarto, New Providence (Author).

Habits and Habitats.—The larvæ breed attached to the roots of *Pistia.* They are abundant in vegetation in rivers and in Gatun Lake.

The adults are common in horse traps and on screens. They readily bite man. They are distinctive in their large size, mottled wings and absence of rings or bands of white on the legs.

This species breeds throughout the year. (Rare prior to the Canal—Knab.) (The adults fly great distances and bite severely —Dyar.)

Mansonia fasciolatus (Arribalzaga)

Tæniorhynchus fasciolatus Arribalzaga, Rev. Mus. La Plata, 150, 1891.

Distribution.—Gatun (Jennings); Ancon, Caño (Zetek); Majagual, Cativa (Shropshire); Caño Saddle, Barro Colorado Island (Shannon); Boca del Toro (McKenney); Porto Bello (Jennings); Trinidad River (Busck); Caldera Island, Upper Pequini River (Jennings); Panama (Ross); Colon (Russell); Gamboa, Gatun Lake, La Joya, La Chorrera, Piña, Lagarto, Salud (Author).

Habits and Habitats.—The larvæ have not been collected.

The adults are very abundant in horse trap collections and on screens. They will readily bite humans. This species and the following species are important pest mosquitoes in the area. An estimated 10,000 or more were seen on several occassions in horse traps, about half of each species. Males are found in small numbers with the females. (Rare prior to the canal—Knab.)

Mansonia nigricans (Coquillett)

Tæniorhynchus nigricans Coquillett, Proc. Ent. Soc. Wash., 6: 166, 1904. (Type Loc.: Panama).

Distribution.—Culebra, Ancon (Jennings); Frijoles, Monte Lirio, Darien (Zetek); Paraiso (Dunn); Caño Saddle, Barro Colorado Island (Shannon); Gamboa (Dyar & Shannon); Panama (Ross); Trinidad River (Busck); Gamboa, Empire, Lake Gatun, La Chorrera, Chilibrillo (Author).

Habits and Habitats.—(Larvæ in roots of sedges in floating islands, undescribed—Dyar).

The adults of this species have the same habits and habitats as *M. fasciolatus*. They are abundant in horse traps and on screens. They are vicious biters and are an important pest mosquito. The two species may be recognized in the field. They may be told from *M. titillans* by the smaller size and presence of white bands on the legs. They may be distinguished from each other by the presence of pale spots on the tibia of *M. fasciolatus* and the black tibia of *M. nigricans*.

Only one other *Mansonia* species recorded—*Mansonia arribalzagæ* (Theobald), which is unknown to the author. Recent works indicate that *M. indubitans* Dyar & Shannon is here determined as *M. fasciolatus* (Arribalzaga) in part.

Aedeomyia Theobald

One species only in the New World.

Aedeomyia squamipennis Lynch Arribalzaga

Aedeomyia squamipennis Lynch Arribalzaga, El Nat. Agr., 6: 151, 1878.

Distribution.—Gatun, Ancon, Cāno (Zetek); Bas Obispo (Shropshire); Gamboa (Dyar & Shannon); Fort Sherman (Baker); Trinidad River (Busck); Gamboa, Gatun Lake, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in floating river vegetation associated with *Mansonia titillans.* One record was made of them occurring in a pothole at La Chorrera. They are seldom seen at the surface of the water, but are found resting against the roots of floating aquatic plants, but not attached.

The adults have been taken on screens at night and in human bait traps. No record of them biting man. (Rare prior to the Canal. Dependent on *Pistia*—Knab.)

Common.

Orthopodomyia Theobald

Orthopodomyia fascipes (Coquillett)

Mansonia fascipes Coquillett, Proc. Ent. Soc. Wash., 7: 192, 1905.

Distribution.—Tabernilla (Jennings); Fort Sherman (Dunn); Majagual, Toro Point, Comacho, Empire, Mindi, Cativa, Margarita, (Shropshire); Caño Saddle (Shannon); Gamboa (Dyar & Shannon); Fort Randolph, France Field (Army Medical Museum); Trinidad River, Alhajuelo (Busck); Rio Chagres (Author).

Habits and Habitats.—The larvæ usually breed in tree holes. The author has collected them in great numbers in a cement sewage digestion tank.

Adults were collected resting inside of the latrine. They made no attempt to bite.

Collected in June and July. Uncommon.

One other species, *Orthopodomyia phyllozoa* Dyar & Knab recorded from Panama, but is unknown to the author.

Aedes Meigen

Subgenus *Stegomyia* Theobald

Aedes ægypti (Linnæus)

Culex ægypti Linnæus, Reise Nach, Palestina, 470, 1762.

Culex fasciatus Fabricius (nec Muller), Syst. Antliat., 36, 1805. (Syn. *calopus* Meigen, *vide* Dyar & Knab, Jour. N .Y. Ent. Soc., 14: 196, 1906.)

Culex calopus Meigen, Syst. Beschr. Ent. Zwefl. (Syn. *argenteus* Poiet, *vide,* Knab, Ins. Ins. Mens., 4: 59, 1916.) (*argenteus* syn. *ægypti* L., *vide,* Dyar, Ins. Ins. Mens., 8: 208, 1920.)

Distribution.—Tabernilla, Pedro Miguel, San Pablo, La Boca (Busck); Ancon, Bas Obispo, Gatun (Jennings); Corozal, Matachin (Zetek); Cativa, Majagual (Shropshire); Fort Davis (Baker); Cristobal (Vernes); Panama (Busck); Porto Bello (Jennings); Tabago Island (Zetek); Fort Clayton, Chiva Chiva, Gamboa, La Chorrera, Piña, Lagarto, Nuevo Chagres, Salud (Author).

Habits and Habitats.—The larvæ breed in artificial containers. The adults are collected in horse traps, houses and on screens. This is a well known domestic mosquito, common throughout the tropics and subtropics and vector of yellow fever.

Subgenus *Finlaya* Theobald

Aedes terrens (Walker)

Culex terrens Walker, Ins. Saund., 429, 1859.

Distribution.—Paraiso (Zetek); Mandingo, Toro Point, Majagual, Margarita, Sweetwater, Empire, Comacho, Cunette (Shropshire); Tabernilla (Jennings); Fort Sherman (Dunn); Barro Colorado Island, Fort San Lorenzo (Dyar & Shannon); Chagres River (Busck); Caldera Island (Turner); Alhajuela (Jennings); Empire, La Chorrera, La Joya (Author).

Habits and Habitats.—The larvæ breed in tree holes. Adults will readily bite humans in the jungle; not found near human inhabitations.

Subgenus *Ochlerotatus* Lynch Arribalzaga

Aedes angustivittatus Dyar & Knab

Aedes angustivittatus Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 9, 1907.

Aedes trivittatus of authors (nec Coq.) (Syn. *angustivittatus* Dyar & Knab, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 162, 1928).

Distribution.—Las Cascadas, La Boca, Pedro Miguel, Alhajuela (Busck); Tabernilla, Miraflores, Gatun, Pedro Miguel (Jennings); Matachin, Fort Sherman (Zetek); Panama (Zetek); Colon (Chidester & Busck); Chiriqui (Dunn); La Chorrera, Chilibra (Author).

Habits and Habitats.—The larvæ breed in temporary shady pools. The adults are collected in horse traps; no record of them biting humans; rest during the day in tall grass near breeding place.

Aedes fulvus (Wiedemann)

Culex fulvus Wiedemann, Auss. Zweifl. Ins., 1: 548, 1826.

Distribution.—Gatun (Jennings); Barro Colorado Island, Fort Sherman (Dyar & Shannon); France Field (Baker); Trinidad River (Busck); Colon (Chidester); La Joya (Author).

Habits and Habitats.—The larvæ have not been collected in Panama; live in temporary rain pools elsewhere. The adults will readily bite humans during the day in the jungle.

Aedes serratus Theobald

Aedes serratus Theobald, Mon. Cul., 2: 45, 1901.

Distribution.—Gatun, Pedro Miguel, La Boca (Jennings); Fort Sherman, France Field (Zetek); Colon (Chidester); David (Zetek); Chiva Chiva, Fort Clayton, La Joya (Author).

Habits and Habitats.—The larvæ breed in small shady ponds, also collected in an old, abandoned cistern. (Transient surface pools in the jungle—Dyar.)

The adults will bite during the day in the jungle.

Aedes tæniorhynchus Wiedemann

Aedes tæniorhynchus Wiedemann, Dipt. Exot., 1: 43, 1821.

Distribution.—La Boca, Paraiso (Busck); Tabernilla, Ancon, Pedro Miguel (Jennings); Matachin, Gatun, Balboa, France Field (Zetek); Miraflores, Cardenas River, Monte Lirio, Flemenco Island, Mindi, Coco Solo, Margarita (Shropshire); Cabina, Tabago Island (Busck); Panama (Zetek); Colon (Chidester); Farfan Beach, Gatun Lake, La Chorrera, La Joya, Old Panama, Chilibre, Salud, Piña, Nuevo Chagres, Lagarto (Author).

Habits and Habitats.—The larvæ breed in salt marshes, tidal flats and potholes, all brackish, as well as in fresh water in potholes, flooded areas and small shallow lakes filled with grass. Always breeds in sunlight, in sparse grass. It was also found in a hole in the sand on the beach (see pool mentioned under *Anopheles albimanus,* vol. 55, p. 195). (In brackish swamp—Busck.)

This species is usually thought of as a salt marsh breeder and is usually collected in such a situation. However, it will breed in large numbers in fresh water habitats, although rarely.

The adults are present in great numbers throughout the lowlands of Panama, and in April to June, depending on the advance of the rainy season, there are flights of this species, during which time they are a great pest even in the Canal Zone towns. (Flies 20 miles—Dyar.) It is common in horse traps at this season and will of course readily bite.

The genus *Aedes* is poorly represented in Panama. In addition to the above, the following are recorded from Panama, but are unknown to the author: *Aedes quadrivittatus* Coquillett, *A. septemstriatus* Dyar & Knab, *A. fluviatilis* Lutz, *A. leucotæniatus* Komp, *A. thorntoni* Dyar & Knab (syn. *A. terrens* Walk.?), *A. podographicus* Dyar & Knab (syn. *A. terrens* Walk.?), *A. euplocamus* Dyar & Knab, *A. hastatus* Dyar, *A. lithoecetor* Dyar & Knab, and *A. nubilus* Theobald.

Hæmagogus Williston

Hæmagogus argyromeris Dyar & Ludlow

Hæmagogus argyromeris Dyar & Ludlow, The Mil. Surg., 48: 679, 1921.

Hæmagogus gladiator Dyar, Ins. Ins. Mens., 9: 108, 1921. (Type Loc.: Corozal, C. Z.) (Listed as syn. *argyromeris* Dyar & Ludlow, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 137, 1928.)

Hæmagogus regalis Busck (nec Dyar & Knab), Smith, Misc. Colls., Quar. Iss., 52: 64, 1908. (Syn. *argyromeris* Dyar & Ludlow, *vide,* Dyar, Ins. Ins. Mens., 9: 113, 1921.)

Distribution.—Paraiso, Corozal, Bas Obispo, Empire, Ancon, Miraflores, Bohio (Jennings); Pedro Miguel, Corozal, Paraiso (Zetek); Gatun (Trash and Zetek); Empire, La Pita (Army Medical Museum); Gold Hill, Bella Vista, Majagual, Las Cascades, Mandingo, Toro Point, West Culebra, Perico Island, Golden Green, Monte Lirio, Comacho, Margarita, Cardenas River, Cerro Gordo, Naos Island, Cativa, Coco Solo (Shropshire); Las Cascadas, Lion Hill (Busck); Chagres River, Tabago Island (Busck and Jennings); Panama, Caldera Island (Jennings); Chiva Chiva, Fort Clayton, Gamboa, Panama, La Joya, La Chorrera, Old Panama, Rio Abajo (Author.)

Habits and Habitats.—The larvæ are thought to breed primarily in tree holes. However, many collections have been made in other habitats such as artificial containers, bamboo joints, stump holes, coconut shells and rock holes. One collection was made in a small permanent pool, in the grassy part in direct sunlight. (Tree hole, container, and old kettle—Jennings; wooden box, old machinery and potholes—Busck.)

Adults are collected inside of native huts. They have been observed biting humans standing in a banana grove.

Hæmagogus chalcospilans Dyar

Hæmagogus chalcospilans Dyar, Ins. Ins. Mens., 9: 110, 1921. (Type Loc.: Caldera Island, R. de P.)

Distribution.—Ancon, Porto Bello (Jennings); Margarita

(Shropshire); Panama, Caldera Island (Jennings); Rio Abajo (Author).

Habits and Habitats.—The larvæ are collected in coconut shells. (Ground pools—Dyar; salt pools in rock and in old kettle—Jennings.)

Adults have not been taken in the field.

Hæmagogus lucifer (Howard, Dyar and Knab)

Stegoconops lucifer Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, pl. 23, fig. 164, 1912. (Type Loc.: Tabernilla, C. Z.)

Distribution.—Tabernilla (Jennings); Tabernilla, Gatun, Ahorca Lagarto, Pedro Miguel, Las Cascadas, Lion Hill (Busck); Toro Point, Empire, Mount Hope (Shropshire); Caldera Island (Jennings); Chiriqui (Dunn); Empire, Chiva Chiva, Fort Clayton, La Joya, Panama, La Chorrera, Rio Abajo, Old Panama (Author).

Habits and Habitats.—The larvæ and adults closely resemble *H. argyromeris* both in appearance and habits. They have been collected with this species in nearly every case.

Hæmagogus equinus Theobald

Hæmagogus equinus Theobald, Ent. 36: 282, 1903.

Aedes affirmatus Dyar & Knab, Proc. Biol. Soc. Wash., 19: 164, 1906. (Syn. *equinus* Theobald, *vide*, Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 4: 871, 1917.)

Distribution.—Ancon, Miraflores (Jennings); Empire, Comacho (Shropshire); Summit (Komp); Porto Bello (Busck); El Valle de Anton (Author).

Habits and Habitats.—(Larvæ in tree holes—Dyar.)

Adults were captured, both males and females swarming and biting in sparse jungle. The males can be readily distinguished from all other Panama *Hæmagogus* by the long palpi. All other Panama species have short palpi in both sexes. (Adults biting in swamp—Busck.)

There is only one other species of *Hæmagogus* recorded from Panama, *H. iridicolor* Dyar, and it is unknown to the author.

Psorophora Robineau-Desvoidy

Psorophora s. str.

Psorophora lineata (Humboldt)

Culex lineata Humboldt, Voy. Reg. Equim., 7: 119, 1820.

Psorophora sæva Dyar & Knab, Proc. Biol. Soc. Wash., 19: 133, 1906. (Listed as syn. *lineata* Humboldt, *vide,* Dyar, Ins. Ins. Mens., 11: 180, 1923.)

Distribution.—Las Cascades (Busck); Tabernilla, Miraflores (Jennings); La Chorrera (Author).

Habits and Habitats.—The larvæ breed in large, shallow ponds filled with grass. They are predaceous, feeding on *Aedès tæniorhynchus.*

Adults were collected on screens in the evening. They were also collected in a coconut grove biting, and in horse traps.

Subgenus *Janthinosoma* Lynch Arribalzaga

Psorophora ferox (Humboldt)

Culex ferox Humboldt, Voy. Reg. Equin., 7: 119, 1820.

Culex posticata Wiedemann, Dipt. Exot., 1: 43, 1821. (Listed as syn. *ferox* Humboldt, *vide,* Dyar, Ins. Ins. Mens., 11: 180, 1923.)

Distribution.—Culebra (Black); Las Cascadas, Lion Hill, Alhajuela (Busck); Tabernilla, Gatun, Miraflores, Cristobal (Jennings); Ancon, Matachin, Balboa, Paitilla, Pedro Miguel, Camp Gaillard, Fort Sherman (Zetek); Toro Point, Monte Lirio, Coco Solo, Margarita (Shropshire); France Field (Dyar & Shannon); Chagres River, Tabago Island, Trinidad River (Busck); Cascajal River (Jennings); Colon (Dunn); David, Panama (Zetek); Chiva Chiva, Empire, Gamboa, Cocoli, La Joya, Empire, La Chorrera, Old Panama (Author).

Habits and Habitats.—The larvæ breed in clear, shady pools. (Newly flooded meadow and still pool—Busck; transient rain pools—Dyar.)

The adults are common, found in horse traps and on screens at night as well as biting during the day in the jungle.

The eggs of *Dermatobia hominis,* the ''human'' bot fly are laid on the abdomen of the adult female of this species. The larvæ crawl out of the shell while the adult mosquito is feeding. They are prevalent in the jungle at La Joya; several of the author's associates became infected with the larvæ of *Dermatobia* while in the jungle. (See Dunn, Psyche, 37: 327–342, 1930 for an account of *Dermatobia hominis* infection in man.) (Adults bite by day in the jungle—Dyar.)

Psorophora lutzi (Theobald)

Janthinosoma lutzi Theobald (nec Coquillett), Mon. Cul., 1: 257, 1907.

Janthinosoma champerico Dyar & Knab, Proc. Biol. Soc. Wash., 19: 134, 1906. (Probably syn. *lutzi* Theobald, *vide,* Dyar, Carnegie Ins. Wash., Pub. 387, 119, 1928.)

Distribution.—Tabernilla, Lion Hill, Alhajuela (Busck); Tabernilla (Jennings); Gatun, Fort Sherman (Zetek); Caño Saddle (Shannon); Barro Colorado Island, France Field (Dyar & Shannon); Caldera Island (Jennings); Trinidad River (Busck); Gamboa, La Joya, Salud (Author).

Habits and Habitats.—(Larvæ breed in transient rain pools—Dyar.)

Adults are common in horse traps. They are also taken biting by day in the jungle. (Adults in jungle, bite by day—Dyar.)

Subgenus *Grabhamia* Theobald

Psorophora confinnis (Lynch Arribalzaga)

Tæniorhynchus confinnis Lynch Arribalzaga, Rev. Mus. de la Platta, 2: 149, 1891.

Janthinosoma columbiæ Dyar & Knab, Proc. Biol. Soc. Wash., 19: 135, 1906. (Syn. *confinnis* L. Arrib., *vide,* Aiken, Rev. de Ent., 11: 677, 1940.)

Distribution.—Panama (Komp); Rio Abajo, Old Panama (Author).

Habits and Habitats.—The larvæ breed in hoofprints, small temporary pools and pasture marshes. It is collected in sunlight among grass in foul water.

Adults were not collected in the field. (Will bite humans—Dyar.)

This species is common during the rainy season.

Psorophora cyanescens (Coquillett)

Culex cyanescens Coquillett, Jour. N. Y. Ent. Soc., 10: 137, 1902.

Distribution.—La Chorrera (Author).

Habits and Habitats.—The adults were collected in a mangrove thicket, biting during the day. (Larvæ breed in transient rain pools—Dyar.)

In addition to the above species, the following which are unknown to the author are reported from Panama: *Psorophora cilipes* (Fabricius), and *P. cingulatus* (Fabricius).

Sabethini

Trichoprosopon Theobald

Trichoprosopon s. str.

Trichoprosopon digitatum (Rondani)

Culex digitatum Rondani, Baudi et Truqui, Studi Ent., 1: 109, 1848.

Trichoprosopon wilsoni Ludlow, Psyche, 24: 66, 1918. (Type Loc.: Las Cascadas, C. Z.) (Listed as syn. *digitatum* Rondani, *vide,* Dyar, Ins. Ins. Mens., 11: 175, 1923.)

Distribution.—Corozal, Barro Colorado Island (U.S.N.M.); Tabernilla (Busck); Bohio, Gatun (Jennings); Culebra, Fort Sherman (Zetek); Paraiso (Dunn); Ancon (Wilson); Majagual, Comacho, Torro Point (Shropshire); France Field (Baker); Upper Pequini River, Caldera Island (Jennings); Porto Bello (Busck); Colon, Panama (Dunn); Caldera Island, Caño Saddle, Erwin Island, Fort Davis (U.S.N.M.); La Chorrera, La Joya (Author).

Habits and Habitats.—The larvæ breed in coconut shells and in tin cans. They are predaceous and cannibalistic.

The eggs are laid singly at the edge of coconut shells or tin cans. (Coconut shells and bamboo, eggs in a boat-shaped mass —Dyar.) The author captured a female of this species in the act of egg laying. The eggs were deposited one at a time on the surface of water in a tin can. These eggs were brought back to the laboratory and reared. Individual rearings were made, the larval skins and pupal skins preserved with the adults, and in each case they proved to be *T. digitatum.* (14 days from egg to adults—Busck.) (Adults in bamboo woods, biting—Busck.) Common throughout the rainy season.

Trichoprosopon compressum Lutz

Trichoprosopon compressum Lutz, Imp. Med., 13: 151, 1905.

Joblotia trichorryes Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 206, 1907. (Type Loc.: Tabernilla, C. Z.) (Syn. *compressum* Lutz, *vide*, Stone, Rev. de Ent., 15: 338, 1944.)

Distribution—Tabernilla (Busck); La Chorrera (Author).

Habits and Habitats.—The larvæ breed in coconut shells. (Bamboo—Busck.) (The eggs are laid singly and float on the water—Busck.)

Adults have been captured on screens in the evening. (Adults bite—Busck.)

Subgenus *Hyloconops* Lutz

Trichoprosopon longipes (Fabricius)

Culex longipes Fabricius (nec Macquart, Theobald), Syst. Antliat., 34, 1805.

Lesticocampa ulopus Dyar & Knab, Proc. Biol. Soc. Wash., 19: 137, 1906. (Syn. *longipes* Fabricius, *vide,* Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 172, 1915.)

Lesticocampa culicivora Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 207, 1907. (Type Loc.: Tabernilla, C. Z.) (Syn. *longipes* Fabricius, *vide,* Dyar, Ins. Ins. Mens., 11: 124, 1923.)

Distribution.—Tabernilla, Lion Hill (Busck); Las Cascadas, Gorgona, San Pablo, Gatun (Jennings); Paraiso, Corozal (Zetek); Ancon, Empire (Dunn); Culebra (Army Medical Museum); Miraflores, Monte Lirio, La Pita, Camp Gaillard, Toro Point (Shropshire); Caño Saddle (Dyar & Shannon); Fort Clayton, Fort Davis (Baker); Boca del Toro (Osterhaut); David (Zetek); La Joya (Author).

Habits and Habitats.—The larvæ breed in the leaf bracts of "Skunk Cabbage." (Breed in red flowered Heliconia and leaf axils of *Calladium.* Predaceous on *Wyeomyia pseudopecten, W. ulcoma, W. chalcocephala* and *W. melanocephala.* Leaf of "*Monstera deliciosa*" and Heliconia—Busck.) (Larvæ feed on *Wyeomyia pseudopecten* and *ulcoma* in flower bracts of Heliconia—Dyar.)

Adults were not captured in the field.

In addition to these species, the following, which are unknown to the author are other *Trichoprosopon* reported from Panama:

Trichoprosopon digitatum var. *townsendi* Stone, *T. compressum* var. *mogilasium* Dyar & Knab, *T. espini* Martini, *T. magna* Theobald, *T. leucopus* Dyar & Knab and *T. lampropus* Dyar & Knab.

Wyeomyia Theobald

Wyeomyia s. str.

Wyeomyia scotinomus (Dyar & Knab)

Phoniomyia scotinomus Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 209, 1907. (Type Loc.: Canal Zone.)

Wyeomyia leucopisthopus Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 212, 1907. (Type Loc.: Tabernilla, C. Z.) (Syn. *scotinomus* Dyar & Knab, *vide,* Dyar & Shannon, Ins. Ins. Mens., 12: 88, 1924.)

Wyeomyia dymodora Dyar & Knab, Proc. U. S. Nat. Mus., 35: 68, 1908. (Type Loc.: Panama.) (Syn. *scotinomus* Dyar & Knab, *vide,* Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 158, 1915.)

Wyeomyia abrachys Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 263, 1909. (Type Loc.: Caldera Island, R. de P.) (Syn. *leucopisthepus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 173, 1923.)

Wyeomyia chesta Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 263, 1909. (Type Loc.: Tabernilla, C. Z.) (Syn. *leucopisthepus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 173, 1923.)

Wyeomyia hapla Dyar & Knab, Smith. Misc. Coll., Quar. Iss., 52: 265, 1908. (Type Loc.: Caldera Island, R. de P.) (Syn. *leucopisthepus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 173, 1923.)

Wyeomyia labesba Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 3: 106, 1915. (Type Loc.: Canal Zone.) (Syn. *leucopisthepus* Dyar & Knab, *vide,* Dyar Ins. Ins. Mens., 11: 173, 1923.)

Wyeomyia incana Dyar, Ins. Ins. Mens., 10: 189, 1922. (Type Loc.: Margarita, C. Z.) (Syn. *leucopisthepus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 173, 1923.)

Distribution.—Tabernilla (Busck); Ancon (Jennings); Bas Obispo, Gatun (Zetek); Empire (Dunn); Margarita, Majagual (Shropshire); Gamboa, Barro Colorado Island (Dyar & Shannon); Baoquaron River (Busck); Caldera Island, Coscojar River, Porto Bello (Jennings); Panama City (Dunn); Gamboa, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in bromeliads, both smooth and spiny-leaved species. (Wild Pineapple, *Tillandsia,* and spiny head, bromeliaceæ (*Aechmea steigera* Mart.)—Dyar.) Adults were not collected in the field. This species breeds during the rainy season and is common.

Wyeomyia celænocephala Dyar & Knab

Wyeomyia celænocephala Dyar & Knab, Proc. Biol. Soc. Wash., 19: 140, 1906.

Phoniomyia chrysomus Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 208, 1907. (Type Loc.: Tabernilla, C. Z.) (Listed as syn. *celænocephala* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 172, 1923.)

Phoniomyia philophone Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 209, 1907. (Type Loc.: Tabernilla, C. Z.) (Syn. *chrysomus* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 66, 1923.)

Wyeomyia megalodora Dyar & Knab, Proc. U. S. Nat. Mus., 35; 69, 1908. (Syn. *celænocephala* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 11: 172, 1923.)

Wyeomyia matœa Dyar & Knab, Proc. U. S. Nat. Mus., 35: 70, 1908. (Syn. *chrysomus* Dyar & Knab, *vide,* Dyar Ins. Ins. Mens., 7: 125, 1919.)

Distribution.—Tabernilla, Lion Hill (Busck); Gatun, Empire (Jennings); Majagual, Seco Hill (Shropshire); Mount Hope, Barro Colorado Island, Mindi (Dyar & Shannon); Caño Saddle (Shannon); Porto Bello (Jennings); David (Zetek); Tabago Island (Zetek, Busck and Jennings); Gamboa, Chiva Chiva, Fort Clayton, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in bromeliads. (*Tillandsia* species and *Aedines setigera*—Dyar. Flower bracts of *Heliconia*—Shannon; *Tillandsia*—Busck.) Adults were collected biting during the day. This species is collected during the rainy season.

Wyeomyia quasileoventralis (Theobald)

Dendromyia quasiluteoventralis Theobald, Mon. Cul., 3: 317, 1903.

Wyeomyia charimon Dyar, Carnegie Ins. Wash., Pub. 387, (addenda), 1928. (Listed as syn. *quasiluteoventralis* Theobald, *vide,* Lane & Cerqueira, Arq. Zool. Estado São Paulo, 3: 557, 1942.)

Distribution.—Gatun (Bath); La Chorrera (Author).

Habits and Habitats.—The larvæ breed in bromeliads and leaves of wild pineapple (*Ananas magdalenæ*).

Wyeomyia arthrostigma (Lutz)

Miamyia arthrostigma Lutz, Imp. Med., 13: 311, 1905.

Wyeomyia bromeliarum Dyar & Knab, Proc. Biol. Soc. Wash., 19: 138, 1906. (Syn, *arthrostigma* Lutz, *vide,* Lane & Cerqueira, Arq. Zool. Estado São Paulo, 3: 561, 1942.)

Wyeomyia espartana Dyar & Knab, Proc. Biol. Soc. Wash., 19: 140, 1906. (Syn. *bromeliarum* Dyar & Knab, *vide,* Dyar, Ins. Ins. Mens., 7: 122, 1919.)

Wyeomyia panamena Dyar & Knab, Jour. N. Y. Ent. Soc., 15: 210, 1907. (Type Loc.: Tabernilla, C. Z.) (Listed as syn. *bromeliarum* Dyar, Ins. Ins. Mens., 11: 174, 1923.)

Distribution.—Tabernilla (Busck); Gatun, Margarita (Shropshire); Ancon (Curry); Fort Davis, Corozal (Baker); Caldera Island (Jennings); Las Sabañas (Army Medical Museum); Chiva Chiva, Fort Clayton (Author).

Habits and Habitats.—The larvæ breed in bamboo joints and occasionally in tin cans. (Tree holes if foul—Dyar.) This species is common throughout the year.

Subgenus *Dendromyia* Theobald

Wyeomyia personata (Lutz)

Dendromyia personata Lutz (in Bourroul), Mos. Bras., 22, 1904.

Wyeomyia aporonoma Dyar & Knab, Jour. N. Y. Ent. Soc., 14: 230, 1906. (Syn. *personata* (Lutz), *vide,* Lane & Cerqueira, Arq. Zool. Estado São Paulo, 3: 602, 1942.)

Distribution.—Gatun (Busck); Tabernilla, Las Cascadas (Jennings); Paraiso, Fort Sherman (Dunn); Pedro Miguel

(Zetek); Fort Randolph, Cerro Gordo, Golden Green, West Culebra (Shropshire); Fort Clayton (Baker); Caldera Island (Jennings); Porto Bello (Busck); Chiva Chiva, Fort Clayton, Empire, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in bamboo joints, tree holes, coconut shells, and tin cans. Adults were captured while biting, during the day. This species breeds throughout the year and is common.

Wyeomyia pseudopecten Dyar & Knab

Wyeomyia pseudopecten Dyar & Knab, Proc. Biol. Soc. Wash., 19: 139, 1906.

Wyeomyia galoa Dyar & Knab, Proc. Biol. Soc. Wash., 19: 140, 1906. (Syn. *pseudopecten* Dyar & Knab, *vide,* Dyar & Shannon, Ins. Ins. Mens., 12: 86, 1924.)

Wyeomyia eloisa Howard, Dyar & Knab, Carnegie Ins. Wash., Pub. 159, 2, pl. 6, fig. 36, 1912.) (Listed as syn.? *pseudopecten* Dyar & Knab, *vide,* Lane & Cerqueira, Arq. Zool. Estado São Paulo, 3: 605, 1942.)

Distribution.—Culebra (Black); Miraflores, Tabernilla, Gatuneilla River (Jennings); Gatun (Dyar); Caño Saddle (Shannon); Gatuneilla River (Zetek); Colon (Chidester); Porto Bello (Shannon); Caldera Island (Jennings); Fort Clayton, Chiva Chiva (Author).

Habits and Habitats.—The larvæ breed in the leaf bases and flower bracts of *Heliconia.* (Larvæ can crawl up side of breeding glass—Dyar.)

Adults were not collected in the field. This is a common species during the rainy season.

Wyeomyia ulocoma (Theobald)

Dendromyia ulocoma Theobald, Mon. Cul., 3: 313, 1903.

Wyeomyia onidus Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 261, 1909. (Type Loc.: Tabernilla, C. Z.) (Syn. *ulocoma* Theobald, *vide,* Dyar & Shannon, Jour. Wash. Acad. Sci., 14: 482, 1924.)

Wyeomyia pantoia Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 265, 1909. (Type Loc.: Canal Zone.) (Syn. *ulo-*

coma Theobald, *vide,* Dyar, Ins. Ins. Mens., 7: 136, 1919.)
Wyeomyia cacodela Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 265, 1909. (Type Loc.: Canal Zone.) (Syn. *ulocoma* Theobald, *vide,* Dyar, Ins. Ins. Mens., 7: 136, 1919.)

Distribution.—Tabernilla (Busck); Gorgona, San Pablo (Jennings); Culebra (Zetek); Empire (Dyar); France Field Dyar & Shannon); Golden Green, Fort Davis (Baker); Porto Bello, Upper Pequini River (Jennings); Fort Clayton, Chiva Chiva (Author).

Habits and Habitats.—The larvæ breed in the flower bracts of *Heliconia.* There are several larvæ to a bract.

The adults were not collected in the field. This species is collected from August to October. It is uncommon.

Wyeomyia complosa (Dyar & Knab)

Dendromyia complosa Dyar, Carnegie Ins. Wash., Pub. 387, 74, 1928. (Type Loc.: San Juan de Pequini, R. de P.)

Distribution.—San Juan de Pequini (Curry); National Forest, La Joya (Author).

Habits and Habitats.—The larvæ breed in "Skunk Cabbage."

These species of *Wyeomyia* are all that are known to the author from Panama. The following have been reported also from Panama: *Wyeomyia melanopus* Dyar, *W. simmsi* Dyar & Knab, *W. guatemala* Dyar & Knab, *W. codiocampa* Dyar & Knab, *W. florestan* Dyar, *W. hosautus* Dyar & Knab, *W. autocratica* Dyar & Knab?, *W. ypsipola* Dyar, *W. melancephala* Dyar & Knab, *W. circumcincta* Dyar & Knab, *W. chalcocephala* Dyar & Knab, *W. phrosa* Howard, Dyar & Knab, *W. clasoleuca* Dyar & Knab, and *W. jocosa* Dyar & Knab.

Limatus Theobald

Limatus durhami Theobald

Limatus durhami Theobald, Mon. Cul., 2: 350, 1901.

Distribution.—Tabernilla (Busck); Ancon, Bas Obispo, Paraiso, Bohio (Jennings); Pedro Miguel, Fort Sherman (Dunn); Gatun, Toro Point, Mindi, Miraflores, Gold Hill, Cerro Gordo, Golden Green, Comacho, Culebra, Empire, Majagual (Shropshire); Caldera Island (Jennings); Colon, David

(Zetek); Chagres River (Busck); Empire, Chiva Chiva, Fort Clayton, Rio Abajo, La Chorrera, Old Panama (Author).

Habits and Habitats.—The larvæ breed in coconut shells, artificial containers, bamboo joints, and palm boats, either in sunlight or in shade. (Tree holes—Dyar; palm leaf, tin can, wooden barrel—Busck.)

(The adults fly by day in the forest and will occasionally bite man—Dyar.)

The larvæ are common throughout the year.

Limatus asullepta Theobald

Limatus asullepta Theobald, Mon. Cul., 3: 315, 1903.

Limatus methysticus Dyar & Knab, Smith. Misc. Colls., Quar. Iss., 52: 266, 1909. (Syn. *asullepta* Theobald, *vide*, Bonne-Wepster & Bonne, Ins. Ins. Mens., 9: 6, 1921.)

Distribution.—Fort Sherman, Corozal (Zetek); Gold Hill, Comacho, Empire, Cerro Gordo (Shropshire); Caño Saddle (Shannon); Barro Colorado Island (Dyar & Shannon); Caldera Island, Upper Pequini River (Jennings); Colon, David, Bella Vista (Zetek); Empire, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in artificial containers, coconut shells, and rock pools in the shade. (Tree holes, husks and bamboo—Dyar; palm spathe—Jennings.) The adults were not taken in trap collections. This species breeds throughout the rainy season and it is uncommon.

These are the only two *Limatus* species thus far recorded from Panama.

Sabethes Robineau-Desvoidy

Sabethes s. str.

Sabethes cyaneus (Fabricius)

Culex cyaneus Fabricius (nec Borroul.), Syst. Antliat., 35, 1805.

Sabethes locuples Robineau-Desvoidy, Mem. Soc. d'Hist. Nat. Paris, 3: 405, 412, 1827. (Syn. *cyaneus* Fabricius, *vide*, Knab, Proc. Ent. Soc. Wash., 11: 154, 1909.)

Distribution.—Empire (Simms, Shropshire); Gatun (Jennings); Tabernilla, Paraiso, Alajuela (Busck); Culebra (Trask); Corozal (Dunn); Fort Sherman (Shropshire); Caño Saddle (Sanders); Porto Bello (Schwartz); Rio Trinidad (Busck); Chiva Chiva, Fort Clayton, La Chorrera (Author).

Habits and Habitats.—The larvæ breed in tree holes. They are predaceous; laboratory reared specimens fed on *Aedes ægypti* larvæ. Unfortunately, larval skins of this species were destroyed. The larvæ are undescribed. The pupæ took seven days to emerge. (Larvæ in Spanish bayonet—Busck.) Adults were captured biting by day and flying in a building.

Subgenus *Sabethoides* Theobald

Sabethes undosus Coquillett

Sabethes undosus Coquillett, Proc. Ent. Soc. Wash., 7: 186, 1906.

Distribution.—Tabernilla, Lion Hill, Gatun (Busck); Tabernilla (Jennings); Porto Bello (Shannon); Fort Clayton (Author).

Habits and Habitats.—The larvæ breed in Bamboo, collected in bamboo joints with no other species. This species was bred in the laboratory and fed on *Aedes ægypti* larvæ. (Bamboo—Jennings, Busck; vegetable feeders—Dyar; predaceous—Busck.) (Adults bite in bamboo woods, diurnal—Busck.)

In addition to these two species, *Sabethes tarsopus* Dyar & Knab, *S. chloropterus* (Humboldt) and *S. aurescens* Lutz are also known from Panama.

This completes the discussion of the distribution, habits and habitats of the Panama Culicines.

(To be continued.)

THE INSECT MOTIF IN GLASS PAPERWEIGHTS

Among the various motifs depicted in old glass paperweights, one finds insects, usually butterflies. In "Old Glass Paperweights" by Evangeline H. Bergstrom, there are two colored illustrations of paperweights made in Baccarat, France. One figures a butterfly resting upon a flower and the other a butterfly within a circle of small conventionalized flowers. Another illustration shows a Bristol (England) paperweight containing a conventionalized butterfly on a sapphire blue background. The skill, workmanship, and artistry that went into the making of many of these old paperweights was of the highest, except apparently when it came to entomological subjects. In these the artistry disappeared. From an entomological viewpoint the two Baccarat butterflies do not resemble butterflies at all, in form, color or design. In this connection the craftsmen had paid but fleeting attention to real butterflies.—H. B. W.

CABBAGE WORMS CONJURED

According to Görres' "Historisch-Politische Blätter" for 1845 (Heft VII, p. 516) a man in Westphalia, whose garden was being eaten by worms, against which the ordinary remedies were useless, employed a professional conjurer who walked among the plants, muttering enchantments and touching them with a wand. These actions were made fun of by several workmen who were repairing the roof of a nearby stable and the conjurer threatened to send the worms up on the roof unless they left him in peace. This threat only increased their gayety which interfered with the work of the conjurer, who in retaliation went to the nearest hedge from which he cut some twigs. These he placed against the wall of the stable and soon the worms began to leave the plants and crawl up the twigs and the wall. In less than an hour the men had to stop work because they were covered with cabbage worms.—H. B. W.

RECORDS AND DESCRIPTIONS OF NEOTROPICAL CRANE FLIES (TIPULIDÆ: DIPTERA), XXIV

By CHARLES P. ALEXANDER

AMHERST, MASSACHUSETTS

The preceding part under this general title was published in this JOURNAL (vol. 56: 137–148; September 1948). The novelties described herewith are all from Peru where they were collected by my friends Messrs. José M. Schunke and Felix L. Woytkowski, the latter assisted by his son George. The types of the species are preserved in my personal collection of these flies.

Genus *Epiphragma* Osten Sacken

Epiphragma (Epiphragma) mithras new species.

Size small (wing, male, 9 mm. or less); præscutum conspicuously patterned, chiefly covered by a Y-shaped brown area, the sublateral parts yellowed; pleura yellow, striped longitudinally with brownish black; femora yellow, with a single brown subterminal ring; wings pale yellow, with a brown pattern that is partly ocelliform; basal half of cell *Cu* uniformly darkened; abdominal sternites conspicuously patterned with yellow and dark brown; outer dististyle terminating in a curved spine and with a subapical flange.

MALE.—Length about 7–8 mm.; wing 8–9 mm.; antenna about 1.8–2 mm.

FEMALE.—Length about 7.5–9 mm.; wing 7–9.5 mm.

Rostrum brown, palpi somewhat darker brown. Antennæ short, as shown by the measurements; scape and pedicel black, the former pruinose; basal flagellar segments yellow, including the fusion-segment, the outer segments deepening to yellowish brown; fusion segment involving three segments. Head fulvous orange, the center of vertex slightly more darkened.

Pronotum and cervical sclerites buffy above, blackened on sides. Mesonotal præscutum conspicuously patterned, chiefly covered by a dark brown Y-shaped area, the fork or cephalic portion more reddish brown, the sublateral parts yellowed, the color continued caudad onto the scutal lobes; posterior sclerites of notum chiefly dark brown, the central area of scutum and the scutellum sparsely yellow pollinose. Pleura obscure yellow, striped longitudinally with brownish black, the complete dorsal stripe extending from the cervical region to the postnotum, widened behind; ventral darkening best indicated on the coxae and meral region, on the latter variegated with paler. Halteres yellow. Legs with the coxæ blackened basally, as described, the tips broadly yellow; trochanters infuscated above, yellow on inner face; remainder of legs yellow, the femora with a single brown ring that is subequal to or a trifle wider than the pale tip. Wings with the ground pale yellow, the costal region more saturated; a conspicuous brown pattern that is in part ocelliform; pale costal interspaces very extensive; dark ocelli centering at origin of *Rs*, cord, outer end of cell *1st* M_2 and fork of M_{1+2}; incomplete ocelli at arculus and marginally at ends of veins R_5 to Cu_1, inclusive; dark marginal areas of radial field, except as noted, solid; more than the basal half of cell *Cu* uniformly darkened; outer end of cell *1st A* with three, cell *2nd A* with about six linear dashes, additional to those at ends of the veins; veins yellow in the ground portions, clear light yellow on cephalic third, brown in the patterned areas. Venation: Sc_2 longer than Sc_1, ending about opposite the fork of R_{2+3+4}; *Rs* square at origin; R_{2+3+4} subequal to either R_{1+2} or R_{2+3}; *m-cu* at near midlength of cell *1st* M_2.

Abdomen dark brown, narrowly paler at the impressed areas; sternites dark brown, conspicuously patterned with obscure yellow, on the intermediate segments including three areas, one basal and medial, the others apical in position; on the outer segments these areas increase in size and finally become confluent and more or less pruinose; hypopygium brownish yellow. Male hypopygium with the lobes of the tergite obtuse, narrower than the median notch. Interbase with the inner rod slender, the tip abruptly recurved into a spine. Membranous notch on mesal face of basistyle unusually deep and conspicuous. Outer dististyle terminating in a curved spine, with a flange on lower margin at base of spine. Inner dististyle longer, appearing as a flattened yellow paddle, the tip obtuse, on the disk with a group of five or six strong setae.

Habitat.—Peru.

Holotype, ♂, Chinchao, Huanuco, on wooded hills. altitude 2500 meters, September 20, 1947 (George Woytkowski). Allotopotype, ♀, September 21, 1947. Paratopotypes, 10 ♂ ♀, September 14–27, 1947.

This unusually small and attractive member of the genus is most similar to *Epiphragma* (*Epiphragma*) *jurator* Alexander, differing in the pattern of the body and wings and in the details of venation. The male of *jurator* is still unknown. The Tropical American species of the genus have been listed in a recent paper (Rev. de Ent., 19: 168–175, fig. 5; 1948).

Genus *Teucholabis* Osten Sacken

Teucholabis (Teucholabis) ludicra new species.

Allied to *perangusta;* head above yellow with a brownish black median stripe on vertex, terminating in a small more blackened tubercle on anterior vertex; thorax reddish, with a transverse girdle on the praescutum and anepisternum; femora yellow, with two narrow brown rings; wings whitish subhyaline, restrictedly patterned with brown, the apex narrowly darkened; male hypopygium with the apical lobe of basistyle unusually long and slender; appendage of style a gently curved rod that narrows gradually into a black terminal spine.

MALE.—Length about 10 mm.; wing 7 mm.

Rostrum darkened above, yellow on sides, about two-thirds as long as remainder of head; palpi black. Antennæ with scape yellow, pedicel brown, flagellum black; flagellar segments oval to long-oval, shorter than the verticils. Front light yellow, remainder of head somewhat deeper yellow; a brownish black median stripe on vertex, on the anterior vertex produced into a small, more intensely blackened tubercle.

Cervical region and pronotum dark liver brown. Mesonotal præscutum chiefly reddish, on either side with a transverse black line placed just behind the pseudosutural foveæ; remainder of notum reddish, each scutal lobe extensively blackened; both the mediotergite and pleurotergite with large brownish black areas. Pleura with central portion chiefly covered by a silvery gray bloom; anepisternum darkened, being a continuation of the præscutal darkened area; ventral pleurites more reddish. Halteres dark brown, the base of stem and apex of knob obscure yellow. Legs with the coxæ and trochanters yellow; femora yellow, each with two narrow brown rings, the outer one paler and subterminal in position; pale space between the dark rings four or five times as extensive as the basal dark ring; dark rings of posterior femora somewhat broader and darker; tibiae yellow, the tips narrowly pale brown; basitarsi yellow, the remaining tarsal segments brownish black; proximal fifth of posterior basitarsi dilated and provided with a linear glandular area. Wings whitish subhyaline, restrictedly patterned with pale brown, including the very narrow wing tip; a somewhat wider band at cord and a larger but more diffuse subbasal area; stigma darker brown; veins pale brown to brownish yellow, the latter including the costa. Venaton; Sc_1 ending about opposite three-fifths *Rs*, the branches of the latter parallel to one another for virtually their entire length; *m–cu* about one-fourth to one-fifth its length beyond the fork of *M*.

Abdomen yellow, the intermediate sternites with a pair of linear brown dashes, these diverging outwardly; basal sternites more extensively darkened. Sternal pockets on segments five and six well developed, particularly on the former, the more posterior setæ of the pocket thickened and strongly curved; pocket of sternite six including about a dozen powerful bristles on either side, the more cephalic ones smaller. Male hypopygium with the apical lobe of basistyle unusually long and slender, provided with numerous setæ, some of which are very long, subequal to or slightly longer than the lobe; appendage of basistyle a gently curved rod that gradually narrows into a black terminal spine, the lower face of the rod fringed with long yellow setæ; mesal flange of basistyle coarsely and irregularly crenate or serrate. Outer dististyle a simple darkened rod, provided along lower margin and near apex with long coarse setæ and a few microscopic serrulations. Inner dististyle with the usual apical blade narrow, terminating in a single point; the usual basal lobe of the style of unusual size, much larger than the blade, terminating in about four stout setæ, with a few other subterminal ones. Aedeagus at apex directed laterad into a slender blackened spine; lower face below apex slightly protuberant and provided with about 15 or 16 strong setæ.

Habitat.—Peru.

Holotype, ♂, Cerro Azul, Loreto, April 20, 1947 (José M. Schunke).

The most similar described species is *Teucholabis* (*Teucholabis*) *perangusta* Alexander, which has the pattern of the body, wings and legs somewhat the same. The present fly differs in the hypopygial characters, particularly the unusually slender apical lobe of the basistyle and the structure of the appendage of the latter. The Tropical American species of *Teucholabis* have been listed in a recent paper (Rev. de Ent., 17: 375–400, 14 figs., 1947).

Teucholabis (Teucholabis) lauta new species.

Mesonotal præscutum reddish yellow, with three brownish black areas; pleura yellow, conspicuously variegated with brownish black; anterior part of head black, the posterior portion abruptly yellow; femora yellow, the tips narrowly blackened; wings broad, pale yellow, very restrictedly patterned with brown, including a small spot at end of vein *2nd A*; abdomen bicolored, dark brown, the incisures yellow; male hypopygium with the appendage of basistyle short, broad-based; outer dististyle simple.

MALE.—Length about 7.5 mm.; wing 6.2 mm.

Rostrum, palpi and antennæ black; flagellar segments oval. Head in front black, the color continued onto the posterior vertex as far as the posterior border of eyes, the remainder of head behind abruptly yellow.

Pronotum light yellow, narrowly darkened on sides. Mesonotal præscutum reddish yellow, with three brownish black areas, the median one most extensive; lateral areas elongate, occupying the outer borders of the lateral stripes; humeral and lateral portions clearer yellow; scutal lobes reddish yellow, the central region clearer yellow, crossing the suture onto the præscutum, the lateral border of each lobe narrowly dark brown; scutellum light yellow, restrictedly darkened on either side; mediotergite yellow on anterior half but narrowly infuscated behind the scutellum, the posterior half more reddish brown. Pleura and pleurotergite pale yellow, variegated with brownish black, the most conspicuous area being a slightly broken dorsal stripe across the propleura, dorsal anepisternum, dorsal pteropleurite and the pleurotergite, the last paler; a further restricted darkening on the ventral sternopleurite. Halteres yellow. Legs with all coxæ and trochanters yellow; femora yellow, the tips narrowly blackened, the amount subequal on all legs, involving about the outer sixth of the posterior femora; tibiæ and basitarsi yellow, the tips more narrowly blackened, remainder of tarsi black; posterior basitarsi very feebly dilated on proximal fifth. Wings broad, pale cream yellow, very restrictedly patterned with brown, including the subcircular stigma and a very narrow seam over the cord, best indicated by a deepening in color of the veins; a much paler brown cloud near outer end of vein *2nd A* in cell *1st A;* veins yellow, darkened as described. Venation: *Sc* long, Sc_1 ending nearly opposite two-thirds the length of *Rs*, Sc_1 relatively long; branches of *Rs* parallel for most of their lengths, R_5 thence strongly deflected caudad, cell R_4 at margin approximately two-thirds of cell R_2; distal section of vein M_{1+2} arcuated at origin; *m–cu* more than one-half its length beyond the fork of *M*.

Abdomen conspicuously bicolored, the incisures, especially the apices of the segments, yellow, the remainder broadly dark brown; hypopygium yellow, the basistyles chiefly darkened. Sternites five to seven, inclusive, with glandular pockets, that on segment five largest and best developed, consisting of a patch of microscopic spinulæ interspersed with scattered strong setæ; on segments six and seven, the setæ are long and delicate, in more or less distinct longitudinal rows on either side of the broad median space. Male hypopygium with the appendage of basistyle apical in position, short, broad-based, with slightly less than the outer half narrowed into a straight black spine, the expanded portion with setæ; mesal flange inconspicuous. Outer dististyle a simple rod that is about twice as long as the appendage of basistyle, gradually narrowed to a short acute spine; surface of style with coarse setæ. Inner dististyle with the outer blade or beak produced into two unequal points, the outer one longest; lobe of style low, with three or four setæ, the longest apical. Aedeagus terminating in a stout black spine or lobe, oblique in position, the lower margin below the lobe with three long setæ.

Habitat.—Peru.

Holotype, ♂, Fundo Sinchono, Huanuco, altitude 1500 meters, August 8, 1947 (José M. Schunke).

The present fly is not closely allied to any of the species so far described. Superficially it suggests forms such as *Teucholabis* (*Teucholabis*) *mendax* Alexander, differing in all details of body coloration and in the structure of the male hypopygium.

Teucholabis (Teucholabis) lineipleura new species.

Mesonotum brownish yellow, the pleura conspicuously striped with black; rostrum yellow; femora obscure yellow, the tips blackened; wings with a strong brownish tinge, the prearcular and costal fields more whitened; branches of *Rs* generally parallel to one another, cell R_2 at margin being fully three times as extensive as cell R_4; male hypopygium with the appendage of basistyle subapical in position, a virtually straight spine that is fringed with conspicuous yellow setæ; outer dististyle a long sinuous simple rod provided with strong setæ, ædeagus terminating in a curved spine.

MALE.—Length about 5.3–5.5 mm.; wing 5.8–6.4 mm.

Rostrum yellow, of moderate length, approximately one-half the remainder of head; palpi brownish black. Antennæ black throughout; flagellar segments oval, shorter than the verticils. Head brownish black, opaque by a sparse pruinosity.

Cervical region and pronotum brownish yellow. Mesonotum almost uniformly brownish yellow, the præscutum with a median black stripe, most distinct on cephalic portion, narrowed or obsolete behind. Pleura with two black stripes, the long dorsal one extending from the propleura through the pleurotergite, the lower stripe occupying the ventral sternopleurite; intermediate region of pleura with a broad longitudinal yellow stripe, the surface more or less silvery, especially behind. Halteres infuscated. Legs with the coxæ and trochanters yellow; femora obscure yellow, clearer basally, the tips blackened, broadly and gradually so on the fore femora, narrowly on the middle and posterior legs; fore tibiæ and tarsi blackened; posterior tibiæ obscure yellow, the tips blackened; tarsi black, the posterior fourth of basitarsus weakly dilated. Wings with a strong brownish tinge, especially on the cells beyond the cord; prearcular and costal fields more whitened; stigma oval, dark brown; veins brown, paler brown in the basal part of wing. Venation: Sc long, Sc_1 ending about opposite two-thirds to three-fourths Rs, Sc_2 at near one-third the length of this vein; R_2 subequal to or longer than R_{2+3+4}; branches of Rs parallel to one another for virtually their whole length, slightly diverging at outer ends, cell R_2 from three to three and one-half times as extensive as cell R_4; *m–cu* about one-third its length beyond the fork of M.

Abdomen, including hypopygium, black, the proximal sternites a little paler. Sternal pocket of segment five concentrated on posterior half of segment, the more cephalic part comprised of a transverse band of strong setæ, directed caudad towards a transversely oval concentrated area near the posterior border; on sternite six with a longitudinal row of about 18 strong setæ on either side, with a transverse elongated glandular area near the posterior border of segment. Male hypopygium with the appendage of the basistyle subapical, on the mesal face opposite the smooth mesal flange, appearing as a long slender spine, subequal in length to the basistyle, virtually straight, the apical fourth narrowed into a black spine, the remainder yellow with a lateral fringe of yellow setæ. Outer dististyle a long sinuous rod, narrowed to the apical spine, the entire outer surface of style with strong scattered bristles. Inner dististyle with the beak terminating in two strong unequal spines; lateral lobe terminating in a microscopic point that is subtended by two strong bristles. Aedeagus flattened, terminating in a curved black spine, before apex with three pairs of setæ.

Habitat.—Peru.

Holotype, ♂, Fundo Sinchono, Huanuco, altitude 1500 meters, August 12, 1947 (José M. Schunke). Paratopotypes, 3 ♂♂.

The most similar species is *Teucholabis* (*Teucholabis*) *spinigera* Schiner, which differs in the coloration and especially in all details of structure of the male hypopygium.

Teucholabis (Teucholabis) perbasalis new species.

General coloration light brown, the pleura yellow with a conspicuous brownish black longitudinal stripe; rostrum black, relatively long; head dark brown; femora yellow, the tips narrowly blackened; wings subhyaline, the small oval stigma brown; abdomen bicolored, brown, the apices of the segments yellow; male hypopygium with the appendage of basistyle unusually proximal in position; outer dististyle with the main blade terminating in a single point.

MALE.—Length about 5.5 mm.; wing 4.6–4.8 mm.

Rostrum black, unusually long, subequal to the remainder of head; palpi black. Antennæ black throughout; flagellar segments oval, verticils long and conspicuous. Head dark brown or brownish black.

Cervical region dark brown. Pronotum above light brown, more darkened on sides. Mesonotum light brown, the pretergites yellow; scutellum somewhat clearer yellow. Pleura yellow with a conspicuous brownish black longitudinal stripe over the dorsal sclerites. Halteres uniformly brownish black. Legs with the coxæ and trochanters yellow; femora yellow, the tips narrowly blackened, the amount subequal on all legs, including about the distal eighth of the posterior femora; tibiæ obscure yellow, the tips more narrowly darkened; tarsi black; proximal third of basitarsus conspicuously dilated. Wings subhyaline, the small oval stigma brown; veins brown, more brownish yellow in the prearcular field. Venation: Sc_1 ending about opposite midlength of Rs, Sc_2 a short distance from its tip; branches of Rs nearly parallel for most of their length, R_5 thence diverging very strongly to the wing tip, cell R_4 at margin a little more extensive than cell R_2; m–cu approximately one-half its length beyond the fork of M.

Abdomen bicolored, brown, the apices of the segments more narrowly yellow; hypopygium yellow. Sternal pockets developed on segments five to seven, inclusive; on sternite five near posterior border with a darkened oval area, with further more scattered rows of microscopic papillæ but without a well-defined setal pattern; on sternites six and seven with relatively few stout setæ on either side of a wide median space. Male hypopygium with the appendage of basistyle unusually basal in position, appearing as a long sinuous rod arising just beyond base of mesal face of style, more cephalad than the low darkened mesal flange; appendage dilated on more than the basal half, provided at near midlength with relatively numerous long yellow setæ, the apical fourth narrowed into a blackened spine. Outer dististyle a stout simple rod with strong scattered setæ, the tip obtuse or with a very short and weak spine. Inner dististyle with the main blade or beak terminating in a single point; lobe of style with four apical and one further more basal seta. Aedeagus stout, apex truncated, the lower angle produced laterad into a short blackened obtuse point; four strong setæ beyond midlength of organ, with two weaker ones just back of tip. Proctiger with unusually long coarse setæ.

Habitat.—Peru.

Holotype, ♂, Pucallpa, Loreto, altitude 180 meters, March 22, 1947 (José M. Schunke). Paratopotype, ♂, March 9, 1947.

The most similar species include *Teucholabis* (*Teucholabis*) *pleuralis* Alexander and *T.* (*T.*) *lineipleura* new species, which likewise have the thoracic pleura distinctly striped. The present fly differs from all described species in the fauna by the unusually proximal position of the appendage of the basistyle, as described.

Teucholabis (Teucholabis) hera new species.

General coloration black, the scutellum broadly yellow; fore femora black, the middle and hind pairs brownish yellow with darkened tips; posterior tibia with a slight swelling before tip; wings with cells before cord very weakly darkened, beyond the cord more strongly so, especially the outer fourth of wing; male hypopygium with the appendage of basistyle a slender spine; outer dististyle distinctive, long and slender, the tip expanded into an elongate pointed head, on mesal face at near midlength with two unequal spines; ædeagus a stout straight pale rod, the apex obtuse.

Male.—Length about 6.5 mm.; wing 6.8 mm.

Rostrum black, about one-half as long as the remainder of head; palpi black. Antennæ black; flagellar segments oval, the more proximal ones somewhat more elongate. Head black.

Pronotum reddish yellow; pretergites and dorsopleural membrane clearer yellow. Præscutum and scutum polished black, the median region of latter and adjoining part of the præscutum obscure yellow; scutellum extensively light yellow, very narrowly darkened basally; postnotum black, the mediotergite sparsely pruinose. Pleura black, with a paler more silvery area extending from above the midcoxa, expanded behind. Halteres with stem infuscated, knob obscure yellow. Legs with the fore coxæ brown, the remaining coxæ black; trochanters obscure brownish yellow, darker at tips; fore legs black, only the femoral bases narrowly brightened; middle and hind femora brownish yellow, the tips brownish black, involving about the distal fifth or sixth; tarsi black; posterior tibia with a slight swelling before tip; posterior basitarsus weakly dilated on more than the proximal third. Wings with the cells before cord very weakly darkened, beyond the cord more strongly so, especially the outer fourth of wing; stigma oval, dark brown; a very narrow and ill-defined darkening over the anterior cord; prearcular cells restrictedly yellow; veins brown. Venation: *Sc* relatively long, Sc_1 ending about opposite three-fifths the length of *Rs*; R_{1+2} a trifle longer than R_2; branches of *Rs* extending nearly parallel to one another for virtually their entire lengths, cell R_4 only a little widened at margin; *m-cu* shortly beyond the fork of *M*.

Abdomen, including hypopygium, black. Sternal pocket of segment five triangular in outline, the point directed cephalad, the outer setæ directed inward; on sternite six with a row of about a dozen setæ on either side of the broad median area. Male hypopygium with the spine of basistyle subapical in position, slender, apparently with a smaller point at base. Outer dististyle of distinctive form, long and slender, the tip expanded into an elongate head, the extreme apex a spine; on mesal face at near midlength the style bears two unequal spines from a common base; proximal half of style dilated, provided with unusually long coarse setæ, the outer margin with microscopic serrulations. Inner dististyle with the outer blade or beak blackened, its apex microscopically roughened; setiferous lobe small and inconspicuous, provided with about three setæ. Aedeagus a stout straight pale rod, the apex obtuse.

Habitat.—Peru.

Holotype, ♂, Utcuyacu, Tarma, Junin, altitude 1600–3000 meters, February 10, 1945 (Felix Woytkowski).

The only generally similar described species is *Teucholabis* (*Teucholabis*) *ducalis* Alexander, which has the male hypopygium quite different in all details.

Genus *Gonomyia* Meigen

Gonomyia (Progonomyia) adela new species.

General coloration of mesonotum gray, the præscutum with three brown stripes; antennæ black, the proximal end of the first flagellar segment whitened; thoracic pleura striped with black and yellow; knob of halteres blackened; legs black; wings whitish subhyaline, with a heavy brown pattern; Sc_1 ending about opposite one-third the length of *Rs*.

FEMALE.—Length about 6.8 mm.; wing 7.5 mm.

Rostrum and palpi black. Antennæ relatively long for the female sex in this subgenus, black, the basal fourth of the first flagellar segment white; flagellar segments long-oval, a little shorter than the verticils. Front yellow; posterior portion of head dark gray, the anterior vertex extensively blackened, relatively broad, nearly four times the diameter of scape.

Pronotal scutum blackened in front, light brown behind; scutellum and anterior pretergites whitened. Mesonotal præscutum gray, with three brown stripes that are more or less confluent behind, extended laterad along the suture; pseudosutural foveæ black, humeral region yellow, the lateral præscutal border more obscure yellow; scutum brownish yellow, the lobes variegated with brown; scutellum reddish brown, parascutella more blackened; mediotergite black, the lateral borders of cephalic half conspicuously light yellow; pleurotergite black ventrally, the dorsal half testaceous yellow. Pleura striped with black and yellow, the conspicuous black dorsal stripe extending from the cervical region to the abdomen, more widened behind; ventrad of this a slightly narrower yellow stripe, beginning behind the fore coxæ, passing beneath the halteres; ventral sternopleurite black, pruinose. Halteres with stem light yellow, knob blackened. Legs with the coxæ brownish black, the tips restrictedly yellow, the surface pruinose; trochanters and remainder of legs black throughout. Wings with the ground color whitish subhyaline, with an unusually heavy brown pattern, as follows: A postarcular area in bases of cells *R* and *M;* a major cloud at origin of *Rs,* not quite reaching vein *M* behind; broad seams over cord; spots at outer fork of *M* and near outer ends of veins *Cu* and *2nd A;* further diffuse clouds or washes in cell *M* and in centers of cells *1st A* and *2nd A;* veins dark brown. Venation; Sc_1 ending about opposite one-third the length of *Rs,* Sc_2 a short distance beyond this origin; R_{3+4} present, about one-third vein R_2 alone; veins R_3 and R_4 divergent, nearly straight; outer fork of *M* with a spur backward from the point of angulation of *m* and outer section of vein M_3; *m–cu* just before or close to fork of *M.*

Abdomen black, the pleural membrane yellow; genital shield blackened.

Habitat.—Peru.

Holotype, ♀, Chinchao, Huanuco, on wooded hills, altitude 2500 meters, September 20, 1947 (George Woytkowski).

Among the relatively few described species of the subgenus having patterned wings, the present fly is closest to *Gonomyia* (*Progonomyia*) *paramœnsis* Alexander and *G.* (*P.*) *velutina* Alexander, especially the former. It differs in the distinctive body coloration and in the unusually heavy pattern of the wings. The Tropical American species of *Gonomyia* have been listed in a recent paper (Rev. de Ent., 18: 83–99, figs. 17–29; 1947).

Gonomyia (Lipophleps) troilus new species.

Belongs to the *manca* group; rostrum yellow; general coloration of mesonotum light brown; thoracic pleura reddish brown, variegated with yellow; legs brown; wings with a dusky tinge, the stigma a trifle darker; male hypopygium with the outer angle of basistyle produced into a stout sinuous spine, its outer third setuliferous; dististyle single, elongate; ædeagus elongate, very slender, at apex dilated into a small blade.

Male.—Length about 3.2 mm.; wing 3.8 mm.

Rostrum yellow; palpi dark brown. Antennæ black; flagellar verticils very long. Head fulvous orange, vaguely patterned medially behind with brown.

Pronotum and pretergites whitish yellow. Mesonotal præscutum almost uniformly light brown, restrictedly darkened in front; scutal lobes light brown, the median region obscure yellow; scutellum weakly infuscated at base, the posterior border obscure yellow; mediotergite light brown, the sides, with the pleurotergite, whitish. Pleura reddish brown, the propleura and a ventral stripe from behind the fore coxæ yellow, extended backward to the base of abdomen. Halteres infuscated. Legs with the coxæ testaceous, the fore pair darker; trochanters testaceous; remainder of legs brown. Wings with a dusky tinge, the stigma a very little darker; prearcular and costal fields yellow; veins pale brown. Venation: Sc_1 ending a distance before origin of *Rs* about equal to three-fourths the length of the latter; cell *1st* M_2 conspicuously widened at outer end; *m–cu* at or close to fork of *M*.

Abdomen brown, hypopygium more yellowed. Male hypopygium with the basistyle relatively small, the outer apical angle produced caudad into a long sinuous spine that narrows very gradually into an acute blackened point; outer third or more of spine with abundant microscopic setulæ. Dististyle single, subterminal in position, a little more than one-half as long as the spine of the basistyle, the extreme tip slightly pointed; two fasciculate setæ near apex, the more basal one stouter. Aedeagus elongate, slender, broad at base, the apex dilated into a small blade.

Habitat.—Peru.

Holotype, ♂, Utcuyacu, Tarma, Junin, altitude 1600–3000 meters, February 11, 1947 (Felix Woytkowski).

The most similar described species include *Gonomyia* (*Lipophleps*) *orthomera* Alexander, *G* (*L.*) *reyesi* Alexander, and others, all of which differ evidently in the structure of the male hypopygium.

Gonomyia (Lipophleps) tersa new species.

Belongs to the *manca* group; pleura pale brown, the silvery stripe well indicated; Sc_1 ending opposite or immediately beyond the origin of *Rs*, Sc_2 removed from its tip; male hypopygium with the apical lobe of basistyle nearly equal in length to the main body of style, provided with long setæ; dististyles of the two sides asymmetrical, one with two blackened points, the other with three such points or spines; phallosome asymmetrical, provided with two blackened spines and other projections.

Male.—Length about 3.5 mm.; wing 3.7 mm.

Rostrum obscure yellow; palpi black. Antennæ black, the elongate flagellar segments provided with a dense erect pale pubescence of unusual length, additional to the scattered verticils. Head above variegated with dark brown and obscure yellow.

Thorax almost uniformly dark plumbeous; median region of scutum and the scutellum obscure yellow, the latter more darkened basally; mediotergite obscure yellow, restrictedly darkened on posterior portion; pleurotergite obscure yellow. Pleura pale brown with a broad more silvery gray stripe that widens posteriorly. Halteres infuscated, the base of stem restrictedly yellow. Legs with coxæ and trochanters yellow; remainder of legs brown. Wings with a weak brown tinge, the prearcular and costal fields more whitened; stigma a little darker than the ground, inconspicuous; veins brown. Venation: Sc_1 ending opposite or immediately beyond the origin of *Rs*, Sc_2 some distance from its tip, Sc_1 alone subequal to *m–cu;* branches of *Rs* divergent, more strongly so one the outer half, cell R_4 at margin approximately three times cell R_2; *m–cu* shortly before the fork of *M.*

Abdomen dark brown, the hypopygium somewhat paler. Male hypopygium with the apical lobe of basistyle nearly as long as the main body, provided with unusually long setæ, especially on the outer portion. Dististyles of the two sides asymmetrical, one with two short blackened spines, the other with an additional elongate spine; fasciculate bristles not or poorly differentiated. Phallosome asymmetrical, with two blackened spines, the longest a curved sickle from an enlarged setuliferous disk, besides the blackened point with a slender elongate pale rod; main body of phallosome flattened, the truncated apex at lower angle produced into a simple pale spinous point.

Habitat.—Peru.

Holotype, ♂, Pucallpa, Loreto, altitude 180 meters, March 16, 1947 (José M. Schunke).

There are rather numerous species of the group in Tropical America that have the male hypopygium of this general type, that is, with an elongate fleshy apical lobe on the basistyle and with the phallosome asymmetrical. Such forms include *Gonomyia* (*Lipophleps*) *anduzeana* Alexander, *G.* (*L.*) *dotata* Alexander, *G.* (*L.*) *lustralis* Alexander, *G.* (*L.*) *macswaini* Alexander, *G.* (*L.*) *petronis* Alexander, *G.* (*L.*) *philomela* Alexander, *G.* (*L.*) *ramus* Alexander, and others, all differing among themselves in the structure of the male hypopygium. *G.* (*L.*) *carrerai* Alexander falls in a different subgroup but has the dististyles on the two sides of the hypopygium even more dissimilar than is the case in the various forms so far described. Of the species above listed, some have symmetrical dististyles while others have these modified and differing from one another in various degrees.

Gonomyia (Lipophleps) vehemens new species.

Belongs to the *manca* group; general coloration of thorax medium brown, the pleura more reddish brown with a poorly indicated pale longitudinal stripe; male hypopygium with the outer apical angle of basistyle produced caudad into a long fleshy lobe; dististyles of the two sides symmetrical, bilobed, the outer lobe a blackened spine; phallosome consisting of blades and spinous points from a bell-shaped base.

MALE.—Length about 3.5 mm.; wing 4.2 mm.

Rostrum and palpi black. Antennæ black, relatively long, if bent backward extending approximately to the wing root; more proximal flagellar segments elongate, the four outer ones short; verticils of the elongate segments of unusual length. Head above obscure orange to yellow, the posterior vertex extensively gray.

Pronotum and pretergites pale yellowish white. Mesonotal præscutum and scutal lobes medium brown; median region of scutum, posterior ends of scutal lobes and the broad posterior border of the scutellum obscure yellow; mediotergite weakly darkened. Pleura pale reddish brown with a poorly indicated longitudinal pale stripe. Halteres infuscated. Legs with the coxæ pale reddish brown; trochanters obscure yellow; remainder of legs dark brown. Wings with a brownish tinge, the stigma barely darker; prearcular and costal fields pale yellow; veins brown, those in the yellow fields paler. Venation: Sc_1 endng opposite origin of *Rs*, Sc_1 subequal in length to vein *m; Rs* nearly as long as its anterior branch; *m–cu* a short distance before the fork of *M*.

Abdomen brown; hypopygium brownish yellow. Male hypopygium with the outer apical angle of basistyle produced caudad into a stout fleshy lobe that is subequal in length to the remainder of style; lobe obtuse, provided with relatively few but very long stout setæ. Dististyles of the two sides symmetrical, conspicuously bilobed, the outer lobe a blackened spine, the subequal inner lobe a little broader, its tip narrowly blackened, obtuse, and provided with microscopic setulæ; face of inner lobe with several strong erect setæ; a single fasciculate bristle before the blackened tip. Phallosome large, from a bell-shaped or calyx-like base, produced into two flattened, slightly divergent blades, with a shorter heavily blackened bispinous structure at their base; an additional more slender pale rod arising from the apex of the calyx.

Habitat.—Peru.

Holotype, ♂, Utcuyacu, Tarma, Junin, altitude 1600–3000 meters, February, 9, 1948 (Felix Woytkowski).

The present fly is most similar to species such as *Gonomyia* (*Lipophleps*) *vindex* Alexander, differing from this and all other regional members of the subgenus in the structure of the male hypopygium.

Sir John Maundevile's Ants

Sir John Maundevile's "Boke of Trauels," which was popular during the fourteenth and fifteenth centuries contains some amazing statements about remote kingdoms, giants, pygmies, animals and people, and hundreds of editions and versions have appeared in various languages. According to Maundevile, on the island of Taprobane, toward the eastern part of Prester John's Land, there were hills of gold kept by ants as large as hounds. These ants refined the gold and devoured people who came to the hills. However some men outwitted these giant ants. When the weather was hot and when the ants were resting in the earth the country folk would take camels, horses and other beasts and carry off the gold while the ants were in the earth. At other times when the weather was not hot and when the ants were abroad, some people would load mares with wide-mouthed, empty, low-hanging vessels, and send them forth to pasture in the fields. When the ants saw the vessels, their instinct being to allow nothing to remain empty, they would fill them up with anything nearby and in this case it was gold. The ants would tolerate all animals except man. Some scholars claim that Maundevile never existed, or that if he did, he was a collossal borrower and liar. Others believe that his book was a compilation by a physician of Liège named Jehan de Bourgogne who borrowed freely from the works of early geographers and added the results of his imagination.—H. B. W.

THE OLD WORLD MEMBRACIDÆ

BY FREDERIC W. GODING

(Continued from Vol. LVII, p. 192)

14(13). Indigo black, no median carina on metopidium, suprahumerals substraight, posterior process impinging upon scutellum; tegmina almost colorless, base, costal and radial cells, and apical area piceus; 8–8.5 × 6–6.5 mm. .... **obesus**

15(12). Suprahumerals broad, sides parallel, tips obtuse almost roundly truncate; pronotum bluish black.

16(17). Tips of suprahumerals slightly curved upwardly and recurved; tegmina pale yellow, base and costal cell black, apical area bronze brown; 10 × 7 mm. .... **perarmatus**

17(16). Tips of suprahumerals straight or slightly decurved; tegmina lurid, base and costal margin piceous, apical margin partly colorless, tarsi ferruginous; 8 × 5.5 mm. .... **malleolus**

18(11). Black, strongly bulbously elevated, seen from front broadened upwardly, inferior margin of suprahumerals distant from eyes tips acute, posterior process not touching tegmina; tegmina smoky hyaline, base black, costal and apical areas reddish bordered with brown; 10 × 7.2 mm. .... **bulbifer**

LIST OF SPECIES

bakeri Funkhouser, Phil. Jour. Sci. x, p. 381, pl. 1, fig. 7. (1915). Iligan, Mindanao, Philippines.

occidentalis Goding, Mon. Aust. Memb. p. 27. (1903). Swan R., West Australia.

ansatus Buckton, Mon. Memb. p. 239, pl. 54, fig. 7. (1903). Mt. Alexander, New Guinea.

bicornis Funkhouser, Rec. Aust. Mus. xv, p. 305, pl. 26, figs. 1, 2. (1927). Elanagora, Koitaki, British New Guinea.

rugosus Funkhouser, Phil. Jour. Sci. xxxiii, p. 111, pl. 2, figs. 7, 8. (1927). Sibuyan Is., Philippines.

globosus Funkhouser, Phil. Jour. Sci. xviii, p. 683, pl. 1, figs. 5, 6. (1921). Dapitan, Mindanao, Philippines.

agnatus Distant, Ann. Mag. N. H. xvii, p. 319. (1916). Chantaboun, Siam.

obesus Fairmaire, Rev. Memb. p. 518. (1846). Java.

malleator Walker, List Hom. B. M. p. 612. (1851). Java.

malleus Walker, List Hom. B. M. p. 613. (1851); Distant, Faun. Brit. Ind. iv, p. 37, fig. 29. (1908); Funkhouser, Biol. Memb. pl. 34, fig. 12. (1917). Kalutara, Ceylon; Castle Rock, N. Kanara, Bombay, India.

tumescens Buckton, Mon. Memb. p. 256, pl. 59, fig. 6. (1903). Samarang, Java.

perarmatus Distant, Faun. Brit. Ind. vi, App. p. 156, fig. 114. (1916). Trichur, Cochin State, British India.

malleolus Walker, List Hom. B. M. p. 614. (1851). Java.

bulbifer Funkhouser, Bul. Brook. Ent. Soc. xxii, p. 106, pl. 6, figs. 1–3. (1927). Lubuksikaping, Sumatra.

Crito

Distant, Ann. Mag. N. H. xviii, p. 43. (1916); *Acanthuchus* Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. Bul. 111, p. 89. (1907), part.

KEY TO SPECIES

1(6). Suprahumerals horizontal, very short.

2(5). Tegmina pale yellow hyaline, base, costal and radial cells darker.

3(4). Brown, head, body, base of metopidium, median carina, and apex of posterior process black, the latter tectiform from middle of pronotal disk and slightly shorter than tegmina; ocelli nearer to eyes; 3–5 × 1.2 mm. .... **minutus**

4(3). Entirely fuscous, posterior process long as tegmina; ocelli equidistant; 4 × 2 mm. .... **interpositus**

5(2). Tegmina bronze subhyaline, apical third pale brown, apical margin purplish brown; piceous, legs pale ochraceous, tips suprahumerals acute, posterior process shorter than tegmina; ocelli equidistant; 5–6 × 3 mm. .... **festivus**

6(1). Suprahumerals moderately oblique, some longer, posterior process long as tegmina; reddish piceous, legs yellow ferruginous; tegmina ferruginous; ocelli slightly nearer to eyes; 5–6 mm. .... **iasis**

LIST OF SPECIES

minutus Goding, Mon. Aust. Memb. p. 28. (1903). Mosman's Bay, Clarence R., Tamworth, N. S. W.; South Australia.

euryone Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. Bul. 111, p. 90. (1907). N. S. W., Australia.

eurynomus Kirkaldy, ibid. p. 91. (1907). Bundaberg, Queensland, Australia.

bispinus Kirkaldy, ibid. p. 91. (1907). Cairns, Brisbane, Queensland, Australia.

interpositus Buckton, (♂), Mon. Memb. p. 231, pl. 52, fig. 1a. (1903). Adelaide, S. Australia.

festivus Distant, Ann. Mag. N. H. xviii, p. 43. (1916). Queensland, Australia.

interpositus Buckton, (♀), Mon. Memb. p. 231, pl. 52, fig. 1. (1903). Adelaide, S. Australia.

iasis Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. Bul. 111, p. 90. (1907). Kuranda, Cairns, Queensland, Australia.

Acanthusus

Stål, Hemip. Afric. iv, p. 87. (1866); *Acanthusus* Distant, Ann. Mag. N. H. xviii, p. 27. (1916).

KEY TO SPECIES

1(8). Suprahumerals directed more or less forward and oblique.

2(7). Posterior process shorter than tegmina; suprahumerals slightly inclined forward.

3(6). Posterior process straight apical half strongly decurved; not pubescent.

4(5). Greenish brown, rugose; suprahumerals straight, median carina foliaceous behind them, posterior process nearly long as tegmina; tegmina vinaceous hyaline, base and costal area yellow, opaque; 5.4 × 3 mm. .... **carinatus**

5(4). Ferruginous, legs yellow; suprahumerals lightly recurved, median carina angulate behind them, posterior process slightly longer than clavus; tegmina sordid hyaline, base, costa and apical spot ferruginous; 5 × 2.5 mm. .... **conspurcatus**

6(3). Posterior process strongly sinuate, almost long as tegmina, middle of dorsum bright yellow, apical third piceous brown, decurved; ferruginous, suprahumerals piceous brown, tips depressed; tegmina pale vinaceous hyaline, broad base and costal margin opaque dark ferruginous; 5 × 2.5 mm. .... **flavidorsus**

7(2). Head broader than long, strongly recurved below the eyes, base arched, brown, finely punctate; eyes pale yellow, globular, very prominent; ocelli vitreous, slightly nearer to and just above a line through center of eyes; margins of genæ sinuate, small lobule each side of clypeus which is long, narrow, tip rounded, well extended beneath. Pronotum piceous brown, finely punctate, not pubescent, median carina strongly percurrent; metopidium vertical; humerals large, prominent; suprahumerals medium, tricarinate, flat, obliquely porrect, compressed, base broad, gradually acuminate, tips curved outwardly, transversely carinate, acute; posterior process slender, unicarinate, impinging upon the scutellum, a slight rounded dorsal node at base, straight, apical third testaceous, strongly decurved, longer than tegmina. Sides of scutellum exposed. Tegmina two and a half times longer than broad, finely wrinkled, vinaceous subhyaline, basal third and costal area dark brown, opaque, punctate, two unequal discoidal and five apical cells their veins oblique, apical angle acute; clavus slightly narrowed to obtuse apex, two veins the exterior vein curved to inner margin behind middle. Wings with four apical cells. Sides of chest and abdomen beneath densely white tomentose, legs simple, tibiæ and tarsi yellow. Type, female; long. 6, lat. int. sum. corn. 3 mm. (*Tepper*). Coll. F. W. G. .... **proclivus**, new species

8(1). Suprahumerals transversely oblique or subhorizontal, not inclined forward.

9(18). Suprahumerals oblique, posterior process reaching or passing apex of clavus.

10(17). Dorsum of pronotum with one elevation on median carina, erect, angular or foliaceous, just behind suprahumerals.

11(16). Suprahumerals long as the intervening space.

12(15). Dorsal crest triangular, size variable, base broad as high, suprahumerals recurved; pubescent, legs ferruginous.

13(14). Yellow brown; ocelli near eyes; dorsal very large, much higher than tips of suprahumerals, gradually passing into the posterior process, the latter thick, heavy, tip lightly decurved; tegmina hyaline, base opaque brown; 7 × 4 mm. ... **pyramidatus**

14(13). Black; ocelli equidistant; dorsal crest very small, high as tips of suprahumerals, posterior process straight, slender, thickest at middle, tip lightly elevated; tegmina smoky hyaline, extreme base opaque; 7.5 × 3.5 mm. .... **minutispinus**

15(12). Dorsal crest moderately long, slender, erect, tips suprahumerals decurved, posterior process distinctly sinuate, apical area decurved; pronotum ferruginous; tegmina hyaline, base and tips ferruginous; 5.5 × 2.5 mm. .... **gracilispinus**

16(11). Suprahumerals less than half as long as the intervening space, dorsal crest a very small foliaceous elevation of median carina, posterior process slightly separated from the scutellum, strongly sinuate, apical are decurved; ocelli nearer to eyes; reddish brown, distal half of tibiæ whitish yellow; tegmina hyaline, basal third, irregular transverse fascia beyond middle and apical angle brown; 6 × 2 mm. .... **brevicornis**, new species

17(10). Dorsum of posterior process with two high acute erect spines, one behind suprahumerals, another at middle; ferruginous, tips of suprahumerals black, abdomen reddish or yellowish; tegmina pale tawny; 6 × 4 mm. .... **rufiventris**

18(9). Suprahumerals subhorizontal, median carina with one elevation, foliaceous, angulate or produced in a spine just behind bases of suprahumerals.

19(22). Posterior process almost as long as tegmina, dorsum gibbously elevated in a rather large compressed crest, basal area concave, apical half convex; suprahumerals long as the intervening space; ocelli equidistant.

20(21). Piceous, thickly pilose; suprahumerals with tips recurved; tegmina bronze, base and costal area piceous, pilose; 3.5–4 × 2.5–3 mm. **nivialis**

21(20). Reddish ochraceous, posterior process nearly to tip testaceous, tibiæ and tarsi stramineous, median carina in front and margins suprahumerals black; tegmina bronze brown, subapical costal spot and larger apical spot stramineous; 4 × 2.5 mm. **festivus**

22(19). Apex of posterior process reaching or slightly passing apex of clavus, much shorter than tegmina, veins to apical cells irregularly curved.

23(26). Dorsal crest a slightly foliaceous or angular elevation of the median carina, not produced in a spine; suprahumerals very short.

24(25). Median carina elevated behind suprahumerals in a slight foliaceous crest, posterior process slightly sinuate; 4.5–5 × 2.5–3 mm. **bispinus**

25(24). Median carina elevated behind suprahumerals in a small obtuse angle, posterior process strongly sinuate; piceous brown, yellow pubescent; ocelli near base and nearer to eyes; exterior discoidal cell almost touching costa; 3.5–4 × 1–1.5 mm. .... **kershawi**

26(23). Dorsal crest elevated in a strong acute spine; tips of suprahumerals recurved, lightly depressed, posterior process strongly sinuate; tegmina hyaline, base ferruginous; ferruginous brown; 6 × 3 mm. .... **trispinifer**

LIST OF SPECIES

carinatus Funkhouser, Rec. Aust. Mus. xv, p. 311, pl. 26, fig. 15. (1927). South Australia.

conspurcatus Stål, Bid. Memb. K. p. 288. (1869). West Australia; Tweed R., Blue Mts., N. S. W.; Mt. Wellington, Huon R., Tasmania; Victoria; South Australia.

flavidorsus Goding, Jour. N. Y. Ent. Soc. xxxiv, p. 244. (1926). Tweed R., N. S. W., Australia.

proclivus Goding, in this paper, supra, new species. South Australia.

pyramidatus Funkhouser, Rec. Aust. Mus. xv, p. 310, pl. 26, figs. 13, 14. (1927). Wedge Bay, Tasmania.

minutispinus Funkhouser, Rec. Ind. Mus. xxiv, p. 323, pl. 10, fig. 1. (1922). Sureil, Darjiling, E. Himalayas, India.

gracilispinus Stål, Bid. Memb. K. p. 289. (1869). Victoria; Tweed R., Clarence R., N. S. W.; North Australia; South Australia; Bunbury, W. Australia.

brevicornis Goding, in this paper, supra, new species. Bruni Is., Tasmania.
trispinifer Goding, Mon. Aust. Memb. p. 15. (1903), part. Bruni Is., Tasmania.

rufiventris Walker, List Hom. B. M. p. 616. (1851).; Goding, Mon. Aust. Memb. p. 14, pl. 1, fig. 13. (1903). Morton Bay, Queensland; S. Australia.

nivialis Distant, Ann. Mag. N. H. xviii, p. 28. (1916). Kuranda, Brisbane, Queensland, Australia.

festivus Distant, Ann, Mag. N. H. xviii, p. 28. (1916). Queensland, Australia.

bispinus Stål, Bid. Memb. K. p. 288. (1869). Homebush, Sydney, Tweed R., Clermont, Maitland, Mittagong, Richmond R., N. S. W.; Geraldton, Pinjarran, Swan R., W. Australia; Largs Bay, N. Mecklenburg, S. Australia; Victoria; Tasmania.

obtusus Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. ix, p. 377. (1906). Sydney, N. S. W., Australia.

kershawi Goding, Mon. Aust. Memb. p. 17. (1903). Thornleigh, Blue Mts., N. S. W., Australia.

dromedarius Kirkaldy, Rept. Exp. Sta. Haw. S. P. Assoc. iv, p. 377. (1906). Cairns, Brisbane, Queensland, Australia.

trispinifer Fairmaire, Rev. Memb. p. 515, pl. 7, fig. 35. (1846); Goding, Mon. Aust. Memb. p. 15, pl. 1, fig. 7. (1903), part; Buckton, Mon. Memb. p. 250, pl. 57, fig. 2. (1903). New Holland; Huon R., Hobart, Mt. Wellington, Tasmania; Tweed R., Gloucester, N. S. W.; Victoria; S. Australia.

Sertorius

Stål, Hemip. Afric. iv, p. 88. (1866).

KEY TO SPECIES

1(6). Posterior process as long or almost as long as tegmina, the latter vinaceous hyaline.

2(5). Costal area of tegmina concolorous hyaline; tips of suprahumerals acute, recurved.

3(4). Posterior process long as tegmina, substraight, apical half abruptly narrowed, decurved; piceous black, legs ferruginous, tarsi piceous; female with brown spot near apex of clavus; 6–7 × 4–3 mm. **australis**

4(3). Posterior process shorter than tegmina, gradually acuminate from base, suprahumerals more slender and longer; entirely castaneous; 8 × 4.5 mm. .... **castaneeus**

5(2). Tegmina subhyaline base and basal half of costal and radial cells black; tips suprahumerals recurved, obtuse, posterior process a little shorter than tegmina; black, legs piceous; 6 × 3 mm. **insularis**

6(1). Posterior process extended to or slightly beyond apex of clavus, much shorter than tegmina, apical half abruptly slender, decurved.

7(8). Base of posterior process straight; black, legs ferruginous; tegmina cinerous vitreous, base piceous; 7 × 3 mm. .... **obstans**

8(7). Base of posterior process slightly convex above scutellum; black, legs yellowish; tegmina vitreous; 8 × 4.75 mm. .... **hospes**

(to be continued)

INDEX TO NAMES OF INSECTS AND PLANTS IN VOLUME LVII

Generic names begin with capital letters. New genera, subgenera, species, varieties and new names are printed in italics.

JOURNAL

of the

NEW YORK ENTOMOLOGICAL SOCIETY

Published quarterly by the Society at N. Queen St., and McGovern Ave., Lancaster, Pa. All communications relating to manuscript for the Journal should be sent to the Editor, Harry B. Weiss, 19 N. 7th Ave., Highland Park, New Jersey; all subscriptions to the Treasurer, David Bigelow, American Museum of Natural History, New York 24, N. Y. Orders for back issues should be sent to the Treasurer, David Bigelow, American Museum of Natural History, New York 24, N. Y. The society has a complete file of back issues in stock. The Society will not be responsible for lost Journals if not notified immediately of change of address. We do not exchange publications.

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Organized June 29, 1892—Incorporated February 25, 1893

Reincorporated February 17, 1943

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