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ENTOMOLOGICAL SERIES, No. 4

NEOTROPICAL MAYFLIES

By

JAMES G. NEEDHAM and HELEN E. MURPHY

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# NEOTROPICAL MAYFLIES

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JAMES G. NEEDHAM and HELEN E. MURPHY

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This paper is based on collections made by the Cornell University Entomological Expedition to South America of 1919-20; also on other collections made by Alfred E. Emerson at the Tropical Research Station of the New York Zoological Society at Kartabo in British Guiana; by E. B. Williamson in Guatemala and in Colombia; and by H. S. Parish mostly near Pará in Brazil. It includes a summary of the known ephemeropterid fauna of the neotropical region, keys to the genera, and descriptions of new species. Its completion was made possible by a grant of money from the Heckscher Foundation for the Advancement of Research, of Cornell University.

All of the material recorded in this paper is preserved in the collections of Cornell University.

Hardly any collecting directed expressly toward obtaining knowledge of the ephemeropterid fauna has as yet been done in any part of the neotropical region. Not a single mayfly has hitherto been reported from the northeastern section of South America—the Guiana-Venezuela region, and very few, indeed, from the Andean region north of Argentina. From the former, Mr. Emerson obtained a number of species, and in the latter region the members of Dr. Bradley's expedition made extensive collections. Most species are known from the countries that collectors frequent: Argentina, Brazil, Central America and Mexico.

The several collectors on whose materials we report in the following pages, have all collected the immature stages. This has made possible a very large increase in our knowledge of the biology of the group. The only descriptions of South American mayfly nymphs hitherto published, so far as known to us, are a few very inadequate notes by Burmeister (*Handb. Ent.* II, p. 1015, 1839) and four careful descriptions by Ulmer (*Festschr. f. Zschokke*, No. 25, pp. 1-22, 1920). Nymphs of most of the known neotropical genera we are now able to describe. Several new and very striking forms of nymphs for which no corresponding adults are as yet known, are among the material before us, and are described and illustrated in the following pages.

Nymphal forms of thirteen genera are here for the first time described. Most noteworthy of these are the following:

Metamonius	Baetodes
Siphonella	Thraulodes and
Atalophlebia	Hermanella.
Atalonella	

## NEOTROPICAL MAYFLIES

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Hardly less noteworthy are the first and the last named of these than is the still unnamed Chilean nymph that was figured by Eaton in his monographic revision on plate 53.

Many parallelisms exist in both adults and nymphs of mayflies; some of those appearing in limpet-shaped forms assumed by the nymphs of lotic species have been pointed out by the senior author in Bull. 68, New York State Museum and in Needham & Lloyd's *Life of Inland Waters*, pp. 369-70. *Hermanella* reveals a new parallelism in the development of protective coverings for the delicate gills. The various devices are as follows: one pair of gill plates becomes operculate and covers the gills behind it in a number of forms; in *Siphonella* (hereinafter described) it is the first pair that forms the opercula; in *Caenis* it is the second pair; in *Ephemerella* it is the third pair; three parallel developments, even these; but in *Baetisca* and *Prosopistoma*, the thorax extends to rearward covering the gills as with a carapace, which in the former is four-spined and enormously enlarged; and in *Hermanella*, herewith described (Plate 10), the abdomen is shortened and the wing cases are extended to cover and protect the gills.

It will be seen that the endemic genus *Campsurus* is by far the largest genus, and that most of the species are comprised in this and the four additional Baetine genera, *Callibaetis*, *Baetis*, *Thraululus* and *Thraulodes*. The two last named and their allies in South America replace the Heptagenine allies of North America; the depressed nymphs of both groups are moulded to similar form in adaptation to life in running streams. The other two genera, *Baetis* and *Callibaetis*, include most of the pond species in both continents.

To the student of the neotropical mayfly fauna there are four works of paramount importance; two that deal directly with that fauna, and two that have greatly extended the foundations for the study of the immature stages. These are:

- 1—Eaton, A. E. Revisional Monograph of Recent Ephemeridae, constituting Vol. 3 of the *Transactions of the Linnaean Society of London, Zool. Series*. This is the ephemeridologist's Bible.
- 2—Ulmer, Georg. Uebersicht ueber die Gattungen der Ephemeropteren; in *Stettiner Entomol Zeitung*, Vol. 81, pp. 97-144, 1920. This is a valuable reference list, and will greatly aid the student in finding widely scattered descriptions of adult mayflies.
- 3—Needham, J. G. The Mayflies of New York State; in Bull. 68 *N. Y. State Museum*, pp. 17-62, 1905. Treats immature stages.
- 4—Lestage, J. Larves des Ephemereres Palearctiques; in *Ann. Biol. Lacustre*, Vol. 8, pp. 215-457, 1917. Reappears in *Larves et Nymphes aquatiques des Insectes d'Europe*, Vol. I, pp. 162-273, 1921.

## NEOTROPICAL MAYFLIES

### THE PRESENT KNOWN NEOTROPICAL MAYFLY FAUNA

GENUS		OLD SPP.	NEW SPP.	DISTRIBUTION
Campsurus .....	n	15	12	General
*Tortopus .....			1	Peru
Asthenopus .....		2		Brazil
Euthyplocia .....	n	1		Mexico to Brazil
*Campylocia .....	n	4	1	Continental
Hexagenia .....	n	1		Mexico to Brazil
Metamonius .....	N	1		Chile
Chirotenetes .....	n	†		Mexico
*Siphonella .....	N		1	Chile
Oligoneuria .....	n	1		Brazil
Homeoneuria .....		1		Guatemala
Spaniophlebia .....		3		Brazil
‡Lachlania .....	n	3		Cuba to Argentina
Caenis .....	n	1		Argentina
Tricorythodes .....	n	1		Guatemala to Argentina
Leptohyphes .....	N	3	2	Guatemala to Argentina
Leptohyphodes .....		2		Brazil
Melanemerella .....		1		Brazil
Atalophlebia .....	N	1	1	Chile
*Atalonella .....	N	1	1	Chile and Argentina
Deleatidium .....	N	2		Chile and Argentina
Nousia .....	N	1		Chile
Hagenulus .....	N	1		Cuba
*Hermanella .....	N		1	Iguazu Falls
Hagenulopsis .....	N	1		Brazil
Thraulodes .....	N	9	2	General
Choroerpes .....	n	2	2	Mexico to Brazil
Thraululus .....	n	7	2	General
Callibaetis .....	n	13	2	General
Baetis .....	n	9	4	General
Pseudocloeon .....	n	3	2	Peru and Argentina
Cloeon .....	n			
*Baetodes .....	N		1	Brazil
Ecdyurus .....	n	1		Chile
Heptagenia .....	n	1		Mexico

35 Genera

— +                      — = 127 Species

† Occurrence reported by Eaton, but species undescribed.

‡ Includes Noya of Navas.

N Nymphs described here for the first time.

n Nymphs described previously, mostly from European or North American species.

\* The genera marked with an (\*) are new.

## NEOTROPICAL MAYFLIES

### KEY TO THE GENERA OF NEOTROPICAL MAYFLIES

#### I. IMAGOS

- 1—Cubital and first anal veins strongly divergent at base, venation copious (see pl. I, fig. 5).....*Ephemerinae* 2
- Cubital and first anal veins parallel at base (in a few forms having reduced and scanty venation appearing a little divergent)..*Baetinae* 7
- 2—*Ephemerinae*: Posterior fork of the median vein very deep, almost reaching the wing base; two long simple inter-calaries between the first and second anal veins..... 3
- Posterior fork of the median vein reaching not more than three-fourths the distance to the wing base..... 5
- 3—Pronotum very short, annular, not widened rearward.....*Asthenopus* 4
- Pronotum longer, about as long as wide, broader behind..... 4
- 4—Middle and hind legs about as long as the fore; vein  $M_2$  in hind wing forked for half its length.....*Tortopus*
- Middle and hind legs small rudiments, very much shorter than the fore; no fork in vein  $M_2$  of hind wing.....*Campsurus*
- 5—Posterior fork of the median vein reaches two-thirds to three-fourths the distance to the wing base; vein  $Cu_2$  not more strongly bent at its base than is the first anal; subcosta weak and indistinct at its tip.... 6
- Posterior fork of the median vein occupies not more than half the length of the vein; vein  $Cu_2$  is more strongly bent at its base than is the first anal; the subcosta is well developed at its tip.....*Hexagenia*
- 6—Behind the first anal vein and parallel therewith, and cutting across the S-shaped veins that join that vein to the margin, one or more strong, straight, intercalary sectors.....*Campylocia*
- Behind the first anal vein no such intercalaries.....*Euthyplocia*
- 7—*Baetinae*: Posterior fork of the median vein in the fore wing present, normal ..... 8
- Posterior fork of the median vein disconnected, vein  $M_4$  detached.... 27
- 8—Intercalaries between first and second anal veins directly connect the former with the wing margin..... 9
- Intercalaries between the first and second anal veins when present variable but usually more or less independent, and not directly dependent from the first anal in a long series..... 10
- 9—Lateral apical angles of ninth abdominal segment produced backward and acutely toothed; second and third anal veins of fore wing parallel at wing margin.....*Chirotenetes*
- Lateral apical angles of the ninth abdominal segment squarely truncate; second and third anal veins slightly convergent to the wing margin .....*Metamonius*



## NEOTROPICAL MAYFLIES

10—Subcostal vein of fore wing obscure or wanting or visible only at the base; wings greyish; venation reduced to 4 to 7 longitudinal veins in the fore wing and very few rather strong cross veins.....	11
—Subcostal vein of fore wing visible, well developed and not tucked under the radial vein.....	14
11—Tails 3 .....	12
—Tails 2 .....	13
12—In the fore wing 3 longitudinal veins extend to the wing base between vein R and the first anal; scattered cross veins..... <i>Oligoneuria</i>	
—In the fore wing only 2 longitudinal veins in this space reach the wing base; no cross veins..... <i>Homeoneuria</i>	
13—In the fore wing 3 longitudinal veins extend to the wing base between veins R and the first anal; cross veins scattered..... <i>Spaniophlebia</i>	
—In the fore wing 2 longitudinal veins in this space extend to the wing base; cross veins in a single line..... <i>Lachlania</i>	
14—Fore wings with no free (unattached) intercalary veins; the hind margin ciliate; hind wings wanting in imago (sometimes rudimentary but present in subimago); small species with whitish wings.....	15
—Fore wings usually with some free intercalary veins; hind margin bare; hind wings generally present in imago (wanting in <i>Hagenulopsis</i> only) .....	18
15—Vein $Cu_2$ and the bisector of the cubital fork extend beside $Cu_1$ to the wing base..... <i>Caenis</i>	
—Vein $Cu_2$ and the bisector of the cubital fork are both much shorter and join $Cu_1$ farther out.....	16
16—Fore wing broadest in the anal region.....	17
—Fore wing broadest in the cubital region..... <i>Tricorythodes</i>	
17—Hind leg longer than the front leg..... <i>Leptohyphes</i>	
—Hind leg equal in length to the front leg..... <i>Leptohyphodes</i>	
18—Anal veins of fore wing 1 and 2 approximated, 2 and 3 separated .....	
..... <i>Melanemerella</i>	
—Anal veins of fore wing, 1 and 2 separated, 2 and 3 approximated.....	19
19—Hind wing present.....	20
—Hind wing wanting..... <i>Hagenulopsis</i>	
20—Claws on each tarsus alike, both hooked.....	21
—Claws on each tarsus unlike, one hooked, the other blunt.....	22
21—Cross veins at the stigma in the forewing erect; subcosta of the hind wing reaching almost to the wing apex, and the first fork of the median vein normal, attached..... <i>Atalophlebia</i>	
—Cross veins at the stigma in the fore wing aslant; subcosta of the hind wing ending at the third fourth of the wing length, and the first fork of the median vein disconnected at base..... <i>Atalonella</i>	

## NEOTROPICAL MAYFLIES

22—Hind wing broadly oval; costal space long and narrow.....	23
—Hind wing angulately broken on the costal border, the costal space wide and generally abbreviated.....	24
23—Hind wing with some cross veins in its posterior half.....	<i>Deleatidium</i>
—Hind wing without cross veins in its posterior half.....	<i>Nousia</i>
24—First and second anal veins of fore wing united in a common stalk .....	<i>Hagenulus</i>
—First and second anal veins of fore wing separated at base.....	25
25—Posterior median fork present in the hind wing*.....	<i>Thraulodes</i>
—Posterior median fork absent in the hind wing.....	26
26—Forceps of male 4-jointed; subcosta in the hind wing extends beyond the costal angulation.....	<i>Choroterpes</i>
—Forceps of the male 3-jointed; subcosta in the hind wing ends at the costal angulation .....	<i>Thraulus</i>
27—Hind wing present, often very small.....	28
—Hind wing absent.....	29
28—Hind wing with obtuse costal angulation and with cross veins in the costal space; fore wing usually with cross veins in basal half of costal space and ornately colored.....	<i>Callibaetis</i>
—Hind wing with no cross veins in costal space and with none in the basal half of this space in the fore wing.....	<i>Baetis</i>
29—The short marginal intercalaries of the fore wing are in pairs .....	<i>Pseudocloeon</i>
—The short marginal intercalaries of the fore wing stand singly...	<i>Cloeon</i>

### II. NYMPHS

1—Mandibles with an external tusk-like ramus projecting forward from the mouth and visible from above.....	<i>Ephemerinae</i>	2
—Mandibles with no tusk that is visible from above.....	<i>Baetinae</i>	6
2—Mandibular tusks short, not conspicuous, only their tips visible from above; gills widely outspread.....	<i>Potamanthus</i>	
—Mandibular tusks long, often longer than the head.....		3
3—Mandibular tusks flattened, incurved; head with no prominence on the front .....		4
—Mandibular tusks cylindric, upcurved; head with a conspicuous shelf-like frontal prominence.....	<i>Hexagenia</i>	
4—Mandibular tusks as long as the head.....	<i>Campsurus</i>	
—Mandibular tusks as long as head and thorax together.....		5

\* Here also will go the genus *Hermanella*, known only from the nymph and the venation (see pl. 10, fig. 133).

## NEOTROPICAL MAYFLIES

5—Claw lateral on the lobed tip of the fore tarsus.....	<i>Euthyplocia</i>	
—Claw terminal on a truncate fore tarsus.....	<i>Campylocia</i>	
6—Postero-lateral angles of rear abdominal segments tipped with thin flat lateral spines.....		7
—No such spines (except small ones intermixed with hairs in <i>Pseudocloeon</i> , fig. 177); no maxillary gills.....		11
7—Gills on midventral line of thorax; none on abdomen....	<i>Metamonius</i>	
—Gills absent from midventral line of thorax, present on abdomen.....		8
8—Gills present on abdominal segments 1 to 4, elytroid on 1; mid-dorsal hooks on the same segments.....	<i>Siphonella</i>	
—Gills on abdominal segments 1 to 7, also on base of Maxillae.....		9
9—Abdominal gills all dorsal and erect.....	<i>Chirotetes</i>	
—Abdominal gills appressed, those of the first pair ventral.....		10
10—Tails three* .....	<i>Oligoneuria</i>	
—Tails two† .....	<i>Lachlania</i>	
11—Gills present on abdominal segments 1 to 7.....		12
—Gills absent from one or more of segments 1 to 7, one pair elytroid, covering those behind it.....		21
12—Thorax depressed .....		13
—Thorax compressed .....		21
13—Labrum as wide as, or wider than the head; maxillary palpus tipped with an enormous brush of brown bristles, its elongated middle segment visible from above at the side of the head.....		14
—Labrum narrower than the head; maxillae not visible from above.....		15
14—Labrum wider than the head; labial palpi 2-jointed.....	<i>Hagenulus</i>	
—Labrum as wide as the head; labial palpi 3-jointed.....	<i>Hermanella</i>	
15—Labrum as wide as the space between the antennae, transverse, narrowly elliptical with an acute median notch in front. Gills long lanceolate, rather thick and densely feather-veined to the tip; femora regularly tapering from near the base, not dilated.....	<i>Atalophlebia</i>	
—Labrum narrower; femora dilated, widest at middle or beyond.....		16
16—Lateral spines on abdominal segments 8 and 9 only.....		17
—Lateral spines on abdominal segments 2 or 5 to 9.....		18
17—Lateral spines on segment 9 slender and sharp.....	(?) <i>Deleatidium</i>	
—Lateral spines on segment 9 broadly triangular.....	<i>Nousia</i>	
18—Lateral spines on abdominal segments 5 to 9 smoothly pointed; labrum with a wide shallow notch in its front margin; last joint of the maxillary palpus about as long as the one before it.....	<i>Atalonella</i>	
—Lateral spines on abdominal segments 2 to 9; labrum not notched on the front border; last joint of maxillary palpus minute.....		19

\* Here should also belong the as yet unknown nymph of *Homeoneuria*.

† Here should also belong the as yet unknown nymph of *Spaniophlebia*.

## NEOTROPICAL MAYFLIES

19—Gills diminishing in size to rearward.....	<i>Thraulodes</i>	
—Gills subequal on abdominal segments 1 to 7.....		20
20—Hind wing present.....	(?) <i>Thraulus</i>	
—Hind wing absent.....	(?) <i>Hagenulodes</i>	
21—Gill plates double, at least on the basal segments.....		22
—Gill plates single on all the segments.....		24
22—Hind wings present.....	<i>Callibaetis</i>	
—Hind wings wanting.....		23
23—Labial palpus three-jointed, the middle joint as long as the terminal one .....	<i>Cloeon</i>	
—Labial palpus with its very short middle joint scarcely differentiated from the long terminal one.....	<i>Pseudocloeon</i>	
24—Gills on segments abdominal 1 to 5, with mid-dorsal hooks on the middle segments .....	<i>Baetodes</i>	
—Gills on abdominal segments 1 to 7; no dorsal hooks.....	<i>Baetis</i>	
—Elytroid gill plates of the second abdominal segment widely separated dorsally, and not wholly covering the gills behind them.....	<i>Leptohyphes</i>	
—Elytroid gill plates of the second abdominal segment very broad, meeting on the middle line of the back and covering the gills completely....		19
—Elytroid gill covers narrowed posteriorly.....	<i>Tricorythus</i>	
—Elytroid gill covers not narrowed posteriorly.....	<i>Caenis</i>	

## CAMPSURUS

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### CAMPSURUS

This endemic neotropical genus is one of the most remarkable in the world. It abounds throughout the continental tropics; it includes near a fifth of the described species of the entire region; and yet there exist no records whatever concerning the habits of any of the species. The only information of this sort we have been able to obtain is contained in Mr. Emerson's statement that these mayflies gather about the lights in the laboratory at Kartabo in such numbers as to be a nuisance.

It is probably one of the most ephemeral of all Ephemera. It has no legs to stand on, and probably never rests after leaving the water at transformation. Our supposition is that the activities of adult life are confined to the duration of a single flight, during which mating and egg-laying occur. Middle and hind legs are reduced to mere stubs, which show three short segments, coxa, trochanter, and a rudiment of a femur. The fore legs are longer, usually about as long as the thorax is wide. They are weak, and twisted, and more or less suffused with brownish and purplish pigment. The wings are broad and translucent whitish, with a costal strip that is more or less suffused with purplish.

The coloration of the body is rather uniform throughout the genus, and certainty of determinations will rest on the venation of the wings and on the form of the male genitalia. Head and prothorax are always more or less blackish above (the latter often being paler at the sides) and on the sutures of meso- and meta-thorax. The dorsum of the pale abdomen is variously decorated with brownish spots or dashes or black lines across the apical borders of the segments. The tails are always white.

The ovaries of the female occupy the entire abdomen, as shown in pl. 3, fig. 27, and at their rear end they terminate in a pair of narrow chitin-lined convoluted oviducts which extend forward to their separate terminations at the base of the eighth segment. Toward the end of each is an ovoid, thin-walled, uterine dilatation and at the outlet is a pair of sacs that are probably seminal receptacles. Ripe females when suddenly placed in alcohol will often extrude the ovaries *en masse*, as indicated for *Campylocia* in pl. 3, fig. 21. Eaton has figured this for *Euthyplocia hecuba* (in Biol. Centr. Amer.; Neuropt., pl. 1, fig. 3a). His "peculiar chitinous bristle, seemingly arising from the middle of the apical ventral margin of the seventh segment, associated with the sac," is the released chitinized oviduct.

The eggs of *Campsurus*, pl. 3, fig. 31, are roundish oval, with a very long filament attached at the micropyle and when coiled, covering this end of the egg as with a cap. It is shown partly uncoiled in the figure. It may be uncoiled to a very great length. Its function is probably to attach the eggs to suitable supports in the water, keeping them from submergence in the bottom mud.

## NEOTROPICAL MAYFLIES

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The imagos of this genus retain upon the sides of the abdomen fleshy basal parts of the nymphal gills, with even a few filaments present showing inclosed tracheae.

There are two fairly well-marked sections in the genus:

1. Those species in which vein  $Cu_2$  has retained its relations rather closely with  $Cu_1$ , and in which the prothorax is elevated at its dorsal front border in a median triangular hump that fits against the rear of the head.

2. Those species in which vein  $Cu_2$  has become detached wholly from  $Cu_1$ , and attached more or less closely to the first anal, and in which the prothorax is smoothly truncate across its front border.

In all this order of fragile insects there is hardly anything more fragile or more unsatisfactory as museum material than what this genus furnishes. Not even the venation can be studied aright without often a careful softening, spreading and mounting of the wings, and such is the capacity of these forms for shriveling that even the male genitalia are not always trustworthy. In alcohol or on pins they may twist into positions that cause differences in appearance. We have found the venation of the wings unexpectedly trustworthy in certain features that have hitherto been little used. Having an abundance of specimens of *Campsurus corumbanus* at hand, we mounted thirty-six pairs of wings of this species for detailed comparison, in order to learn what venational characters might be trusted. While there is much variation in individual cross veins, we have found that in the general abundance or scarcity of cross veins and in their distribution among the areas of the wing there is relative stability, and the general relations between the longitudinal veins are quite constant. Venational characters are therefore used as far as available in the following key. The designation of veins is that of fig. 5 on plate 1.

### NYMPH

Herr Georg Ulmer has described and figured a nymph of this genus in *Zeitschrift für Zschokke*. No. 25, pp. 17-19. His was from Tijuca Preto, Rio Negro, Parana. We have a single nymph of a second (undetermined) species of the genus obtained by Dr. J. C. Bradley at Porto America, Brazil, on the 1st of September, 1920. Our specimen is fully illustrated on plate 4. It is a well grown specimen of a very large species measuring about 23 mm. in length of body, with tails 9 mm. additional. The wings are so crumpled within their sheaths as to be of no use in further identification. This nymph differs from Ulmer's in being much larger (his measured 11.5 mm. without tails); in having the teeth on the inner border of the mandibular tusks less regularly serrate, and in having the claw that tips the fore leg less slender and less arcuate.

This specimen is in the Cornell University collection.

## CAMPSURUS

### KEY TO THE SPECIES OF CAMPSURUS

- 1—Vein  $Cu_2$  of the fore wing at its proximal end occupying a position intermediate between the first anal vein and the bisector of the cubital fork, usually appearing to be conjoined to the latter..... 2
  - Vein  $Cu_2$  at its proximal end more closely approximated to the first anal, usually appearing to spring therefrom..... 10
- 2—Vein  $Cu_2$  joining the bisector by a rounded curve..... 4
  - Vein  $Cu_2$  ending proximally in a disconnected spur; size small..... 3
- 3—Cross veins of the hind wing fewer than ten..... *lucidus*
  - Cross veins of the hind wing numerous..... *latipennis*
- 4—Cross veins in costal and subcostal spaces of hind wing numerous (more than ten, and distributed to tip of these spaces; species of largest size ..... *major*
  - Cross veins of costal and subcostal spaces of hind wing fewer (less than six) or wanting (except the humeral); when present restricted to basal half of these areas..... 5
- 5—The two long anal intercalary veins usually attached separately to the first anal vein; two pairs of darker spots on the dorsum of the mesothorax, one pair before and one behind the paler convex middle portion ..... 6
  - Anal intercalaries conjoined before their attachment to the first anal vein; no tetrad of darker spots upon the mesothorax..... 7
- 6—Basal curve at origin of vein  $Cu_2$  opposite the fork that separates between veins  $M_3$  and  $M_4$ ..... *evanidus*
  - Basal curve of  $Cu_2$  farther out in the wing—beyond the level of this fork; therefore, first cubital cell longer..... *holmbergi*
- 7—Fore legs yellow..... *primus*\*
  - Fore legs purplish..... 8
- 8—Prothoracic dorsum with a large round median dark spot on a paler background behind the transverse suture, this spot connected by a broad trapezoidal band with the black on the rear of the head; spots in the dorsal brown band of the middle abdominal segments—shaped, and placed end to end, a single pair on each segment, their tips pointing backward..... *violaceus*
  - Prothoracic dorsum not as above, pale spots in the brown on the dorsum of the middle abdominal segments roundish..... 9

\* This is probably the species whose fore wing was figured by Eaton in Trans. Ent. Soc. Lond. for 1871, pl. 1, fig. 3 as "*Asthenopi* (sp. nondescript); in Mus. M'Lach.; de Texas," and whose hind wing was figured in his Revisional Monograph, pl. 5, fig. 8b, with the statement on p. 41, "In M'Lachlan Museum are several female examples of a *Campsurus* taken by Belfrage in Bosque Co., Texas, which has the fore legs yellowish, like the hinder legs."

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- 9—One pair of such spots.....*scutellaris*  
 —Two pairs of such spots.....*jorgensini*
- 10—Vein  $Cu_2$  joined to vein  $A_1$  by a small rounded curve in proximal end of the inclosed space, rather blunt; anal intercalaries arising by a common stalk; pale species..... 11  
 —Vein  $Cu_2$  more closely approximated to vein  $A_1$ , the inclosed space sharply lanceolate ..... 12
- 11—With few cross veins in the hind wing none (save the humeral) in costal or subcostal spaces.....*segnis*  
 —With abundant cross veins in the hind wing, numerous in basal half of both costal and subcostal spaces.....*pallidus*
- 12—With a pair of pale [-marks placed back to back on the dorsum of each of the middle abdominal segments.....*albifilum*  
 —Not so marked..... 13
- 13—Apical margins of the abdominal segments pale; base of antennae brown .....*notatus*  
 —Apical margins of abdominal segments blackish, forming dorsal half rings; base of antennae purplish..... 14
- 14—A large yellow spot each side of the prothoracic dorsum, well defined and completely encircled with dark purplish..... 15  
 —Yellow of the sides of the prothorax more diffuse, more extended, that of the two sides often confluent in the rear..... 17
- 15—Rear of head behind ocelli pale; pale spots within the brown band on the dorsum of the abdomen sharply defined.....*corumbanus*  
 —Rear of head blackish; spots diffuse obsolete..... 16
- 16—Upper median fork of hind wing deeper than half the length of the wing .....*mutilus*  
 —Upper median fork of hind wing of a depth less than half the length of the wing.....*striatus*
- 17—Upper median fork of hind wing deeper than half the length of the wing .....*argentinus*  
 —Upper median fork of hind wing of a depth less than half the length of the wing; a smaller species with more open venation.....*claudus*

### CAMPSURUS LUCIDUS SP. NOV.

Male—Length of body 6 mm.; of wing 7 mm.; of tails more than 21 mm.

A small pale species with a black head, brownish thorax and hyaline wings. The head is black above except a narrow stripe across the rear. Prothorax yellowish with a somewhat darkened median tract and a black dash just before and another just behind the ends of the transverse cervical groove. A high angulate prominence in the front of the prothorax overarches the rear of the



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head and is somewhat darker in color. Mesothorax yellowish above. The three usual longitudinal grooves scarcely tinged with blackish, a little more deeply at the rear, and there is a little sooty black pigment about the outer curving grooves before the wing roots. A pale narrow mid-dorsal line begins on the metathorax, on either side of which is a horizontal  $\subset$  mark, and extends the length of the abdomen, on either side of which are brownish clouds tending to form broad bars across the segments dorsally. Fore legs pale except for a tinge of purplish brown at the tip of the tibia and upon the bodies of all the tarsal segments; claws pale. Wings tinged with violaceous at the base and along the subcostal and radial veins. Stigma unmarked. Venation as shown in pl. 1, figs. 4 and 4a.

This species is allied to the type of the genus, *Campsurus latipennis*, but differs in the form of the genitalia. The basal joint of the male forceps has an elongate triangular projection upon the outer side. The terminal joint is slender, incurved, dilated and hairy at the tip. There is a small rounded notch in the apex of the penultimate ventral segment.

One male; Rio Putumayo between Puerto Alfonso and the mouth of the Rio Igara-Paraná, Aug. 14, 1920, collected by Dr. J. C. Bradley. Holotype C. U. No. 617; mounted on two slides.

### CAMPSURUS MAJOR SP. NOV.

Male—Length of body 13 mm.; of wing 20 mm.

This is the largest species of our list, a pale yellowish robust form, destitute of color pattern (in the old alcoholic specimen which is the type), except for a slight darkening of the tibiae of the front legs, the black pigment of the eyes and ocelli, and a purplish-gray tinge to the costal strip of the fore wing, which becomes imperceptible beyond the middle of the wing. There is, therefore, no color to describe, but the species is very distinct from all others by the male genitalia shown in pl. 3, fig. 28. The venation is shown in pl. 1, fig. 5.

The basal segment of the forceps is stout, cylindrical, as wide as long and truncate on the apex. The second segment is long, slender, incurved and dilated and spatulate at the tip where it is clothed with hairs. The high frontal prominence upon the prothorax that overlaps the rear of the head is in this species rather sharply triangular.

This species is of larger stature than any of the other species except *Campsurus wappei* Weyenbergh, but it does not at all agree in venation with the figure given for that species. (Tijd. v. Entom., Vol. 26, pl. 10, fig. 1.)

A single male specimen from Buenos Aires sent me by M. Baer, bearing date of December 16, 1898. Holotype, No. 618; genitalia and two wings mounted on slides, remainder in alcohol.

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### CAMPSURUS EVANIDUS SP. NOV.

Male—Length of body 8-9 mm.; of wing 8-9½ mm.; of tails more than 26 mm.

Female—Length of body 9½-10½ mm.; of wing 10-12 mm.

General color pale yellowish. Head yellow except immediately about the black eyes and ocelli. Prothorax yellowish, slightly tinged with purplish only at the sides and on the transverse cervical groove. Mesothorax pale brownish with a smudge of purplish crossing front and rear. The two transverse bands thus formed divided by the usual longitudinal sutures into short streaks. Abdomen yellow with a touch of purplish on the extreme base above and a deeper one on segments 6 to 9 becoming darker on the tips of these segments; apical segments of the abdomen, especially 8 and 9 more broadly brownish, the brown divided by a narrow median pale line; segment 10 yellow. Fore legs yellow scarcely tinged with purplish; about as long as the body. Venation, as shown in pl. 1, fig. 1.

The basal segment of the male forceps (pl. 3, fig. 29) is somewhat the shape of a truncated cone, without prolongation of the angles; the second segment is slender, incurved, dilated and hairy at the tip.

Numerous specimens, both males and females, from Pirapora on the Rio Sao Francisco, State of Minas Geraes, Brazil, Nov. 11 to 13, 1919. Holotype, No. 619; wings and genitalia mounted on slides; remainder in alcohol.

### CAMPSURUS VIOLACEUS SP. NOV.

Male—Length of body 10 mm.; of wing 10 mm.; of tails more than 32 mm.

Female—Length of body 11½ mm.; of wing 14 mm.

Head blackish above with a tinge of violet about the borders. Prothorax vilaceous brown, very dark in front, becoming somewhat paler toward the rear and with a paler dash each side upon the transverse cervical groove. Sides yellow except for a marginal line and a little angulate spot projecting rearward and laterally from the large purplish tract of the dorsum, which covers more than one-third of the middle of the segment, and a median band that widens forward to the hind angles of the head. Meso- and metathorax of the same violaceous brown color above, deepest on the sutures and on the transverse carinae at the rear. Abdomen purplish brown above, the color deepening toward the rear on all the segments and wholly overspreading segments 8 and 9 with a pale median dorsal longitudinal line on 1-7, and an obscure  $\subset$  mark invading the brown on each side of these same segments. There is also a faint longitudinal dash sometimes showing in the midst of the brown on segments 8, 9 and 10. Fore legs and bases of antennae are of a clear violet color. The entire costal strip of the fore wings, including the cross veins is strongly tinged with violet. Venation as shown in pl. 1, fig. 8.

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The basal segment of the male forceps (pl. 3, fig. 24) is broadly cylindrical, with a strong prolongation of the inner angle at the tip and a sparse clothing of short hairs on the surface. The second segment is long and slender, incurved, and spatulate and hairy at the tip.

Two male and numerous female specimens from Santa Fe, Argentina, February 19, 1920. Holotype, male, C. U. No. 620; wings and genitalia mounted on slides, remainder in alcohol.

### CAMPSURUS SCUTELLARIS SP. NOV.

Male—Length of body  $8\frac{1}{2}$  mm.; of wing 7 mm.

Head black across eyes and ocelli and purplish in the rear. Base of antennae pale scarcely tinged with purple on the under side. Prothorax mostly pale but with a line of purplish about the lateral margins interrupted in the middle of the border at the rear with a brownish triangular patch covering the prominence that overlies the rear of the head, and extending rearward therefrom in a narrow mid-dorsal band. Mesothorax pale above, the median sutures brownish, the other sutures and all carinae more broadly and diffusely bordered with brown. Abdomen obscure brownish with a pale mid-dorsal longitudinal line and pale apical margins to segments 1 to 8, these paler borders outlining brownish quadrangles on each side of the same segments. In the midst of each patch of brown is a very faint  $\odot$  mark. There is also a double  $\odot$  mark at the lateral margin of each segment. Segment 9 is all brownish above. Fore legs yellowish with a purplish spot on coxae and trochanter in front. Wings transparent, faintly and rather uniformly milky-white, slightly tinted in the usual costal strip. Venation as shown in pl. 1, fig. 2. There is a border of purplish dots at the very base of the abdomen beneath near the median line, and there is another similar pair underneath the middle of the thorax, and there are some irregular dark dashes upon the sides.

The basal segment of the male forceps (pl. 3, fig. 18) is prolonged at both inner and outer angles, the outer prolongation being three times the size of the inner. The second joint is straight, slightly and regularly widened to the obtuse tip.

A single male specimen from Iguazu Falls, Argentina, January 22, 1919, collected by Dr. J. C. Bradley. Holotype, C. U. No. 621, two wings and genitalia mounted on slides, remainder in alcohol.

### CAMPSURUS SEGNIS SP. NOV.

Male—Length of body  $7-7\frac{1}{2}$  mm.; of wing 7 mm.; of tails 21 mm.

Female—Length of body  $7\frac{1}{2}$  mm.; of wing 8 mm.

Color pale brownish with blackish head and fore tarsi, purplish brown

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abdomen, and hyaline wings. Head mostly covered by the deep black eyes and ocelli. Thorax rather uniformly brownish, slightly darker upon grooves and carinae. Fore legs pale, sooty on the base of the tarsi, and soot lines upon the carinae of the femora. Abdomen brownish with a very faint narrow mid-dorsal line and paler joinings to the segments; lateral margins darker, segment 10 yellowish. The usual darker coloration of the costal strip is restricted to the basal portion of costa, subcosta and radius and is brownish rather than purplish. The female is slightly darker than the male and the color of the abdomen is more opaque with a suggestion of pale spots above on the dorsum of abdominal segments 2 to 8. Venation as shown in pl. 1, fig. 6.

The basal segment of the male forceps (pl. 3, fig. 17) is short, cylindric, with a long external projection, as long as the body of the segment. The second segment is long and slender, dilated, and hairy at the tip.

Three males, Bartica, British Guiana, November 14, 1920, collected by Alfred E. Emerson. A number of both males and females from Igarape-Assu near Para, Brazil, January 25, 1912, collected by H. S. Parish. C. U. holotype, male, No. 622, mounted on a slide.

### CAMPSURUS PALLIDUS SP. NOV.

Male—Length of body 9 mm.; of wing 12 mm.

Pale yellowish species almost destitute of the usual purplish-brown coloration, there being only a faint touch of it upon the top of the head and the dorsum of abdominal segments 5-9, and in its place there is no definite color pattern. The wings are tinged with purplish lightly on the basal half of the usual subcostal strip. The venation is as shown in pl. 1, fig. 3. The fore legs are faint purplish in color, shorter than the body.

The basal segment of the male forceps (pl. 3, fig. 26) is stout, cylindric, oblique, truncate and without prolongation. The second segment is cylindric and straight, or a little dilated at the apex.

One male from above Posadas on the Alta Parana, Argentina-Paraguay, January 18, 1920. C. U. holotype, No. 623; head, legs, wings and genitalia on slide, remainder in alcohol.

### CAMPSURUS NOTATUS SP. NOV.

Male—Length of body 13½ mm.; of wing 11½ mm.; of tails more than 30 mm.

An elegant species with purplish-brown saddle marks arranged serially the entire length of the body. Head blackish above, a narrow line across the occiput and basal segment of the antennae brown. Prothorax yellowish brown with an oval saddle mark of darker color occupying the middle portion of the anterior

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half, with a narrow peripheral carina of purplish color interrupted in the middle, as is also a line on the rear of the head. Meso- and metanotum all pale, excepting the sutures and carinae which are brown. The dorsal saddle marks of the abdominal segments increase in size posteriorly until they quite cover segments 8 and 9, each mark being invaded laterally by a round pale spot on either side in segments 2-7; segment 10 paler. Fore legs purplish brown. Costal strip of the fore wings rather uniformly purplish along costal, subcostal and radial veins. Membrane transparent. Venation as shown in pl. 2, fig. 14.

The basal segment of the male forceps (pl. 3, fig. 25) is stout, cylindric and prolonged in an obtuse triangular lobe on the inner side; the second segment is straight, rather short, and slightly dilated at the tip where clothed with a few thin hairs externally.

Four male specimens from Paraguay River, between Puerto Esperança and Corumbá, Brazil, attracted to the lights of a river steamer, December, 1919.

C. U. holotype, male, No. 624, wings, legs and genitalia mounted on slides, remainder in alcohol.

### CAMPSURUS CORUMBANUS SP. NOV.

Female—Length of body in specimens from Corumbá 13½-14 mm., wing 14-14½ mm., and in specimens from Pirapora, length of body 16½-17 mm.; of wing 18½-19 mm.

Head with broad black band between the eyes, extending forward on the middle ocellus; rear of head paler. Base of the antennae purplish brown, a diffuse broad mid-dorsal band of purplish-brown color extends from head to tail; on the prothorax this band is invaded by a pale streak on the cervical grooves and is constricted somewhat at the rear before the purplish peripheral carina; sides yellow. On the mesothorax this band is bounded laterally by the paired dorsal grooves, from whose anterior ends other dark streaks extend outward to the wing roots. Declivous portions of the rear of meso- and metathorax are brownish, remainder pale. Middle abdominal segments with a somewhat paler mid-dorsal band, and the yellow of the sides invades the brown on each segment producing a double row of pale spots, well rounded, and well defined at their inner ends; segments 8 and 9 more extensively brownish, lacking these spots, and showing instead faint longitudinal streaks; extreme apical margins of segments 5 to 8 black above. Fore legs pale violaceous, about as long as the prothorax is wide. Wings with costal strip violet tinted throughout costa, subcosta and radius and intervening cross veins. Venation as shown in pl. 1, fig. 7. Egg and oviducts as shown in pl. 3, figs. 19 and 27 respectively.

A slight variability in the attachment of vein  $Cu_2$  to the first anal occurs in this species, the extent of which is indicated in pl. 1, fig. 7B, by two figures of that portion of the wing. This is supplemental to the whole wing therein figured.

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Numerous female specimens from Corumbá, Brazil, collected on the 14th to the 23rd of December, 1919, and at Pirapora, Brazil, on the 11th of November, 1919, by J. C. Bradley.

Holotype, C. U. No. 625, mounted on a slide.

### CAMPSURUS MUTILUS SP. NOV.

Female—Length of body 13 mm.; of wing 15-16 mm.

A large yellow species with deep purplish-black color on top of the head and pale purplish marks on the dorsum of the thorax. The purple of the rear of the head continues in a wide band upon the thorax, becoming much lighter in color and interrupted by a pale streak each side on the cervical groove. The marginal carina of the prothorax is purplish. The still paler purplish color of the front of the mesothorax becomes pale brown on the metathorax. Abdominal segments 4 to 8 with sooty transverse apical bands that extend forward and become more or less connected in a pair of longitudinal streaks, outside which is a row of very obscure paler spots on each side. Segments 8 and 9 paler, segment 10 yellow. Fore legs and base of antennae purple. Costal strip of both wings becomes much paler apically. Venation as shown in pl. 2, fig. 10.

Five female specimens from Amazonas on the Rio Solimões below the mouth of the Rio Iça, Brazil, September 2, 1920, collected by J. C. Bradley.

Holotype, C. U. No. 626, mounted on slides.

### CAMPSURUS STRIATUS SP. NOV.

Female—Length of body 9 mm.; of wing 13 mm.

A rather stout purplish species, with rather open venation, and with deeply colored longitudinal thoracic grooves, and with the dorsal apical margins of abdominal segments heavily marked with blackish. The head black above, including the rear, and the basal segments of the antennae. Prothorax with a large yellow spot each side enclosed by blackish purple. Mesothorax with the three usual longitudinal grooves conspicuously marked with deep purple upon a paler purple field; the lateral grooves that go to the wing roots marked with purple only at their front ends. Metathorax pale. Dorsum of the abdomen heavily marked with blackish at the margins of the segments, this color becoming diffuse anteriorly, especially on the basal segments, thus giving the abdomen a ringed appearance. Fore legs purplish, as are also all the heavier veins of the wing. Wing membranes transparent. Venation as shown in pl. 2, fig. 13.

One female specimen from Rio Paraguay between Puerto Esperanca and Corumbá, Matto Grosso, Brazil, December, 1919.

Holotype, C. U. No. 627, two wings mounted on a slide, the remainder in alcohol.

## ASTHENOPUS — TORTOPUS

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### CAMPSURUS CLAUDUS SP. NOV.

Female—Length of body 12 mm.; of wing 16 mm.

A stout black-headed, pale-bodied species with the black of the abdomen concentrated toward the tip. Head all black above including the rear and the basal segments of the antennae. The fore legs also are blackish. Prothorax pale with a diffuse purplish-brown median saddle mark next the rear of the head and a continuous purplish marginal carina. Meso- and metathorax obscure. Abdomen with apical cross bands on the segments very pale, unless on the basal segment, but very well marked upon the middle of the abdomen; blackest on segments 7 to 9. Costal strip of fore wing heavily tinged with purplish-brown color along all the heavier veins and cross veins. Venation as shown in pl. 2, fig. 15.

Vein  $Cu_2$  appears to be fused with the first anal for a greater distance outward in this than in any other species.

Two female specimens from Pirapora on the Rio Sao Francisco, Minas Geraes, Brazil, November 11, 1919, collected by J. C. Bradley.

Holotype, C. U. No. 628, two wings mounted on a slide, remainder in alcohol.

## ASTHENOPUS

This genus, founded by Eaton in *Trans. Ent. Soc. Lond.* for 1771, p. 59, suppressed by Eaton in his *Revisional Monograph of Recent Ephemeridae* in 1883, and resurrected by Ulmer in *Stettiner Ent. Zeit.* 81:103, 1920, is distinguished from *Campsurus* by the very short and annular pronotum, and by having rather longer fore feet in the male, these being as long as the body. Ulmer (*l. c.*, p. 107) records three species, all from Neotropical America, none of which was found among the material before us.

## TORTOPUS N. GEN.

Allied to *Campsurus*, which it much resembles in appearance, but differing by important characters in legs and wings. All the legs are degenerate and apparently functionless, but the middle and hind legs are as long as the fore, though slenderer. In the fore wing the vein  $Cu_2$  appears to attach laterally to the bisector of the cubital fork, and the latter in turn, by a similar rather long curvature, to vein  $Cu_1$ . In the hind wing the posterior fork of the median vein is present. The eggs in *Tortopus* are similar in size and appearance to those of *Campsurus*, but are much fewer.

Nymph unknown.

Type the following species:

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### TORTOPUS IGARANUS SP. NOV.

Female—Length of body 6-10 mm.; of wing  $9\frac{1}{2}$ - $12\frac{1}{2}$  mm.

Color above yellowish, tinged with plumbeous on top of the thorax; sutures and carinae brown; there is a diffuse portion of purplish brown on the dorsum of the abdomen regularly deepening posteriorly. The head dark purplish above, this color forming a cross band between the eyes including the ocelli; paler in the rear. Prothorax purplish brown with a paler area on each side just within the lateral margin, and in some specimens with a pale transverse line crossing the collar. The paired sutures on the dorsum of the metathorax are sinuous, meeting behind and enclosing a shield-shaped pale field; remainder of thorax pale brownish. Dorsum of the abdomen obscure brownish. In the better colored specimens there is a trace of the pale mid-dorsal line together with two lateral lines. On the basal half the segments are bordered with darker color around their apical margins, and there is a narrow mid-dorsal line on segment 9. Legs (pl. 3, fig. 32) yellowish; those of the first pair about as long as the prothorax is wide, and those of the middle and hind pairs but little shorter. Wings transparent, with *veins purplish throughout*. Venation as shown in pl. 1, fig. 9.

This species is unique in the following points of its venation: the basal fork of the upper division of the median vein in the fore wing is oblique, being skewed forward; the bisector of the cubital fork appears to replace vein  $Cu_2$  basally, where it is strongly askew to rear. In the hind wing the rear division of the median vein is forked to a depth equal to one-half the length of that wing. As indicated in the key, middle and hind legs are much better preserved than in any species of *Campsurus*.

One female specimen from Rio Igara-Paraná, Peru, July 15-17, 1920. One female specimen from Puerto Bermudez, Peru, taken at light on bank above the river, and a dozen other females, among them the type, from Rio Putumayo between Puerto Alfonso and the mouth of the Igara-Paraná, Peru, August 14, 1920.

Holotype, C. U. No. 629, abdomen in alcohol, remainder on slides.

## EUTHYLOCIA

The single species of this genus as here restricted, *E. hecuba* Hagen from Mexico, is represented in the collections before us by several nymphs from Gualan, Guatemala, collected by Mr. E. B. Williamson. One of these was described by the senior author in Bull. U. S. Bur. Fish., 36:287, pl. 79, figs. 46-51, 1917. It was not there identified beyond the genus; but Ulmer's later description and figures (in *Festschr. für Zschokke* No. 25, pp. 10-12, figs. 5 and 6) enable us to recognize that it belongs at least in this section of the old and wider genus



## CAMPYLOCIA

Euthyplocia. The mouth parts of this same nymph have been figured also by the junior author in Bull. Lloyd Libr. No. 22, p. 16, fig. 21, and pl. 4, fig. 59.

We have also a well-grown nymph and a small young one collected by Dr. J. C. Bradley at Eneñas along the Camino del Pichis, Peru, on July 4, 1920, that seems to differ in having the claw of the front tarsus somewhat shorter, not reaching the level of the tip of the apical process of the tibia.

### CAMPYLOCIA N. GEN.

Similar to Euthyplocia in appearance but differing in both nymphal and adult stages. Behind the first anal vein in the fore wing there are one or two straight intercalary sectors that cut across the short curving veinlets which connect the first anal with the wing margin. In the nymph there is a very different conformation of the antero-lateral angles of the prothorax, and of the tips of the mandibular tusks and of the fore tarsi. Type: *Euthyplocia anceps*.

#### KEY TO THE SPECIES OF CAMPYLOCIA

- 1—A single intercalary behind the first anal vein and parallel therewith, cutting across the curving veinlets that connect that vein with the wing margin ..... 2  
—Two such intercalaries.....*guntheri*†
- 2—With two short intercalaries in the space between vein  $M_2$  and the long intercalary that normally stands before it; two other similar short pairs in the spaces behind veins  $M_3$  and  $M_4$  respectively.....*ampla*  
—With no intercalaries in these spaces..... 3
- 3—Second fork in vein  $M_1$  of the hind wing at the first third of the length of the wing; a short intercalary between the first and second anal veins; wings broader, oval in form.....*anceps*  
—Second fork in vein  $M_1$  of hind wing at midway the length of the wing; no intercalary between first and second anal veins of hind wing; wings narrower, ellipsoidal in form.....*burmeisteri*\*

#### CAMPYLOCIA AMPLA SP. NOV.

Female—Length of body 19-24 mm., of wing 22-24 mm.

A large, pale, broad-winged species. Head blackish around eyes and ocelli, paler in the rear and beneath. Prothorax pale, brownish, indistinctly mottled with blackish; its peripheral carina blackish, especially on the obtuse lateral

† Also a nymph from Colombia as noted below.

\* According to fig. 7b of pl. 5 of Eaton's Revisional Monograph.

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angles before which the color becomes more intense to the cervical groove, where recurved upon the dorsum half way to the median line. Meso- and metathorax pale except the lateral sutures and carinae. Abdomen broadly washed with brownish, this color tending to form broad transverse bands on the middle segments and darkening posteriorly, wholly overspreading segment 9, where it becomes divided by a narrow median pale line. Lateral margins of abdominal segments 2 to 7 somewhat produced and angulate, marked by an oblique brownish streak on exterior half of prominence and bearing on each angle rudiments of basal portion of nymphal gills; on the posterior side of each of these there are a few gill filaments, some of which show inclosed tracheae.

Fore legs wanting; middle and hind legs pale bearing externally lines of brown on the carinae of the femora and tibiae; tarsi paler; a brown spot covers the middle coxa below. Wing dull hyaline, more obscure toward the wing roots, especially in the costal and subcostal spaces. Venation as shown in pl. 2, fig. 12. Genitalia and egg as shown in pl. 3, figs. 21, 22 and 31.

One female from El Encanto, Peru, August 25, 1920, and

One female from Puerto Bermudez on the Rio Pichis, Peru, J. C. Bradley, collector.

One female from Para, Brazil, H. S. Parish, collector.

Holotype from Peru, C. U. No. 630.

### CAMPYLOCIA ANCEPS (Eaton Monogr. p. 38).

Some good alcoholic specimens of this species, both males and females, collected by Mr. A. E. Emerson at Kartabo, British Guiana, on October 20, 1920, enable us to present a new figure of the male genitalia (pl. 3, fig. 33) and to add a few new measurements. We have also a few female specimens from Para, Brazil, that were collected by Mr. H. M. Parish, on the 25th of January, 1912. The notes and figure are from the Bartica specimens.

Length of body, male 9.5 mm., female 11 mm.

Length of wing, male 11 mm., female 12.5 mm.

Our specimens agree well in venation with the figure published by Eaton in his Revisional Monograph (pl. 4, fig. 7c), and confirm Ulmer's supposition in Stettiner Ent. Zeit. 81:106 that the male genitalia figured by Eaton under the same number do not belong to this species. Comparison will show that they are much more like Eaton's fig. 7d of the plate cited.

### THE NYMPH

The nymph of *Campylocia anceps* has been described and figured by Ulmer in Festschr. für Zschokke No. 25, pp. 3-8, 1920. We have a nymph collected by Mr. E. B. Williamson in Colombia that differs very slightly from Ulmer's, but

## HEXAGENIA

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that seems to combine the added median intercalaries of *ampla* with the added anal intercalary of *guntheri*, and that probably represents a species as yet undescribed. The mounted nymphal wings show both these characters with striking clearness. The wings are wholly suffused (except for the veins) with purple pigment, and would perhaps be colored in the adult.

In this genus the nymphal gills are in part preserved in the adult insects upon the sides of the abdomen, a fleshy basal portion only bearing a few filaments that contain tracheae (pl. 3, fig. 22).

The egg in this genus is broadly elliptical, sub-truncate at both ends and capped over the truncate portion by an extremely long closely coiled filament. One end is shown partly uncoiled in fig. 31 of pl. 3. The extruded egg mass, and the chitinized oviduct are shown in fig. 21 of the same plate.

## HEXAGENIA

This genus, so abundant in all the larger inland streams of North America, appears to be represented southward by a single yellow-winged species in Mexico, and by a fine widely distributed white-backed, brown-lined species in South America. *H. callineuria* of Banks from Colombia, appears on examination of adequate material to be the female of *H. albivitta* of Walker. A fine series of both sexes of this latter species, collected at Kartabo, British Guiana, by Mr. A. E. Emerson in October, 1920, enables us to add descriptive notes and figures (pl. 2, fig. 16, and pl. 3, fig. 23).

### HEXAGENIA ALBIVITTA (Walker Cat. p. 566)

*H. albivitta* is certainly one of the handsomest of insects. Its delicacy of structure and rich coloration—a chocolate brown body bearing a wide dorsal stripe of chalky white, and glistening wings bordered in front by amber yellow—confer an unusually striking appearance. Walker's specimens are supposed to have come from Brazil. Banks' type was from Colombia. We have besides the Emerson specimens from British Guiana, a single male collected by Dr. J. C. Bradley at Puerto Bermudez, Peru, July 13, 1920.

Male—Length of body 20 mm., wings 14 mm., tails 35 mm.

Female—Length of body ♀ 22 mm., wings 19 mm.

*Male*—On the top of the head there is a zigzag band of brown through the ocelli between the eyes. There is a pair of distinct chocolate brown spots behind this near the occiput, whence start the two long brown lines that extend backward to the tail, bordering on either side the chalky white mid-dorsal stripe. The latter is washed with yellowish on the top of the mesothorax, where some included points in front and a transverse bar in the rear are of a distinct chalky white.

## NEOTROPICAL MAYFLIES

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Inclosed within the brown stripe that covers each side of the abdomen there is a row of triangular chalky white spots some of which are confluent dorsally and posteriorly with the dorsal white band. A line of brownish dashes borders the lateral margin of the abdomen beneath, the brown being dilated toward the mid-dorsal line at the front border in each segment.

The front femora are amber yellow, brownish at the tip; tibiae and tarsi, brown. Middle and hind legs pale, extreme tips brownish. Chalky white irregular markings besprinkle the sides of the thorax; wings hyaline, except for the amber yellow costa, with brown veins. Central area of hind wings beautifully marked with small brown blotches bordering the pale veins. Tails honey yellow, marked at irregular intervals with rings of brown.

*Female*—Similar, but lacking the yellow costal strip of fore wing. The extent of the brown upon the abdomen is very variable, the lateral white spots being sometimes wholly enclosed with brown, sometimes wholly confluent with the dorsal white band.

Venation and genitalia of the male are as shown in pl. 2, fig. 16, and pl. 3, fig. 23, respectively.

### METAMONIUS?

To this genus there is doubtfully referred a very curious type of nymph from Chile, having obvious relationship with *Chirotenetes* and yet differing very markedly from all known Ephemerid nymphs in lacking dorsal gills upon the abdomen, and in having unpaired mid-ventral gills beneath the thorax. *Chirotenetes* is known in the neotropical region only from undescribed specimens reported by Eaton (Biol. Centr. Amer. Neur., p. 16) from Mexico. *Metamonius* is a monotypic genus from Chile.

The two specimens at hand are grown nymphs about ready for transformation, the wings being already crumpled within their sheaths. By carefully removing the fore wings from their sheaths, softening them in glycerine and spreading them out upon a slide, portion of the venation could be made out. So much as appeared is shown in pl. 5, fig. 51. No corresponding adult mayflies were obtained. When this venation is compared with Eaton's careful figure of *Metamonius anceps* (Rev. Monogr., pl. 20, fig. 34b), allowance being made for the elongation of the wing at transformation, it will be seen that the agreement is fairly close. There is the same general disposition of forks and veins, the same one-sidedness in the branching of the cubital vein, with skewness to the rear, and the same incurvature of the second and third anal veins to the hind margin, but the veinlets connecting the first anal vein with the hind margin are forked and appear to traverse a wider area than in *Metamonius*.

The nymph agrees roughly with the nymph of *Chirotenetes* in having gills upon the base of the maxilla (though there are but two single filaments instead of

## OLIGONEURIA

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a bundle of filaments), and in the general conformation of the mouth parts (though its labial palps are very much more enlarged). It is unique in having a single pair of gill filaments upon the labium. In its cowl-shaped head and its short spiny legs it differs conspicuously from *Chirotenetes*. Whether so different a nymph can belong to a genus so closely allied to *Chirotenetes* as is *Metamonius* seems doubtful; yet it is either of that genus or of one as yet undescribed.

The characters of this nymph are so fully set forth in plate 5 as to call for no description, beyond the few notes and data hereto appended.

### METAMONIUS? SP? (nymph)

Length of body 12 mm., tails 7.5 mm., additional.

Color wholly blackish (though in younger nymphs possibly not so; these were ready for transformation) only a little paler beneath; the long hairs fringing the femora beneath are tawny yellowish brown; the gills are dirty whitish. These are as shown in the figures; two pairs on base of maxillae, one pair on base of labium; one pair at base of fore legs within, and single mid-ventral gills on each of the three thoracic segments. There are no signs of gills upon the abdomen.

Head broadly rounded to a dome-shaped frontal prominence, its sides overhanging the mouth parts (as indicated by the dotted line in fig. 52 of pl. 5). The clypeus is seen from above, but not the labrum, which is underneath; the latter is densely hairy, especially from a line across its base; the hairs stiff and bristly, some as long as the labium itself; the front border is distinctly concave. Antennae short, hardly surpassing the tip of the labrum.

The angulate lateral margins of the abdominal segments are beset with spinules. The apical ventral margin of the ninth segment is produced to the level of the tip of the tenth segment and widely notched, with a short acute tooth at either side of the notch. Tails 2.

Two male nymphs from Puerto Varas, Chile, April eighth or ninth, by Dr. J. C. Bradley.

## OLIGONEURIA

A single female imago of the sole known neotropical species *Oligoneuria anomala*, being well preserved in alcohol, shows certain characteristics of this species that have not yet been well described, and therefore a few descriptive notes are here added.

### OLIGONEURIA ANOMALA

Female—Length of body 10½ mm., length of wing 9 mm.

Head brown above, with a narrow pale line each side bordering the eyes, the two lines connected across rear of head to form a faint U mark. Prothorax brown,

## NEOTROPICAL MAYFLIES

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with five longitudinal pale lines, the narrow median one and two similar sub-marginal ones on the border, less distinct; a pale tract on either side lying in an intermediate position. Mesothorax paler, touched with brownish at front and rear. Metathorax also darker at rear. Abdomen brownish above, with paler joinings to the segments, a pair of pale dots within the brown of the dorsum that are at once sub-basal and sub-median on segments 2 to 9. There are two very narrow darkish parallel brown lines running lengthwise of the abdomen between the pale dots; these lines become sub-joined on the apex of segment 7, into one that is mid-dorsal on segments 8 and 9. Tails short, blackish with paler tips, as long as segments 7 to 10 taken together, medians and laterals about of equal length. Under parts of entire body pale. The rudimentary legs are clouded with brown on all segments; fore legs paler than the others, as well as weaker. Frontal carina of head produced downward in a triquetral snout, which is thick and bare and papilliform, lobed at the tip, as long as the head, and of a very black color. Egg, as shown in pl. 6, fig. 76.

### SIPHLONELLA N. GEN.

This name is proposed for a remarkable Baetine nymph from Chile, that is certainly very different from anything hitherto made known. It has double lamelliform gills on abdominal segments 1 to 4 only, on segment 1 elytrid and covering the others; it has large mid-dorsal hooks on these same segments and on these four only. It combines these characters with a Siphonurus-like series of lateral spines on the sides of the abdomen, and form of body, and appearance, together with Cloeon-like claws.

The venation of the nymphal wings shows affinities with Siphonurus rather than with Cloeon; for the posterior median fork of the fore wing is complete ( $M_4$  not detached), and the hind wing is broad and copiously veined. Unfortunately the specimens are not well enough preserved to show the venation in full detail; but we have been able to make out that in the fore wing the numerous costal cross veins at the stigmal region are very oblique and variously anastomosing, and the posterior median fork is somewhat unilateral being slightly askew to the rear, as in common in Siphonurine genera. The hind wing in the nymph is about as broad as it is long, with a rather wide and straightish costal border (in which no cross veins can be clearly seen) for two-thirds the wing length, then an oblique declivity of the margin (apparently with thickened border), then a further straight extension in an obtusely triangular, terminally rounded wing apex. In this apical portion at least are numerous cross veins; the basal parts are not clear, and no forks can be distinctly seen; 12 or 13 longitudinal veins behind

## SIPHLONELLA

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subcosta can be seen reaching the wing margin. These characters should be sufficient for recognition of the adult when found.

The nymph may be described as follows:

### SIPHLONELLA VENTILANS SP. N.

Length of body 10 mm., of tails 4 mm., additional.

Color translucent greenish brown, with ringed legs and tails. Head and thorax without distinct color pattern but with extensive mottling of lighter and darker throughout. The better colored specimens show on the dorsal surface of each of the middle abdominal segments a large brownish basal spot shaped like the keystone to an arch, with another similar one set upon it, outspread against the hind margin. Rearward these spots are divided by paler; mid-laterally on these segments the brown tends to form three small pale clouds.

The tails are three, bare at their slender and flexous tips, the middle one slightly shorter. They are obscurely ringed with brown at the apex of alternate segments; the lateral ones are heavily fringed within and thinly fringed without, where beset with close laid single spinules, one on each segment, and each as long as its segment. The hairs of the inner web are all uniformly dull gray.

Legs pale, with a faint dark cloud at two-thirds the length of the femora above, a conspicuous spot on the very oblique suture between tibia and tarsus and another on the top of the tarsus. Tibia and tarsus are consolidated to simulate a single segment, of which the former composes only a third part (pl. 9, fig. 104). Claw Cloeon-like, as long as the tibia (half as long as the tarsus) smoothly and very gently curved to a slender tip.

The abdomen is depressed with thin sharp lateral margins that terminate on each of segments 1 to 9 in backwardly directed, thin, sharp lateral spine, triangular on segment 1 and becoming longer and sharper to rear, on 9 about as long as is segment 10. There are mid-dorsal spines on segments 1 to 4, on 1 erect, on 2 to 4 directed to rearward like the teeth of a circular saw, thin, flat, acutely tipped. The gills are restricted to segments 1 to 4. On 1 they are elyroid, broader than the wing sheaths, which they resemble, being traversed lengthwise by palmately arranged and branching pigmented tracheae, and being somewhat similar in shape, though less pointed at tips. They are crossed by a pale suture-like line in the middle. All are double, and except on segment 1, where the anterior lamella is indurated, the upper or anterior lamella is reduced in size and lies closely upon the base of the posterior; the pairs grow smaller to rearward, and only the top plate of the first pair is pigmented; this one overtops and conceals all the others. See pl. 9, figs. 103, 104, 109, 110, 116 and 117.

Half a dozen nymphs, mostly well grown from Butalcura, Chile, April 5, 1920, collected by Dr. J. C. Bradley.

Holotype, C. U. No. 631, mounted on slides.

## NEOTROPICAL MAYFLIES

### LACHLANIA

Several nymphs of this genus were collected by Mr. E. B. Williamson in Guatemala. Some of the mouth parts of this nymph were figured by the junior author in the Bulletin of the Lloyd Library No. 22 in pl. 4, fig. 56, and in pl. 5, fig. 83. These may belong to the species *L. lucida*, the only one yet known from Guatemala. The type of the genus *L. abnormis* Hagen is from Cuba. Ulmer (Festschr. für Zschockke No. 25, p. 20) has described the nymph of *L. pallipes* (under the name *Noya pallipes*, following Navas) from Argentina, and it is so nearly identical with the specimens before us as to be surely congeneric with them. We are not, therefore, retaining the genus *Noya*. The venation of the nymphal wing of one of our specimens (see pl. 6, fig. 68) shows them to belong to *Lachlania*. The only deviation shown by our specimens from Ulmer's figures, are in the shape of the claw of the front tarsus, which in ours is stouter and more sharply hooked. Our largest specimen measures about 25 mm. in length of body with tails 12 mm. additional; abdomen 9 mm. Details of structure are illustrated in the figures on plate 6.

### LEPTOHYPHES

This genus of diminutive, well nigh dipterous mayflies ranges over the continent and is represented by four described species, to which two new ones are now added, and the nymphs of the genus (two undetermined species) are for the first time here described. These may be separated by the following keys:

#### ADULTS

- |   |                     |   |
|---|---------------------|---|
| 1—Large species (wing 8 mm.), black in color.....   | <i>eximius</i>      |   |
| —Smaller species (wing 3 to 6 mm.), yellowish or brown.....   |                     | 2 |
| 2—Brownish species from Central America.....  |                     | 3 |
| —Yellowish species from below the equator.....  |                     | 4 |
| 3—Dark or dull brown.....   | <i>costaricanus</i> |   |
| —Chestnut brown .....   | <i>brevissimus</i>  |   |
| 4—Hind wings veinless; their costal process slightly recurved.....  | <i>mollipes</i>     |   |
| —Hind wings with two long veins; their costal process longer and very strongly recurved; its point blunt..... |                     | 5 |
| 5—Penes of the ♂ divaricate and blunt at tips.....  | <i>peterseni</i>    |   |
| —Penes of the ♂ parallel and acuminate at tips.....   | <i>indicator</i>    |   |

#### LEPTOHYPHES MOLLIPES SP. N.

Male—Length of body 3 to 4.5 mm., wing 3.5 to 4.7 mm., tails 4 mm.

Female—Length of body 4.5 mm., wing 4 mm.



## LEPTOHYPHES

Color pale brown similar in males and females, with blackish head and whitish abdomen and tails. Disc of the prothorax very wide, more or less shield-shaped, wider than the head, flat above with a pale median area and a 4-rayed pale spot each side surrounded by blackish brown. Mesothorax pale brown with only narrow blackish isolated lines on some of the more prominent carinae and two pairs of blackish marks beside the dorsal crest. Abdomen whitish, the two basal and the three apical segments washed with brown above. A wash of the same color darkens the extreme tip of the tails. There is a faintly indicated longitudinal stripe along each side of the abdomen. All femora and tibiae are faintly tinged with purplish brown and all tarsi are white. Venation as shown in pl. 7, fig. 89. There are no veins at all in the hind wing. The genitalia of the male are shown in pl. 7, fig. 90.

Both imagos and subimagos of each sex from Cordisboro, Brazil, in November, 1919; collected in trap-lantern.

Holotype, C. U. No. 632, wings mounted on a slide, remainder in alcohol.

### LEPTOHYPHES INDICATOR SP. N.

Male—Length of body  $3\frac{1}{2}$  mm., of wing  $4\frac{1}{2}$  mm., of tails 5 mm.

Similar in form and color to the preceding but with the prothorax less broad and more blackish. The abdomen is faintly ringed with fuscous on each segment above; the hind femur has a broken ring of the same color near the apex. Venation as shown in pl. 7, fig. 77. In the hind wing there are two faint longitudinal veins as in *L. peterseni*, the rear one shorter and fainter, the costal process is very long and slender and gently arcuate to a long, sharp, recurrent point. Genitalia of the male as shown in pl. 7, fig. 78.

One male, Iguazu Falls, Misiones, Argentina; collected by Dr. J. C. Bradley.

Holotype, C. U. No. 633-1, wings and genitalia on a slide, remainder in alcohol.

### KEY TO THE NYMPHS OF LEPTOHYPHES

1—Prothorax normally angulate at its anterolateral angles.

*Leptohyphes* No. 1

(From Guatemala)

—Prothorax with a roll rim at the front immediately behind which is a flat ledge on the lateral margin and between the two a notch as viewed from above.

*Leptohyphes* No. 2

(From Peru)

### LEPTOHYPHES NYMPH NO. 1

This minute nymph having a length of body of 5 millimeters may belong to *L. brevissimus* Etn, the only member of the genus hitherto known from Guatemala,

## NEOTROPICAL MAYFLIES

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whence it comes, but the venation shown by the nymphal wing (see pl. 7, fig. 84) is more like that of the type species *L. eximius* as figured by Eaton in his Revisional Monograph (pl. 15, fig. 25). It has square cut angles to the front of the prothorax, a fringe of flat, short, oval and numerous (20 to 24) scales fringing the outer margin of the middle femora, lateral spines on the terminal abdominal segments that are closely applied to the sides of the body, and the mid-dorsal apical margin of segment 10 is produced into a triangular lobe.

The lacinia of the mandible of this species is figured by the junior author in the Bulletin of the Lloyd Library, No. 22, pl. 4, fig. 52. Herewith we present a small figure of the nymph and another of the venation of the fore wing of the same (pl. 7, figs. 88 and 84).

An immature nymph in alcohol, collected by Mr. E. B. Williamson at Gualan, Guatemala, in July, 1905, and now in the Cornell University collection.

### LEPTOHYPHES NYMPH NO. 2

This nymph from Camino de Pichis, Peru, we present in plate 7 in more detail. It is a dirty brownish specimen, showing no venation in its wings. It is blackish on the front of the head, on the top of the mesothorax and the dorsum of that part of the abdomen posterior to the gills; it is paler beneath and on antennae, tails and tarsi. As indicated in the key there is a notch just behind the front angle of the prothorax between the frontal rim and the prominent flat lateral carina. Gills are as in the other species, on segments 2 to 6 of abdomen, the first semi-operculate, oblique, indurated; the others smaller, thinner, more delicate.

The single nymph known was collected by Dr. J. C. Bradley on July 4, 1920, at Eneñas on the Camino del Pichis, in the Cerro de Sal, Junin, Peru, at an altitude of 1,491 meters.

## ATALOPHLEBIA

This antipodean genus is represented in Chile by two species: *A. chilensis* (Eaton, Rev. Monogr. Ephem., p. 91) and the following:

### ATALOPHLEBIA FULVIPES SP. N.

Male—Length of body 12 mm., of wing 13 mm., of tails 13 mm.

Color brown, becoming yellowish beneath. Eyes above testaceous, the lower division black. Prothorax with a narrow blackish collar. Mesothorax brownish fulvous, darker around the sides and at the front, and showing a faint mid-dorsal yellowish stripe. Legs tawny yellow; fore legs wanting; middle and hind femora with a brownish ring just beyond the middle and with darker tips. Wings

## ATALOPHLEBIA

hyaline, with a very faint tinge of fulvous at the costal strip, whose veins are brown, with the humeral cross vein blackish. Venation as shown in pl. 8, fig. 96.

Abdomen obscure but paler and translucent on middle segments; color pattern not preserved; segments 9 and 10 darker.

Forceps (pl. 8, fig. 98) rufous and penes yellowish. Tails fulvous, constricted on second segment, and faintly ringed by darker color toward tip of succeeding segments.

One male from Butalcura on Chiloe Island, Chile, August 5, 1920, collected by Dr. J. C. Bradley.

Holotype, C. U. No. 634.

### NYMPHS

We have had for study some well preserved alcoholic specimens of nymphs from Argentina, the venation of whose developing wings shows rather close correspondence with that of *A. chilensis* as figured by Eaton (Rev. Monogr. Ephem., pl. 10, fig. 16g). They may be described as follows:

*Atalophlebia* sp? nymph—Length of body 11 mm., tails 11 mm., additional.

Color greenish brown, darkest on dorsum of thorax and abdomen; paler on the face, on the sides of the prothorax, and on the entire lateral margin of the abdomen; in the male the dorsum of abdominal segments 4 and 5 and 8 to 10 are paler than in the female. Antennae pale with blackish tips. Tails pale with the joinings of a few of the basal segments narrowly ringed with brown. Legs (pl. 9, fig. 118) pale, with a streak of brownish on the middle of the external face of each femur. The femora bear among the hairs of their upper surface several lines of small and inconspicuous blunt-tipped spinules. Each claw (pl. 9, fig. 119) bears underneath a row of about a dozen minute denticles. Head and mouth parts are as shown in pl. 9, figs. 105, 110, 111 and 121.

The gills are double, long-lanceolate, very slowly tapering, with dense pinnately arranged, purplish, main tracheal branches, that are several times dichotomously branched in each division of the gill plate, and that give color to the gills quite to their tips.

Nine well preserved nymphs from Puente del Inca, Argentina, 3,300 meters altitude, March 22, 1910.

## ATALONELLA GEN. NOV.

This genus is established to include two small species from Chile, one of which, *A. fusca* (Ulmer, Arch. f. Naturg. 85:20), has hitherto been included in *Atalophlebia*, and the other of which, *A. ophis*, is described herewith as new. The nymph corresponding to the latter is also described herewith. Both nymphal and adult characters seem to separate these forms clearly from typical *Atalophlebias*. The venational distinctions are stated comparatively as follows:

## NEOTROPICAL MAYFLIES

FORE WING		
<i>Characters</i>	<i>Atalophlebia</i>	<i>Atalonella</i>
Costal cross veins in the basal half of the subcostal space	Numerous	Wanting
Costal cross veins of the stigmal region	Erect	Aslant
Bisector of the cubital fork at its proximal end	Nearer to the first anal vein	In middle of the fork
Second anal vein	Straight in its apical third	Curved all the way to the tip

HIND WING		
<i>Characters</i>	<i>Atalophlebia</i>	<i>Atalonella</i>
Tip of subcostal vein at	Nine-tenths of wing length	Three-fourths of wing length
Upper fork of median vein	Normal, attached	Disconnected at base
Bisector of lower fork of median vein	Present	Absent
Cross veins between the anal veins	Present	Absent

The differences in nymphal characters may be stated comparatively as follows:

NYMPHS		
<i>Characters</i>	<i>Atalophlebia</i>	<i>Atalonella</i>
Lateral spines on abdominal segments	5 to 9	On 9 only
Femora	Dilated	Slender
Distal tooth under tarsal claw	Minute	Excessively large
Width of labrum exceeds length	Three times	Two times
Glossae of labium at tips	Conic-pointed	Widened

### ATALONELLA OPHIS SP. N.

Male—Length of body 7 mm., of wing 7.5 mm., of tails 10 mm., of fore leg 9.5 mm.

Color deep rich brown, darkest on eyes and on top of mesothorax. Prothorax with a narrow dark nuchal line; balance of thorax all brown, paler only on the sutures and beneath. Legs pale translucent yellowish, a darker touch upon the knees shows on middle and hind legs more plainly because these are paler than the fore legs. No bands on femora. Wings hyaline and iridescent with a duller but hyaline costal strip and a brown humeral cross vein. Venation as shown in pl. 8, fig. 97.

## ATALONELLA

Abdomen brown, wholly so at ends, and across apex and sides of middle segment, each of which is invaded by an obscure paler triangle and a pair of lateral subapical round spots. Forceps (pl. 8, fig. 101) and penes yellow, the former brown at base externally. Tails nearly concolorous pale, faintly ringed about the joinings of the short basal segment.

Many specimens, all males from Butalcura, Chile, April 4, 1920, collected by Dr. J. C. Bradley. Holotype, C. U. No. 635, mounted on a slide.

This species is near to *A. fusca* Ulmer in size and in venation, but differs in color pattern of legs and abdomen, and in form of genitalia.

### NYMPH

To this genus is referred a Chilean nymph corresponding in size with *A. fusca*, which is very closely related to *A. ophis*. Its hind wing (see pl. 9, fig. 113) agrees fairly well with the hind wing of the latter species (pl. 8, fig. 97a); therefore, though not proved, the reference to this genus seems safe. It may be described as follows:

### ATALONELLA SP? (SUPPOSITION) NYMPH

Length of body 6 to 7 mm., tails broken.

A pale greenish brown nymph with broad depressed linear body and broad pale femora. Head and thorax obscurely mottled, a little darker at the lateral margins. There are pale spots before each ocellus and also on the rear of the head. Mouth parts, as shown in pl. 9, figs. 106 and 112.

Abdomen obscure; in the paler specimens there appears a double row of inverted U-spots, a pair on each segment, each opening to the rear. In darker specimens the brown overspreads the dorsum leaving sometimes a row of pale spots each side (the portion within the U-spots), and a mid-dorsal streak. Gills purplish, lanceolate in outline with acuminate tips and rather coarsely pinnate tracheation.

The lateral spines on abdominal segments 5 to 9 are short and triangular in front and become longer and sharper on successive segments, on segment 9 being about as long as the body of that segment, and closely appressed to the sides of segment 10. The prolonged sternite of 9 is produced backward in a long and wide triangular lobe, obtuse at tip, and surpassing the tenth segment by the length of that segment.

Each tarsal claw (pl. 9, fig. 107) has a few minute denticles underneath in a series that abruptly terminates in a denticle so long that it simulates a fork with the tip. Fore leg as shown in pl. 9, fig. 108.

Numerous specimens in alcohol (not very well preserved) from Puerto Varas, Chile, April 8, 1920, collected by Dr. J. C. Bradley.

## NEOTROPICAL MAYFLIES

### (?) DELEATIDIUM

Three species of nymphs having some relationships with the two preceding genera are before us, none of them in proper condition for the study of the venation. All come from Chile. They are doubtfully referred to the two remaining allied genera that are now known from Chile. Two large species, having long sharp lateral spines on abdominal segments 8 and 9 are referred to Deleatidium, and the third, a small species having short triangular lateral spines on these same segments, to Nousia. These nymphs, though quite different in size, and all apparently well grown, agree well in color pattern and in form. The front border of the broad labrum is widely emarginate, and broadest across the anterior portion. The lanceolate gills terminate in long tapering points. One nymph is too large to belong to any described species of Deleatidium; the two referred to that genus may be distinguished by size as follows:

- 1—Length of body 16 mm. . . . . Deleatidium Nymph No. 1  
—Length of body 11 mm. . . . . Deleatidium Nymph No. 2

#### (?) DELEATIDIUM NYMPH NO. 1

Length of body 16 mm., tails 10 mm., additional.

A stout bodied brownish nymph with dilated and brown-banded femora, and stout bare tails and antennae.

The general brownish color includes some marmorate paler areas upon the thorax. A triangle of paler spots on the head, one before each ocellus, a pair on the clypeus, a narrow median line on the occiput, and a generally paler color on the dorsum of the middle abdominal segments leaving, besides brown lateral and apical margins to the segments, two parallel rows of brownish spots, the outer darker and less interrupted. Tails and antennae are pale brown. The lateral spines on the abdomen are like those shown in pl. 9, fig. 115.

Ten nymphs from Butalcura, Chiloe Island, Chile, April 5, 1920, collected by Dr. J. C. Bradley.

#### (?) DELEATIDIUM NYMPH NO. 2

Length of body 11 mm., tails 5 mm., additional.

Very similar to the preceding, especially in distribution of the pale spots on the head; but on the middle abdominal segments there is a median basal pale spot, and there are two additional mid-lateral ones on each side of each segment. The lateral margin of the abdomen is not darker than the general ground color. The lateral spines on the abdominal segments are as shown in pl. 9, fig. 115.

A dozen or more poorly preserved alcoholic nymphs from Puerto Varas, Chile.

## NOUSIA — HERMANELLA

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### (?) NOUSIA

The nymphs herewith doubtfully referred to this genus differ from the two last preceding chiefly in having short flat triangular lateral spines on abdominal segments 8 and 9 (pl. 9, fig. 120), and in their smaller size.

#### (?) NOUSIA NYMPH No. 1

Length of body 7 mm., tails broken off and lost.

Color obscure greenish with very numerous narrow brown markings all over the dorsal surface, but defined on the top of the thorax. The spots on the face are arranged as in the two preceding species. The brown of the abdomen tends to form two submedian and two mid-lateral longitudinal lines. The broad femora show obscure clouds of fuscous on the outer face. A pale specimen shows on the mesothorax two small brown U-marks on the front margin, opening backward, and opposed to a brown W-mark behind.

Ten specimens from Butalcura, Chiloe Island, Chile, April 5, 1920, collected by Dr. J. C. Bradley.

### HERMANELLA GEN. N.

This genus is based on two nymphs from Chile of very unique character. One of these nymphs shows venation in its wings completely enough to allow the genus to be characterized thereby; for it is an unique venation. Fore and hind wings are shown in pl. 10, fig. 133. In the fore wing there are numerous costal cross veins; both principal median forks are well outward in the wing and the rear one is oblique, strongly askew to rearward, as is also the deep cubital fork. The basal half of the latter fork lacks cross veins, the bisector of the fork being but half its length. The two long intercalaries between first and second anal veins hardly differ in appearance from these veins and are conjoined by many erect cross veins. The apex of the hind wing is eroded at the front beyond a low costal angulation and no cross veins are visible in the costal or subcostal spaces before this angulation. The first median fork is strong and contains two equal intercalaries, conjoined by two cross veins, and behind the fork are two additional long veins conjoined by a single cross vein.

The nymph of this genus is a grotesque-looking little black creature, strongly depressed, with a big, flat, squarish head that appears almost as large as the thorax, stout spiny legs, an abbreviated abdomen and very long tails. The enormous maxillary palpi stick out like elbows beyond the sides of the head, the elongated white second joint showing conspicuously alongside, and the copious brown brushes of long plancton-gathering bristles that clothe the last segment

## NEOTROPICAL MAYFLIES

showing more or less, according to their extension, at the front. The ample wing sheaths of the nymph well nigh cover the abbreviated abdomen, functioning as opercula for the gills which they completely conceal.

Type, the following species:

### HERMANELLA THELMA SP. N.

Length of body of nymph 4 mm., middle tail 6 mm.

Color blackish brown above, pale beneath. There are cloud-like pale spots at sides of head and of prothorax in front and at base and apex of femora, and there are dark rings on the pale tibiae and tarsi. Details of structure are illustrated in the figures of plate 10. There are lateral spines on the eighth and ninth abdominal segments and the ninth in the female is produced on the ventral side beyond the apex of the tenth segment, and bifid at the tip, where it terminates in a pair of triangular points. Tails rather bare, and faintly ringed with darker color at the closely set joinings of the segments. The upper division of the eyes of the male nymph are reddish brown, and only partially cover the black annular lower division.

Two specimens from Iguazu Falls, Argentina, January 25, 1920, collected by Dr. J. C. Bradley.

Holotype, C. U. No. 636, mounted on slides.

## THRAULODES

This genus of ornate little mayflies is abundantly represented in Neotropical America. To the ten species hitherto described we add two new ones from Peru. We are able to describe also a nymph of this genus.

### ARTIFICIAL KEY TO THE IMAGOS

- |   |                  |
|---|------------------|
| 1—Large species (wing 15 mm.), legs brown, not banded nor striped.....  | 2                |
| —Smaller species (wing 11 mm. or less), legs mostly banded or striped.. | 3                |
| 2—Color light brown.....  | <i>columbiae</i> |
| —Color rufous .....   | <i>nervosa</i>   |
| 3—Species of intermediate size (wing 8 to 11 mm.).....                  | 4                |
| —Species of the smallest size (wing 7 mm.).....                         | 9                |
| 4—Legs plain brown, tips of tails black.....                            | <i>lepidus</i>   |
| —Legs banded or streaked with brown.....                                | 5                |
| 5—With lengthwise stripe on femora.....                                 | <i>valens</i>    |
| —With brown rings on femora.....  | 6                |
| 6—Legs with a single ring of brown.....                                 | 7                |
| —Legs with two rings of brown.....                                      | 8                |



## THRAULODES

- |     |  |                      |
|-----|--|----------------------|
| 7—  | Top of mesothorax plain yellowish brown.....   | <i>telegraphicus</i> |
|     | —Top of mesothorax having a shield-shaped field that is sharply defined by angulate brown lines..... | <i>plicatus</i>      |
| 8—  | Spots on lateral margin of abdominal segments single.....  | <i>laetus</i>        |
|     | —Spots on lateral margin of abdominal segments in threes....   | <i>bomplandi</i>     |
| 9—  | Thorax grayish black.....  | <i>vitripennis</i>   |
|     | —Thorax brownish .....   | 10                   |
| 10— | Thorax yellowish brown.....  | <i>lepidus</i>       |
|     | —Thorax blackish brown.....  | <i>mexicanus</i>     |

### THRAULODES TELEGRAPHICUS SP. N.

Male—Length of body 9.5-10 mm., of wing 11-11.5 mm., of tails 25 mm.

Female—Length of body 8.5-9.5 mm., wing 11-11.5 mm.

Colors yellow and brown. Upper eye of ♂ red brown. Basal segment of antenna rufous, surrounded by a rufous ring that is again surrounded by a yellow ring. There is a yellowish median spot between the ocelli, and another lies upon the clypeolabral border. Prothorax yellow, with a narrow brown line running obliquely downward to the base of the fore leg. The mesothorax is fawn-yellow with brownish trimmings; the crest at its rear is brown in the middle and yellow at the sides. The more convex of the ventral surfaces are broadly washed with pale brown.

The wings are hyaline, with yellowish venation and an arcuate basal brown spot runs from the humeral cross vein backward in both wings. The venation is as shown in pl. 8, fig. 99.

The legs are yellowish, with a wide subapical brown ring on the femora, proximal to which the outer face has a fawn yellow area bordered with brown. Tibiae and tarsal segments are marked with brown at the tip, the latter more faintly.

The abdomen in the male is brown at both ends above, and translucent whitish in segments 2 to 6—so translucent that the spots of the opposite side show through. There is a row of roundish brown spots on the lateral margins of segments 2 to 7, elongated to broad dashes on segments 8 and 9, and there is a second row of similar spots midway of the sides on segments 2 to 6. The dorsum of segments 7 to 10 is a rich chestnut brown color bordered laterally by whitish, the brown deepening in intensity but narrowing in width to the rearward. The abdomen in the female has similar lateral markings, but dorsally there is a median brown band that descends to sides at base of the segments in tracts that increase in breadth to rearward. In old females the pale areas at the sides become chalky white and contracts beautifully with the rich red brown of the dorsum. The humeral cross vein also reddens with age.

## NEOTROPICAL MAYFLIES

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The tails beyond their yellowish extreme basal segments, are conspicuously ringed with black and white, not in alternate segments, but irregularly, forming dots and dashes (suggesting a telegraphic message, whence the specific name). Forceps of the male (pl. 8, fig. 102) brownish externally on the basal half.

A very beautiful species, near to *Th. laetus* from Colombia.

Four specimens, one imago and one subimago of each sex, from Campamiento, Colony of the Perené, Junin, Peru, June 28, 1920, collected by Dr. J. C. Bradley. One additional male bears date of June 27th.

Holotype, C. U. No. 637, mounted on a slide.

### THRAULODES PLICATUS SP. N.

Male—Length of body 8 mm., of wing 10 mm.

Female—Length of body 10 mm., of wing 9.5 mm.

Color yellowish with a shield-shaped area on the top of the mesothorax outlined in angulated fuscous lines. Head blackish. Abdomen yellowish, becoming rufous toward the tip in the male or yellow in the female. Prothorax broad, laterally expanded at the front in epaulet-like lobes that are narrowly edged with black. The disc of the mesothorax bears a median pale line that is expanded to form a double hook at the front end, and that runs rearward out of the shield-shaped area to a yellow spot upon the crest. The sides of the thorax bear faint touches of brown about the bases of the legs.

The wings (pl. 8, fig. 100) are hyaline, with a fuscous spot crossing the veins Sc and R at the humeral cross vein. The legs are yellowish with an obscure band of brown beyond the middle and a touch of brown externally at the knees. There is a much darker and more distinct brown spot at the apex of the tibia. Front feet of male, missing; of female, white.

The abdomen in the male is translucent whitish on segments 2 to 7, and not distinctly annulate, though paler at the joinings of the segments; there is a mid-lateral roundish brown spot each side and another smaller one below this at the stigma; on segments 8 and 9 there is a blackish dash along the lateral margin. Segment 1 is brownish at the sides and segments 9 and 10 are rufescent dorsally. In the female the abdomen is transversely banded with brown, the joinings of the segments being whitish. The brown is restricted to the base at the sides, and in the paler area stigmatic spots appear as in the male. The sides of segment 1 are blackish, and the dorsum of the apical segments is whitish or yellowish. Only the bases of the broken tails are present; in these the segments increase rapidly in length and the broken rings at their tips increase in width proportionately.

One male imago (the type) and one male subimago, El Campamiento, Colony of the Perené, Junin, Peru, June 20, 1920; also two female subimagos,

## HAGENULOPSIS

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Puerto Bermudez on the Rio Pichis, Peru, July 11 and 19, 1920, J. C. Bradley collector.

Holotype, C. U. No. 638, two wings and genitalia on slides, the remainder in alcohol.

### THE NYMPH

The nymphs here referred to *Thraulodes* and those described under the two following generic names, are much more closely related to each other than were those of the three preceding genera. The three rather closely agree in the following diagnostic characters:—

1. Lateral spines with eroded tips on abdominal segments 2 to 9.
2. Labrum pointed at ends, not notched in the middle in front.
3. Last joint of labial palpus minute.
4. Glossae of labium, semi-elliptical, inner margin straight.
5. The rearward projecting triangular lobe of the ninth abdominal sternite is notched at the tip.

Unfortunately, the venation of the wings is not well preserved in any of them. Only in the first described have we been able to make out the single point that the median fork of the hind wing is present; hence its reference to *Thraulodes*.

To the genus *Thraulodes* we refer two nymphs from Peru having the gills graduated in size and becoming smaller to rearward, on the basis of the venation of the hind wing, which, though poorly preserved, yet shows a well developed posterior fork, such as is characteristic of *Thraulodes*. The nymph may be briefly characterized as follows:

### THRAULODES SP? NYMPH

Length of body 10 mm., tails 10 mm., additional, antennae 5 mm. ..

Color above uniform brown, with only faint touches of paler on the top of the thorax, and no discernible pattern on the abdomen. Form strongly depressed with a broad squarish head. The postero-lateral spines on the abdomen have exteriorly eroded tips as shown in pl. 9, fig. 123.

Two nymphs from Eneñas on the Camino del Pichis in the Cerro de Sal, Junin, Peru, July 4, 1920 (altitude 1,401 meters), collected by Dr. J. C. Bradley.

## HAGENULOPSIS

A single nymph from Peru is doubtfully referred to this genus. There is no venation discernible in its wings, owing to bad preservation, and the reference to this genus is based solely on the fact that it has no hind wings, and that

## NEOTROPICAL MAYFLIES

Hagenulopsis is the only known South American genus of Thraululus allies that has this character; all the others have two pairs of wings. It may be briefly characterized as follows:

### HAGENULOPSIS SP? NYMPH

Length of body 4 mm., tails 11 mm., additional.

A curious, little, flat, long-tailed nymph of pale greenish-brown color that is hardly varied with paler in a few mottled areas on top of head and thorax. Abdomen with transverse darker line across the apical margin of its segments, and with spots of same at sides of middle segments. Legs blackish, fringed externally with scurfy brownish hairs.

One nymph: Eneñas on the Camino del Pichis, Junin, Peru, July 4, 1920.

## THRAULUS

Of the five described neotropical species of this genus of delicate mayflies, two are represented in the collections made by the Cornell University Entomological Expedition: *T. missionensis* and *T. valdemari*, both from Argentina, the latter from Rio Alta Parana. To these five we add two new species. The seven may be separated by the key given below.

The nymphs here referred to this genus do not agree well with those of European *T. bellus* as described and figured by Eaton. (Rev. Monograph. Ephem., pl. 35) especially in the form of the gills, but are more like those than like any other known forms. Unfortunately none of the nymphs was positively determinable.

### KEY TO THE NEOTROPICAL SPECIES OF THRAULUS.

- 1—With two brown rings on each femur, and a brown costal strip on fore wing ..... *ehrharti*
- With not more than one brown femoral ring..... 2
- 2—With an arcuate brown band across the base of both wings..... *bradleyi*
- With no arcuate brown band across the base of both wings..... 3
- 3—Tails ringed with brown..... 4
- Tails not ringed with brown..... 6
- 4—Legs blackish; basal half of wings yellowish..... *primanus*
- Legs yellowish; basal half of wings not yellowish..... 5
- 5—Wings marked with brown on cross veins..... *maculipennis*
- Wings hyaline not with brown on cross veins..... *missionensis*\*

\* New figures of venation and genitalia of this species are shown in Pl. 11, figs. 139 and 144.

## THRAULUS

- 6—Legs brown ..... 7  
—Legs yellow, with a brown ring on the femur.....*maculatus*  
7—Thorax dark brown; wing length 7.5 mm.....*valdemari*  
—Thorax light brown; wing length 11-12 mm.....*versicolor*

### THRAULUS BRADLEYI SP. N.

Male—Length of body 7 mm., of wing 6.5 mm.

Female—Length of body 6.5 mm., of wing 7 mm.

Color of the male imago rich red brown, only the bordering carinae of the thoracic segments narrowly bordered with blackish. Legs lost. Wings hyaline; both fore and hind wings with an arcuate brown spot covering the base at the level of the humeral cross vein; bases of the stronger veins yellowish. Venation as shown in pl. 11, fig. 137. Abdomen brownish above on the base of the first segment, whitish translucent on segments 2 to 6, with bands of brown across the apices, increasing in width to rearward; segments 7 to 9 brownish, and segment 10 paler. Tails broken off and lost. Genitalia of male as shown in pl. 11, fig. 142.

The male subimago is similar, with colors fainter.

The female has the head yellowish above with a flexuous fuscous band across the ocelli, another across the front border of the prothorax. There are narrow fuscous lines before the roots of the fore wings, and on the sides of the dorsal crest at the rear of the mesothorax. There are transverse bars of brown covering the dorsum of segment 1 of the abdomen, and faintly over-spreading segments 2 to 5, divided with paler by a narrow median line.

One male imago and one female subimago from Rio Alta Parana above Posadas, Argentina, January 18, 1920; also two ♂ and one ♀ subimagos from Paraguay River, Brazil, December, 1919.

Holotype, male imago, C. U. No. 641, wings and genitalia mounted on slides.

### THRAULUS MACULATUS SP. N.

Male—Length of body 5.5 mm., of wing 5.5 mm., of tails 6 to 8 mm.

Color brown. Eyes black in the lower, red in the upper division. There are rings of black about the ocelli and about the bases of the yellow antennae. Thorax wholly brown, only a little paler below, especially about the bases of the legs. Legs whitish, faintly tinged with brown, with obscure subapical rings on the femora, that are most evident on the hind legs. Wings hyaline, with only the bases of a few of the stronger veins yellowish. Venation as shown in pl. 11, fig. 138.

Abdomen brown above with yellowish spots; the larger of these form a row of right triangles on each side, with their inner margins forming an interrupted

## NEOTROPICAL MAYFLIES

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longitudinal line, and their outer margins (hypothenuse) resting on the serrated lateral border of brown. There is also a pair of small more dorsal roundish basal spots on each of the same segments, with a very narrow pale median line dividing the brown between them. Tips of forceps (pl. II, fig. 143) white. Tails white.

Many male specimens from two localities in Argentina, Cosquin, and Santa Fe. Holotype, male imago, C. U. N. —

The smallest species of the genus, near *missionensis* Peterson.

### THRAULUS NYMPH NO. 1

Length of body 10 mm., of which the head comprises nearly 2 mm., tails broken.

Color dark brownish above, mottled with paler. There is a pale sinuate line from eye to eye before the ocelli and there are other fine pale lines on the face. A narrow pale mid-dorsal line traverses pro- and mesothorax, on the latter accompanied by two others out-curving toward the front of the segment. On the disc of pro- and mesothorax are also some obscure paired paler areas. The joinings of the abdominal segments are brownish, the lateral margins, and a pale wash across the apex, and all of the tenth segment being paler.

The venation of the nymphal fore wing is very imperfectly preserved (of the hind one, not preserved at all); it shows the weak cross veins of the stigmal region very oblique but not conjoined. It shows the rear fork of vein M at midway the length of the wing. It shows a rather wide cubital fork, deeper than the preceding fork, and skewed considerably to the rear.

Numerous specimens Eneñas on the Camino del Pichis in the Cerro de Sal, Junin, Peru, altitude 1,491 meters.

### THRAULUS NYMPH NO. 2

Length of body 7 mm., tails broken.

A broadly depressed, squarish headed, brown nymph with narrowly lanceolate double gills. Color brown. Head with a blackish spot between the ocelli that is surrounded in front by a paler area. Prothorax brownish with a paler area on each side of the disc. Mesothorax brownish obscurely mottled with paler. Abdomen brown with darker bands across the apical margins of the segments and an interrupted longitudinal line traverses them on each side. Base of (broken) tails is brownish, but the legs are paler.

The fore wing of the nymph shows the following features: There are rather numerous cross veins in the basal half of the costal space. The posterior division of the median vein is a little askew to rearward at its fork. There are two short intercalaries on a common stalk between the first and second anal veins,

## CHOROTERPES

and attached to the former, with no cross veins showing in this area.

Numerous alcoholic specimens from Tambo Miriatiriani on the Camino del Pichis, Junin, Peru, July 9, 1920.

### (?) THRAULUS NYMPH No. 3

Length of body 7 to 8 mm., tails broken and lost.

Color greenish brown. A pale arcuate area in front of ocelli, and rear of head paler, especially next the eyes. Three nearly contiguous pale clouds extend across the rear of the prothorax. Front femora pale, showing two faint bands of brown, the proximal one incomplete.

Abdomen pale, with brownish bands across the apices of the segments; these narrow and complete on segments 8, 9 and 10, wider on segments 4 to 7, and interrupted in the middle and expanded at the sides, on the basal segments. Gills lanceolate pale with the larger middle tracheae pale purplish.

Four specimens from Tambo Miriatiriani on the Camino del Pichis, Junin, Peru, July 9, 1920.

## CHOROTERPES

To the single described neotropical species of this genus we add descriptions of two new ones. The three may be separated as follows:

- 1—Size small (wing 5 mm.).....*ermersoni*  
—Size larger (wing 7-9 mm.)..... 2  
2—Thorax black above.....*inornata*  
—Thorax yellow above with two black stripes.....*bilineata*

### CHOROTERPES EMERSONI SP. N.

Male—Length of body 4 mm., of wing 5 mm., tails 10 mm.

Female—Length of body 4½ mm., of wing 5 mm.

Color reddish brown deepening to black on the head, with hardly any pattern. The abdominal segments are lineate with blackish across the dorsal apical margins of the segments and along the lateral carinae. Tails yellow, the joinings of the segments narrowly marked with brown. Wings hyaline, obscurer along a costal strip, especially in the stigmatic area of it. Venation as shown in pl. II, fig. 141. Legs yellowish, the front femora brownish as are also the tips of the tibiae. There are also faint submedian and apical brownish clouds on the femora of middle and hind legs.

The male forceps (pl. II, fig. 145) are brown externally. In the female the tenth abdominal ventral segment is produced to rear into a triangular lobe as

## NEOTROPICAL MAYFLIES

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long as the body of the segment and bifid at the tip. The seventh segment is produced to rear in a long triangular ovipositor (see pl. 11, fig. 146) whose tip is on a level with the tips of the tenth segment.

Male and female specimens from Kalacoon, Bartica District, British Guiana, collected by Alfred E. Emerson on March 23, 1918.

Holotype, C. U. No. 639, wings and genitalia mounted on slides.

They were collected from spiders' webs that overhung Kalacoon brook. In the same brook were found nymphs that appear to belong to this species. They differ from the nymphs of this genus hitherto made know (in Europe and North America) by the shape of the gills. These in the Kalacoon species are double, lanceolate and smoothly tapering to long slender tips, not at all notched or lobed.

### CHOROTERPES BILINEATA SP. N.

Male—Length of body 6.5 mm., of wing 7 mm.

Female—Length of body 7 mm., of wing 9 mm.

Color pale yellowish, with two dorsal blackish stripes extending from head to tail, blackest on the prothorax, widest apart on the mesothorax and becoming confluent on the apical segments of the abdomen. No other markings except on the wings, which have a regular costal strip of yellow or fawn color with brown overspreading a few cross veins in the stigmatic region. Humeral cross vein deep blackish brown. Membrane of the wings hyaline and iridescent; veins yellowish. Venation shown in pl. 11, fig. 140.

Two male subimagos from Rio Putumayo, Peru, August 14, 1919.

Five females, La Chorrera, Putumayo Distr., Peru, August 16, 1919, collected by Dr. J. C. Bradley.

Holotype, female, C. U. No. 640-1, wings mounted on a slide, the remainder in alcohol.

A handsome and very distinct species.

## CALLIBAETIS

An American genus, abundantly represented in both continents, containing species of moderate size and of very beautiful coloration. A few species are wholly pale, but the wings of most species are marked with brown in very ornate patterns. There are differences between the sexes in depth of coloration, and often great differences between imago and subimago in the extent of it. The following key, being based largely on published descriptions of imagos, is not to be trusted too far; careful reference must be made to original sources.

Nymphs of this genus have been described and figured by the senior author in N. Y. State Museum Bull. 68; 216-217, pl. 7.



## CALLIBAETIS

### KEY TO NEOTROPICAL SPECIES; IMAGOS

- |  |                     |
|--|---------------------|
| 1—Wings colored .....  | 2                   |
| —Wings hyaline .....   | 14                  |
| 2—Brown of the wings, diffuse.....   | 3                   |
| —Brown of the wings mainly confined to a costal strip covering the three veins C, Sc and R <sub>1</sub> .....                              | 9                   |
| 3—Brown of the wings fenestrate, by hyaline areas surrounding cross veins .....  | <i>apertus</i>      |
| —Brown of the wings in oblique cross bands separated by hyaline area that follows lines of cross veins.....                                | 4                   |
| 4—Hyaline areas, rather narrow bands.....  | 5                   |
| —Hyaline areas broader, the intervening brown bands more or less interrupted or scattered.....   | 8                   |
| 5—Short intercalaries over most of the hind margin of the fore wing single or wanting.....   | 6                   |
| —Short intercalaries over most of the hind margin of the fore wing in pairs .....  | 7                   |
| 6—Costal area of fore wing fenestrate with hyaline on the cross veins .....  | <i>trifasciatus</i> |
| —Costal area of the fore wing uniformly tinted.....  | <i>sellacki</i>     |
| 7—Wing three times as long as wide; brown bands very oblique, parallel to the hind margin; cross veins numerous, in three rows..           | <i>fasciatus</i>    |
| —Wing two and a half times as long as wide; bands more transverse; cross veins fewer in incomplete, indistinct rows.....                   | <i>jocosa</i>       |
| 8—Brown dispersed across the wing apex.....  | <i>apicatus</i>     |
| —Brown extended across the middle of the wing.....   | <i>guttatus</i>     |
| 9—Pale brownish markings extend rearward from the apex of the colored costal strip around the distal portion of the hind border.....       | <i>pictus</i>       |
| —No such markings behind the costal strip.....   | 10                  |
| 10—Costal strip broken into spots between paler areas in its middle portion; hind wing with about two cross veins behind its costal area.. | <i>zonalis</i>      |
| —Costal strip not wholly interrupted by its paler markings; cross veins of hind wing numerous.....   | 11                  |
| 11—Intercalaries of hind wing between second and third long veins, distinct .....  | <i>jaffueli</i>     |
| —Intercalaries of hind wing indistinct or wanting.....   | 12                  |
| 12—Base of hind wing tinged with brown.....  | 13                  |
| —Base of hind wing hyaline.....  | <i>viparius</i>     |
| 13—Basal half of costal space with cross veins.....  | <i>montanus</i>     |
| —Basal half of costal space with no cross veins.....   | <i>viviparus</i>    |

## NEOTROPICAL MAYFLIES

- 14—Hind wing with short intercalaries between the second and third long veins ..... 15  
 —Hind wing with no intercalaries between these veins.....*abundans*  
 15—Color of thorax pale yellow; wing length 5.5 mm.....*pallens*  
 —Color of thorax piceous; wing length 7.8 mm.....*vitreus*

### CALLIBAETIS VIVIPARUS SP. N.

Female—Length of body 8.5 mm., wings 7.5 mm.

Color yellowish, besprinkled with dots of purplish brown. A wide dorsal band of pale brownish color begins on the head (where separated from the eye on each side by a longitudinal pale line) and continues on the thorax (where divided by a pale line and narrowly interrupted on the rear margin of the prothorax by another transverse one), darkest in color on the front of the mesothorax and becoming obscure on the abdomen. Antennal segments 1 and 2 ringed with brown, 2 more broadly.

Wings with a distinct costal band of brown fenestrate (with hyaline as shown in pl. 12, fig. 152) in the places where costal cross veins normally occur (these, however, being very faint or wanting). The band is traversed by about ten simple oblique costal cross veins in the region of the stigma. Base of radius blackish, as are the cross veins in the base of the subcostal space; these latter occur in more or less irregular groups surrounded by hyaline spots. A few paler cross veins are similarly surrounded in the subcostal space at beginning of the stigma, and behind these are two other similar, rather more conspicuous clear spots, that widen to rearward, covering the cross veins in the first radial space and overlapping the first branch of the median vein. The brown costal strip overspreads vein  $M_1$  a little at the wing apex, and again at the base where it extends rearward upon the anal arc. The hind wing is hyaline. There is an oblong axillary spot of deep brown color on the thorax underneath the base of the fore wing.

There are roundish brown spots both above and below the stigma on each side of abdominal segments 2 to 9, these mostly double, a large portion above a smaller one. Sides and venter of abdomen and of thorax thickly sprinkled with dots of bright purplish color. Legs pale, with faint brown touches on the joinings of the segments. Tails lost.

Three female specimens, all imagos, from Corumbá, Brazil, December 14, 1919.

Holotype, C. U. No. 643, mounted on a slide.

This handsome species is near *C. montanus*, but differs by the characters given in the key. The eggs in these females contained well developed embryos as indicated in figure 154 of pl. 12. Hitherto *Cloeon* in Europe is the one

## BAETIS

ephemerid known to be viviparous, while *Ameletus ludens* in North America is the only one known to be parthenogenetic (Morgan, Ann. Ent. Soc. Amer. 4; 117, 1911).

### CALLIBAETIS POLLENS SP. N.

Male—Length of body 5.5 mm., wing 5.5 mm., tails 10 mm.

Female—Length of body 6 mm., wing 5.7 mm.

Color wholly pale yellow with an amber tint on the upper eyes of the male and on the second joint of the antennae; lower division of eyes black. There are several faint rings on a few basal joinings of the tails of the male, and a female subimago shows a double row of blackish sub-spiracular spots on the abdomen in segments 3 to 9.

Wings hyaline; veins white; venation as shown in pl. 12, fig. 147; forceps of the male as shown in pl. 12, fig. 162.

A male imago and a female subimago from Corumbá, Brazil, December 14, 1899, collected by Dr. J. C. Bradley.

Holotype, male, C. U. No. 644, mounted on slides.

### CALLIBAETIS JOCOSA.

This species appears to be represented by a single female imago from Paraguay River above Porto Esperança, Brazil, collected in December, 1919. Since it is somewhat smaller in size (length of body 6.2 mm., wing 5.5 mm.), and does not quite agree in details of color it is referred here doubtfully; but its venation agrees with that of *C. Jocos*a as figured by Navas in *Brotéria* 10; 196.

## BAETIS

This cosmopolitan genus of small mayflies is well represented in South America. To the half dozen species hitherto described we add four new ones. A still larger number of species were obtained as nymphs by the Cornell University Expedition, and three of these that show differences from the nymphs of the genus hitherto made known in Europe and North America, are described in the following pages.

### KEY TO THE SPECIES—IMAGOS

- |   |   |
|---|---|
| 1—Hind wings with three longitudinal veins..... | 2 |
| —Hind wings with two longitudinal veins.....    | 6 |
| 2—The second of these veins forked.....         | 3 |
| —The second of these veins simple.....          | 5 |

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3—Fore wings with a brownish costal band.....	<i>salvini</i>
—Fore wings hyaline.....	4
4—Hind wings with cross veins.....	<i>peruvianus</i>
—Hind wings with no cross veins.....	<i>comes</i>
5—Costal angle of hind wing obtuse.....	<i>opacus</i>
—Costal angle of hind wing acute.....	<i>melleus</i>
6—Second vein of hind wing forked.....	<i>socius</i>
—Second vein of hind wing simple.....	7
7—Veins of hind wing convergent to wing apex.....	8
—Veins of hind wing parallel toward wing apex.....	9
8—Hind wing broad, its veins meeting margin before the wing apex...	<i>virellus</i>

### BAETIS MELLEUS SP. N.

Male—Length of body 5.5 mm., wing 4.5 mm.

Female—Length of body 4.5 mm., wing 5 mm.

Color honey yellow slightly paler beneath. There are some faint broken lines of brown on the thoracic carinae and about the wing root. The upper division of the eyes in the male is amber brown.

The middle segments of the abdomen of the male are translucent whitish; along the sides of the abdomen black sooty lines of pigment on the tracheae show through the skin. Legs and tails pale. Wings hyaline. There are strong costal cross veins in the region of the stigma. Hind wing flabellate, with a prominent costal angulation and veins as shown in fig. 148, of plate 12. The form of the forceps of the male is shown in pl. 12, fig. 158.

One male Santa Fe, Argentina.

Holotype, C. U. No. 645, mounted on slides.

Two females, La Chorrera, Putumayo District, Peru, August 16, 1920, collected by Dr. J. C. Bradley.

### BAETIS SOCIUS SP. N.

Female—Length of body 8 mm., of wing 8 mm.

Color pale brown, yellow on head, on the tenth abdominal segment, on legs and on tails. There is a brown transverse line on the collar abutting the rear of the head interrupted in the middle. There is a vertical dark brown line at the front of the mesothorax each side, and another oblique narrow one before the wing roots. There are some pale yellow streakings on the prothorax. A very narrow median pale line and three wider oblique ones converge rearward upon the crest of the metathorax where a pale spot is inclosed by two unequal transversely placed ( )-marks, the smaller in front, the larger behind. Abdomen

## BAETIS

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with dark brown lines across the apices of segments 2 to 10. There is a small obscure median T-spot on the base of segments 2 to 9, with a pair of small round dots close behind it.

Wings of a uniform pale brownish with veins indistinctly showing slightly paler. Venation as shown in pl. 12, fig. 153. Bases of legs and tails pale; tips broken off.

One ♀ subimago, Huacapistana on the Rio Tarma, Peru, June 1-3, 1920.

Holotype, a female, C. U. No. 646, wings mounted on a slide, remainder in alcohol.

Near *B. comes*, but larger and with a different sort of hind wing.

### BAETIS TANTILLUS SP. N.

Female—Length of body 4 mm., of wing 3 mm.

Color pale brown above with abdomen paler beyond its basal segment. There are some darker narrow arcuate lines about the borders of the mesothorax above. All else is pale, including legs and antennae. Wings hyaline, slightly milky at the stigma. Venation as shown in pl. 12, fig. 157.

Two females, La Chorrera, Putumayo District, Peru, August 16, 1920.

Holotype, C. U. No. 647, wings on a slide, the remainder in alcohol.

This species is allied to *B. inops* and *B. dryops*, but is smaller, and has two parallel longitudinal veins in the hind wing and also some traces of cross veins.

### BAETIS DRYOPS SP. N.

Male—Length of body 4.5 mm., of wing 5 mm.

Female—Length of body 5 mm., of wing 5.5 mm.

Color amber brown throughout, with narrow lines of rich chestnut brown on all carinae and thoracic sutures; similar in male and female except that the dorsum of abdominal segments 2 to 6 are fawn color. Legs lost in the male, in the female wholly pale yellow. Wings hyaline with a more or less yellowish tint at the front, darker between veins Sc and R, this color expanding to cover the whole stigma. Cross veins at the stigma few and incomplete. Cross veins in the disc of the wing tending to form three more or less complete transverse series. The paired marginal intercalaries are rather long. Venation as shown in pl. 12, fig. 155.

Two males and one female from El Campamiento, Junin, Peru, June 28, 1920, collected by Dr. J. C. Bradley.

Holotype, male, C. U. No. 648, wings and genitalia mounted on slides.

This species is nearest *B. inops* but differs in shape of hind wing and in not being reticulate at the stigma of the fore wing.

## NEOTROPICAL MAYFLIES

### NYPHS

Neotropical nymphs of this genus differ among themselves about as do the species of the Holarctic realm. Since none of ours from South America was reared, and but one was specifically identified by supposition, it will not be profitable to describe all the forms collected, for a number of them are very much alike. Three species, showing marked differences in the length of the middle tail, are selected for description. These may be separated as follows:—

- Middle tail as long as the laterals.....*Baetis nymph* No. 1  
Middle tail 5/7 as long as the laterals.....*Baetis peruvianus* ?  
Middle tail 2/5 as long as the laterals.....*Baetis nymph* No. 2

#### BAETIS PERUVIANUS NYMPH (Supposition)

The supposition that this nymph belongs to the above named species is based on size, locality, and a comparison of the venation of the nymphal wing with Ulmer's figure of the venation of the hind wing of *B. peruvianus*, as given in Arch. f. Naturg. 85:53, 1919. On pl. 13, fig. 182, is shown the venation of the nymphal wing.

Length of body 7 mm., tails 7 mm. (middle one 5 mm.), additional.

Color greenish brown with a very narrow mid-dorsal pale line on head and thorax, brownish lengthwise streaks on the sides of the prothorax, two brown submedian lines on the mesothorax, these wider in front and tapering to a point behind. Knees and apical margins of abdominal segments narrowly brown as usual in this genus, and pair of brown submedian dots on each abdominal segment above. Middle leg as shown in pl. 13, fig. 179.

Tails white, as are also the very scanty fringes of soft, short hairs between them. The gills (pl. 13, fig. 167) are broad, oval, a little one-sided, obtuse at tip, and largest on middle segments.

The maxillary palpi are very weak and slender, not surpassing in length the tips of the lacinae. Mouth parts as shown in pl. 13, figs. 173, 174 and 180.

Five specimens from Puente del Inca, Mendoza, Argentina, March 22, 1920, 9,000 to 10,000 feet altitude.

Several smaller specimens, apparently of the same species, are from Matucana, Province of Lima, Peru, May 26-28, 1920. All were collected by Dr. J. C. Bradley.

#### BAETIS SP. ? NYMPH NO. 1

Length of body 8 mm.

A nymph somewhat similar to *B. peruvianus* but larger. It shows in the venation of the hind wing a similar fork. Some specimens show a pale, open U-mark on the mesothorax opening forward with a narrow, median line crossing it, and another obscurer U-mark outside of and surrounding the first one. There

## BAETODES

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is also a broad brownish cloud crossing and covering the middle half of the fringes of the tails. Tails about equal in length.

Numerous specimens from Tambo Eneñas on the Camino del Pichis, Junin, Peru, July 4, 1920, collected by Dr. J. C. Bradley.

### BAETIS SP. ? NYMPH No. 2

Length of body 8 mm., tails 5 (middle one 2) mm.

Pale greenish or blackish brown with narrow darker lines across the apices of the abdominal segments and across their corners at the bases of the gills and along the margins of the legs. Dorsum of thorax with numerous obscure paler streakings. On each of the middle abdominal segments are four pale dots in two pairs, one pair close together at the base and the other pair submedian. There are short spinules upon the dorsal crest of the femora.

Gills oblique, oval, with a few of the coarsely branched tracheae tinged with purple; a chitinized rib stiffens the front border of each, and there is a small emargination at the tip of the rib in some of the middle gills.

Coarsely toothed claws, enlarged basal segments to the antennae, and the short middle tail mark this species as transitional to Baetodes; but this species has two pairs of wings, and gills on segments 1 to 7.

Half a dozen specimens Huacapistana on the Rio Tarma, Junin, Peru, June 1-3, 1920, collected by J. C. Bradley.

## BAETODES GEN. NOV.

This genus is based on the nymphs of two species from Brazil, having no hind wings and a venation that is shown in part in pl. 13, fig. 168. The nymphs are stiff, long-legged, bare tailed concolorous forms, having drooping, simple, oval gills upon segments 1 to 5 only of the abdomen, having stout, rather few-jointed antennae, and greatly reduced palpi and glossae. The middle tail is rudimentary. The dorsal crest of the femora bears a single line of long brown spines. The two nymphs are described below, the named one being the type of the genus:

### BAETODES SERRATUS SP. N.

Length of body of nymph 7 to 8 mm., tails 10 mm., additional; the middle one only 1 mm.

A plain, greenish brown nymph with white obovate drooping gills upon the first five abdominal segments, mid-dorsal hooks the entire length of the abdomen, long, stiff legs and a very short middle tail between the two long flexuous bare ones. Coloration nearly uniform, lighter on the sutures and underneath the body. Tails, antennae and legs grow darker toward the tips and the femora are darker

## NEOTROPICAL MAYFLIES

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about the margins and at the ends. The legs are long, front legs slightly longest. Each of the femora bears a row of 6 to 8 stiff spines scattered along its dorsal crest. The tibiae show the white sutures indicated in figure 169 of plate 13. The claws (pl. 13, fig. 170) are stout and hooked and bear a row of rather stout teeth beneath.

The abdomen is subcylindric, regularly but slowly tapering to rear and bears a row of triangular dorsal hooks (pl. 13, fig. 178) its entire length, highest on the middle segments, diminishing both ways, and increasingly inclined backward on the hinder segments; no lateral spines. Gills on segments 1 to 5 white, ovate, obtuse, drooping obliquely downward and backward and diminishing in size to the rear. Tails bare, long, flexuous, pale at base becoming darker toward the slender tips.

The mouth parts (pl. 13, figs. 175 and 176) are characterized by the extreme weakness of both maxillary and labial palpi, and by the reduced glossae of the labium. The antennae are rather coarsely segmented, the two basal segments swollen, the first oblique; only one suture at base of flagellum is indistinct; length of antennae about half that of the thorax. The labrum is pale distinctly bordered with brown and a diffuse brownish spot occupies the V-shaped frontal suture, that in this form is well down on the face.

A number of nymphs of various sizes from Tijuca, Rio de Janeiro, Brazil, October 17, 1919.

Holotype nymph, C. U. No. 649-1, mounted on a slide.

### BAETODES NYMPH NO. 1

This nymph is similar in most respects, but lacks the dorsal hooks of the abdomen, has its middle tail even shorter ( $1/3$  mm.), has the spines on the dorsal crest of femora more numerous (about 10-12) and more hair-like, and has the labrum less extensively edged with brown. It is also slightly larger (length of body 10 mm.). The legs are slightly shorter and the antennae are slightly longer than in the preceding species.

Many nymphs in alcohol from Tijuca, Rio de Janeiro, Brazil, collected by Dr. J. C. Bradley, October 17, 1919.

### PSEUDOCLOEON

To the three described neotropical species of this dipterous genus of small mayflies we add two new ones, and a description of the nymph of one undetermined species. The adults may be separated as follows:



## PSEUDOCLOEON

### KEY TO THE SPECIES—IMAGOS

- 1—Upper division of the eye of the male turbinate or shaped like the cap of a mushroom, as high as the head..... 2  
—Upper division of the eye of the male cylindric, erect and parallel with its fellow, twice as high as the head..... *binocularis*
- 2—Minute species (wing 2.25 mm.)..... *turbinops*  
—Larger species (wing 4 or more mm.)..... 3
- 3—Legs grayish ..... *oldendorffi*  
—Legs brownish ..... 4
- 4—Antepenultimate joint of the ♂ forceps twice as long as wide.... *dubium*  
—Antepenultimate joint of the ♂ forceps twice as long as wide. *brunneum*

### PSEUDOCLOEON OLDENDORFFI

Numerous adults of this little known species were collected at Santa Fe, Argentina, February 19, 1920. From a good male specimen a new figure of the forceps has been drawn, and it is presented herewith in pl. 12, fig. 161.

### PSEUDOCLOEON BINOCULARIS SP. N.

Male—Length of body 5 mm., of wing 4.5 mm., of tails about 9 mm.

Color rich reddish brown, nearly uniform; middle segments of the abdomen translucent whitish. Ocelli, sides and top of the upper division of the eye and flagellum of the antennae yellow. Unfortunately the end of the abdomen is lost; but a broken off bit of the tail shows pale brown annulations of the basal portion.

The very remarkable eyes of the male of this species are shown in pl. 12, fig. 156. They are quite distinctive. The venation of the wing is shown in pl. 12, fig. 149.

One male, Campamiento, Junin, Peru, July 1, 1920.

Holotype, C. U. No. 650, wings mounted on a slide, the remainder in alcohol. Also, one female in bad condition from La Chorrera, Loreto, Peru, appears to be the same species.

### PSEUDOCLEON TURBINOPS SP. N.

Length of body, male and female, 3-3.5 mm., of wing 2.25 mm.

General color pale brown, darkest on the rear of the thorax, with narrow lines on the carinae of the same. Ocelli and lower part of eyes black. Upper part in the male red, translucent. Wings hyaline. Venation as shown in pl. 12 for the male in fig. 151, and for the female in fig. 150. Legs pale the fore femur with an indistinct spot at two-thirds its length. The second segment of the

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fore tarsus is about half as long as the tibia and the segments diminish in length in the following order; 2, 3, 4, 5, 1.

Abdomen brown above, pale on the joinings of the segments, so that the dorsum is covered by a band of brownish quadrangles, with darker interrupted lines on the lateral margins. The female is similar to the male, with more of a yellowish tint to the thorax, and a plumbeous tint on the abdomen. Forceps of the male as shown in pl. 12, fig. 160.

Three specimens, two males and one female, Kartabo, British Guiana, October 20-22, 1920, collected at light by Mr. A. E. Emerson.

Holotype, male, C. U. No. 651, mounted on a slide.

### THE NYMPH

Nymphs of *Pseudocloeon*, determinable by lack of hind wings and by the venation discoverable in the fore wings of some of them, were taken by Dr. Bradley in both Argentina and Peru in considerable numbers. They are among the most beautifully colored of all mayfly nymphs dappled with green and brown, and are clean, agile, sprightly forms with long straightish slender claws. The mouth parts are as shown in plate 13; also the legs and the lateral margin of the abdomen. There are gills on segments 1 to 7 of the abdomen, slightly diminishing in size to rearward, erect, double on the first 6 segments, oblique ovoid-triangular in form with the anterior lamina hardly larger than the posterior, but a little thicker and more heavily pigmented along its few coarse widely branching dendritic tracheae. Legs slender, tibiae and tarsus of about equal length, consolidated into an apparently single segment with only an oblique suture across the middle of it marking their limits.

### PSEUDOCLOEON NYMPH NO. 1

Length of body 7 to 9 mm., of tails 3 to 4 mm., additional, antennae 1.5 mm.

Color greenish brown marmorate with irregular longitudinal pale streaks that mostly run lengthwise on the top of the thorax, becoming darker and broader and fewer at the rear. Abdomen above with a brownish median more or less interrupted band on segments 2 to 7 divided at each side by a narrow pale line made of short curves placed end to end. Sides pale with a brown blotch upon the middle of the flattened-out lateral margin; a brown mark across the apex of segment 10. Lateral spines on abdominal segments as shown in pl. 13, fig. 177. Mouth parts as shown in the same plate, figs. 164, 165, 171 and 172.

The tails bear closely appressed whorls of short spinules, and fringes of pale hairs within, and there is a band of darker color crossing the three tails at three-fourths their length. The middle tail is very little shorter than the laterals.

Numerous specimens from Cosquin, Argentina, March 8, 1920, and from El Campamiento, Junin, Peru, June 19, 1920, collected by Dr. J. C. Bradley.

## NEOTROPICAL MAYFLIES

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### EXPLANATION OF PLATES

Unless otherwise stated, the drawings were made with the aid of the camera lucida.

#### PLATE I

Venation of *Campsurus* and *Tortopus*.

Abbreviations for venation given under explanation of fig. 5.

- Fig. 1. Fore wing, *Campsurus evanidus*.
- Fig. 1A. Hind wing of same.
- Fig. 1B. Portion of fore wing of same, for variant venation.
- Fig. 2. Fore wing, *Campsurus scutellaris*.
- Fig. 2A. Hind wing of same.
- Fig. 3. Fore wing, *Campsurus pallidus*.
- Fig. 3A. Hind wing of same.
- Fig. 4. Fore wing, *Campsurus lucidus*.
- Fig. 4A. Hind wing of same.
- Fig. 5. Fore wing, *Campsurus major*; b, bulla; C, costa; Cu, cubitus; h, humeral cross vein; Int, intercalaries; M, media; R, radius; Sc, subcosta; st, stigma.
- Fig. 5A. Hind wing of same.
- Fig. 6. Fore wing, *Campsurus segnis*.
- Fig. 6A. Hind wing of same.
- Fig. 7. Fore wing, *Campsurus corumbanus*.
- Fig. 7A. Hind wing of same.
- Fig. 7B. Portion of fore wing of same, for variant venation.
- Fig. 8. Fore wing, *Campsurus violaceus*.
- Fig. 8A. Hind wing of same.
- Fig. 9. Fore wing, *Tortopus igaranus*.
- Fig. 9A. Hind wing of same.
- Fig. 9B. Portion of fore wing of same, for variant venation.
- Fig. 9C. Portion of fore wing of same, for variant venation.

#### PLATE II

Venation of *Campsurus*, *Campylocia* and *Hexagenia*

- Fig. 10. Fore wing, *Campsurus mutilus*.
- Fig. 10A. Hind wing of same.
- Fig. 11. Fore wing, *Campsurus Holmbergi?*
- Fig. 11A. Hind wing of same.
- Fig. 12. Fore wing, *Campylocia ampla*.

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- Fig. 12A. Hind wing of same.  
Fig. 13. Fore wing, *Campsurus striatus*.  
Fig. 13A. Hind wing of same.  
Fig. 14. Fore wing, *Campsurus notatus*.  
Fig. 14A. Hind wing of same.  
Fig. 15. Fore wing, *Campsurus claudus*.  
Fig. 15A. Hind wing of same.  
Fig. 16. Fore wing, *Hexegenia albivitta* Walker.  
Fig. 16A. Hind wing of same.

### PLATE III

#### *Campsurus, Tortopus, Campylocia*

- Fig. 17. Genitalia, ♂ *Campsurus segnis*.  
Fig. 18. Genitalia, ♂ *Campsurus scutellaris*.  
Fig. 19. Egg and egg cap, *Campsurus corumbanus*.  
Fig. 20. Second leg, ♂ *Campsurus segnis*.  
Fig. 21. Extruded ovary and oviduct, *Campylocia ampla*. Oviduct, N, nematode parasite.  
Fig. 22. Gill vestige, imago of *Campylocia ampla*. Tr, main lateral trunk; G, gill; N, nematode parasite.  
Fig. 23. Genitalia ♂ *Hexagenia albivitta* Walker.  
Fig. 24. Genitalia ♂ *Campsurus violaceus*.  
Fig. 25. Genitalia ♂ *Campsurus notatus*.  
Fig. 26. Genitalia ♂ *Campsurus pallidus*.  
Fig. 27. Reproductive system, ♀ *Campsurus corumbanus*. Ov, ovary; Sr, seminal receptacle; Ut, uterus; Ovi, oviduct.  
Fig. 28. Genitalia ♂ *Campsurus major*.  
Fig. 29. Genitalia ♂ *Campsurus evanidus*.  
Fig. 30. Genitalia ♂ *Campsurus lucidus*.  
Fig. 31. Egg, *Campylocia ampla*.  
Fig. 32. Legs ♀ *Tortopus igaranus*; 32A, 32B, 32C, first, second and third legs, respectively.  
Fig. 33. Genitalia, ♂ *Campylocia anceps*.

### PLATE IV

#### *Campsurus nymph*

- Fig. 34. Left mandible, dorsal aspect.  
Fig. 35. Third leg.  
Fig. 36. Labrum.  
Fig. 37. Hypopharynx.

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- Fig. 38. First leg.
- Fig. 39. Nymph, *Campsurus* sp?
- Fig. 40. Labium.
- Fig. 41. Right mandible, ventral aspect.
- Fig. 42. Second leg.
- Fig. 43. First gill.
- Fig. 44. Maxilla.
- Fig. 45. Fourth gill.

### PLATE V

#### (?) *Metamonius nymph*

- Fig. 46. Head, lateral aspect.
- Fig. 47. First leg.
- Fig. 48. Second leg.
- Fig. 49. Third leg.
- Fig. 50. Tail segments, in detail.
- Fig. 51. Fore wing showing incipient venation.
- Fig. 52. Head, dorsal aspect.
- Fig. 53. Thorax, ventral aspect, showing position of gills.
- Fig. 54. Abdomen and tails, dorsal aspect.
- Fig. 55. Maxilla.
- Fig. 56. Right mandible.
- Fig. 57. Tarsal claw, first leg.
- Fig. 58. Tarsal claw, second leg.
- Fig. 59. Tarsal claw, third leg.
- Fig. 60. Labium.

### PLATE VI

#### *Lachlania nymph*

- Fig. 61. Antennal segment in detail.
- Fig. 62. First leg.
- Fig. 63. Second leg.
- Fig. 64. Tarsal claw, first leg.
- Fig. 65. Tarsal claw, second leg.
- Fig. 66. Tarsal claw, third leg.
- Fig. 67. Third leg.
- Fig. 68. Fore wing, showing incipient venation.
- Fig. 69. Front border, head.
- Fig. 70. Metathorax, first and second abdominal segments; G, ventral abdominal gill.

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- Fig. 71. Abdomen and tails, dorsal aspect.
- Fig. 72. Labium.
- Fig. 73. Labrum.
- Fig. 74. Left mandible.
- Fig. 75. Maxilla bearing basal gill-tuft.
- Fig. 76. Egg, *Oligoneuria anomala*.

### PLATE VII

#### *Leptohyphes, imago and nymph*

- Fig. 77. Fore wing, *Leptohyphes indicator*.
- Fig. 77A. Hind wing of same.
- Fig. 78. Male genitalia of same.
- Fig. 79. First gill of nymph *Leptohyphes* sp ? No. 2.
- Fig. 80. Third gill of same.
- Fig. 81. Fifth gill of same.
- Fig. 82. Antero-lateral angle of prothorax of same.
- Fig. 83. Abdomen of nymph of same.
- Fig. 84. Wing of nymph of *Leptohyphes* sp ? No. 1, showing incipient venation.
- Fig. 85. Head, anterior aspect, nymph of *Leptohyphes* sp ? No. 2.
- Fig. 86. Labium of nymph of same.
- Fig. 87. Labrum of nymph of *Leptohyphes* sp ? No. 1.
- Fig. 88. Nymph of *Leptohyphes* sp ? No. 1.
- Fig. 89. Fore wing, *Leptohyphes mollipes*.
- Fig. 89A. Hind wing of same.
- Fig. 90. Male forceps and penis of *Leptohyphes mollipes*, one side only.
- Fig. 91. Left mandible nymph, *Leptohyphes* sp ? No. 2.
- Fig. 92. First leg of same.
- Fig. 93. Second leg of same.
- Fig. 94. Maxilla of same.
- Fig. 95. Third leg of same.

### PLATE VIII

#### *Atalophlebia, Atalonella and Thraulodes*

- Fig. 96. Fore wing, *Atalophlebia fulvipes*.
- Fig. 96A. Hind wing of same, more enlarged.
- Fig. 97. Fore wing, *Atalonella ophis*.
- Fig. 97A. Hind wing of same.
- Fig. 98. Male genitalia of *Atalophlebia fulvipes*.
- Fig. 99. Fore wing, *Thraulodes telegraphicus*.
- Fig. 99A. Hind wing of same, more enlarged.

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- Fig. 100. Fore wing, *Thraulodes plicatus*.  
Fig. 100A. Hind wing of same.  
Fig. 101. Male genitalia of *Atalonella ophis*, ventral aspect.  
Fig. 101A. Same lateral aspect.  
Fig. 102. Male genitalia of *Thraulodes telegraphicus*.

### PLATE IX

Siphonella, Atalophlebia, Atalonella, ? Nousia, ? Deleatidium, and Thraulodes nymphs

- Fig. 103. Maxilla, *Siphonella ventilans*.  
Fig. 104. Third leg of same.  
Fig. 105. Maxilla, *Atalophlebia* sp ?  
Fig. 106. Left mandible, *Atalonella ophis*.  
Fig. 107. Tarsal claw, first leg of same.  
Fig. 108. First leg of same.  
Fig. 109. Labium, *Siphonella ventilans*.  
Fig. 110. Head and labrum, *Atalophlebia* sp ?  
Fig. 111. Labium of same.  
Fig. 112. Labrum, *Atalonella ophis*.  
Fig. 113. Hind wing of same, showing incipient venation.  
Fig. 114. Lateral spines on abdominal segments 2 to 9 of *Atalonella ophis*.  
Fig. 115. Lateral spines ? *Deleatidium* sp ? nymph No. 2.  
Fig. 116. Labrum, *Siphonella ventilans*.  
Fig. 117. Left mandible of same.  
Fig. 118. Second leg, *Atalophlebia* sp ?  
Fig. 119. Tarsal claw, second leg of same.  
Fig. 120. Lateral spines on abdominal segments 8 and 9 of ? *Nousia* sp ?  
Fig. 121. Left mandible, *Atalophlebia* sp ?  
Fig. 122. Fourth gill of same.  
Fig. 123. Lateral spine of *Thraulodes* sp ?, showing eroded outer margin.

### PLATE X

*Hermanella thelma* nymph

- Fig. 124. Spines on posterior border of rear abdominal segments.  
Fig. 125. Hypopharynx.  
Fig. 126. Fifth gill.  
Fig. 127. Second gill.  
Fig. 128. Seventh gill.  
Fig. 129. ? *Hermanella* sp., maxilla swung outward, showing plancton-gathering brushes.

## NEOTROPICAL MAYFLIES

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- Fig. 130. *Hermanella thelma*, dorsal view of whole nymph.  
Fig. 131. Labrum.  
Fig. 132. Labium.  
Fig. 133. Fore wing, *Hermanella thelma*, showing incipient venation.  
Fig. 133A. Hind wing of same.  
Fig. 134. Left mandible.  
Fig. 135. Third leg.  
Fig. 136. Maxilla.

### PLATE XI

#### *Thraulus, Choroterpes.*

- Fig. 137. Fore wing, *Thraulus bradleyi*.  
Fig. 137A. Hind wing of same.  
Fig. 138. Fore wing, *Thraulus maculatus*.  
Fig. 138A. Hind wing of same.  
Fig. 139. Fore wing, *Thraulus missionensis* ?  
Fig. 139A. Hind wing of same.  
Fig. 140. Fore wing, *Choroterpes bilineata*.  
Fig. 140A. Hind wing of same.  
Fig. 141. Fore wing, *Choroterpes emersoni*.  
Fig. 141A. Hind wing of same.  
Fig. 142. Male genitalia, *Thraulus bradleyi*.  
Fig. 143. Male genitalia, *Thraulus maculatus*.  
Fig. 144. Male genitalia, *Thraulus missionensis* ?  
Fig. 145. Male genitalia, *Choroterpes emersoni*.  
Fig. 146. End of abdomen of female of *Choroterpes emersoni*, showing ovipositor.

### PLATE XII

- Fig. 147. Fore wing, *Callibaetis pollens*.  
Fig. 147A. Hind wing of same.  
Fig. 148. Fore wing, *Baetis melleus*.  
Fig. 148A. Hind wing of same.  
Fig. 149. Wing *Pseudocloeon binocularis*.  
Fig. 150. Wing *Pseudocloeon turbinops*, female.  
Fig. 151. Wing *Pseudocloeon turbinops*, male.  
Fig. 152. Fore wing, *Callibaetis viviparus*.  
Fig. 152A. Hind wing of same, more enlarged.  
Fig. 153. Fore wing, *Baetis socius*.  
Fig. 153A. Hind wing of same, more enlarged.



## NEOTROPICAL MAYFLIES

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- Fig. 154. Embryo in egg of *Callibaetis viviparus*, taken from body of female.
- Fig. 155. Fore wing, *Baetis dryops*.
- Fig. 155A. Hind wing of same.
- Fig. 156. Head, *Pseudocloeon binocularis*, from the front.
- Fig. 157. Fore wing, *Baetis tantillus*.
- Fig. 157A. Hind wing of same, more enlarged.
- Fig. 158. Male forceps, *Baetis melleus*.
- Fig. 159. Male forceps, *Baetis dryops*.
- Fig. 160. Male forceps, *Pseudocloeon turbinops*.
- Fig. 161. Male forceps, *Pseudocloeon oldendorffi*.
- Fig. 162. Male forceps, *Callibaetis pollens*.

### PLATE XIII

#### *Pseudocloeon, Baetis, Baetodes nymphs*

- Fig. 163. Second leg, *Pseudocloeon* sp ?
- Fig. 164. Right mandible of same.
- Fig. 165. Maxilla of same.
- Fig. 166. Left mandible, *Baetodes serratus*.
- Fig. 167. Gill, *Baetis peruvianus*.
- Fig. 168. Fore wing, *Baetodes serratus*, showing incipient venation.
- Fig. 169. Second leg of same.
- Fig. 170. Tarsal claw, second leg of same.
- Fig. 171. Labium, *Pseudocloeon* sp ?
- Fig. 172. Labrum of same.
- Fig. 173. Labium, *Baetis peruvianus*.
- Fig. 174. Labrum of same.
- Fig. 175. Labium, *Baetodes serratus*.
- Fig. 176. Labrum of same.
- Fig. 177. Lateral spines on abdomen, *Pseudocloeon* sp.
- Fig. 178. Dorsal hooks on abdomen, *Baetodes serratus*.
- Fig. 179. Second leg, *Baetis peruvianus*.
- Fig. 180. Maxilla of same.
- Fig. 181. Hind wing of same, more enlarged than is the fore wing.
- Fig. 182. Lacinia from right mandible of same.
- Fig. 183. Left mandible of same.
- Fig. 184. Maxilla, *Baetodes serratus*.
- Fig. 185. Antennae of same.



PLATE I

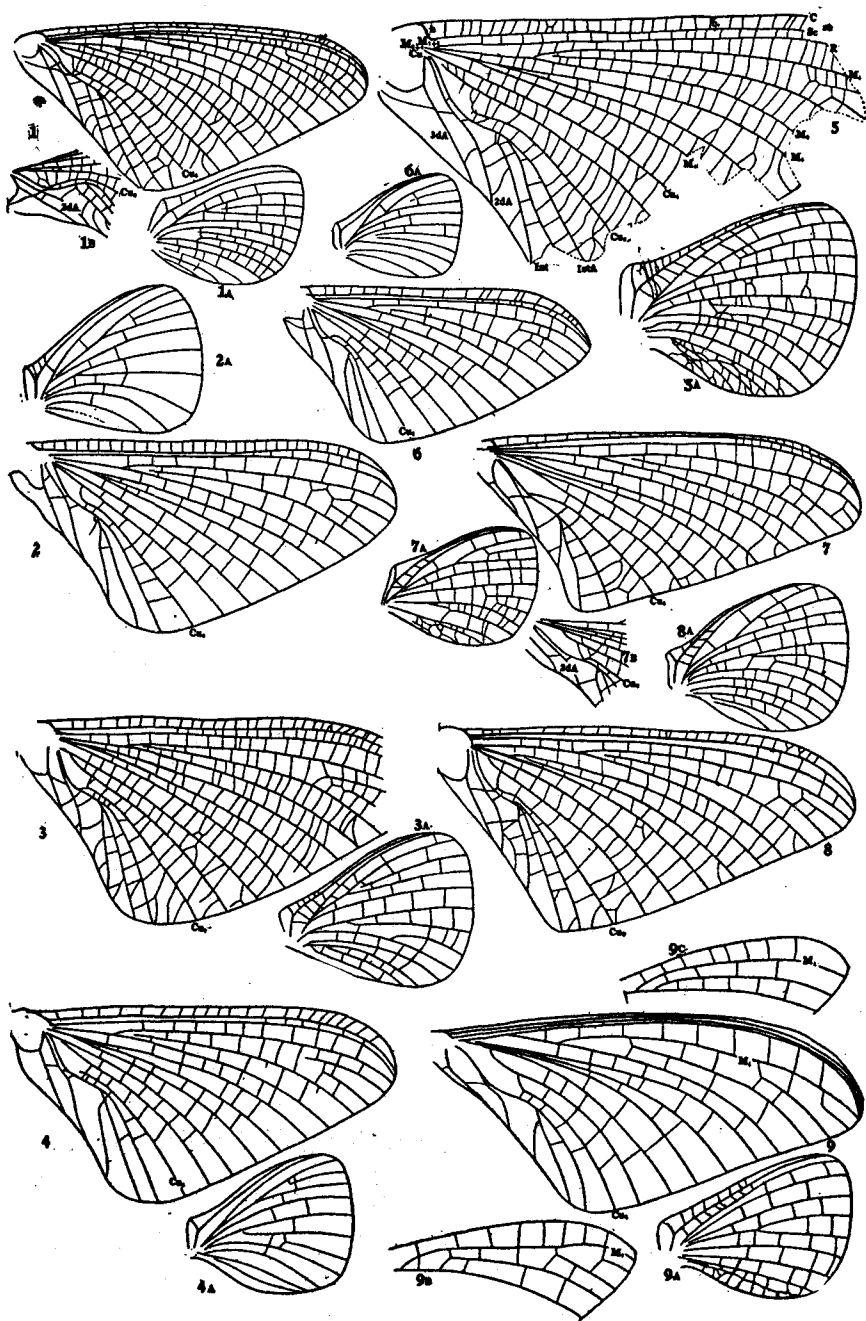


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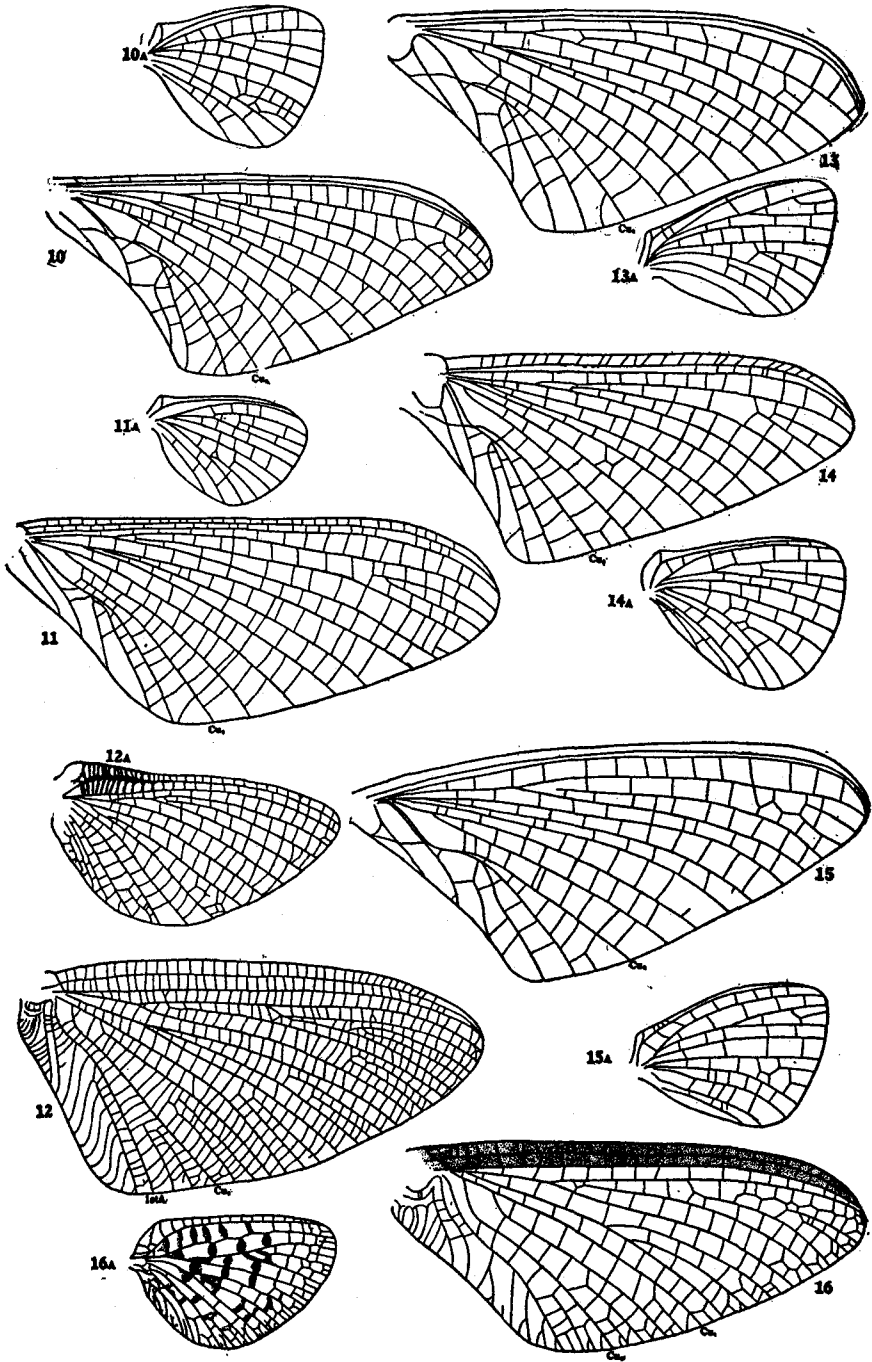




PLATE IV

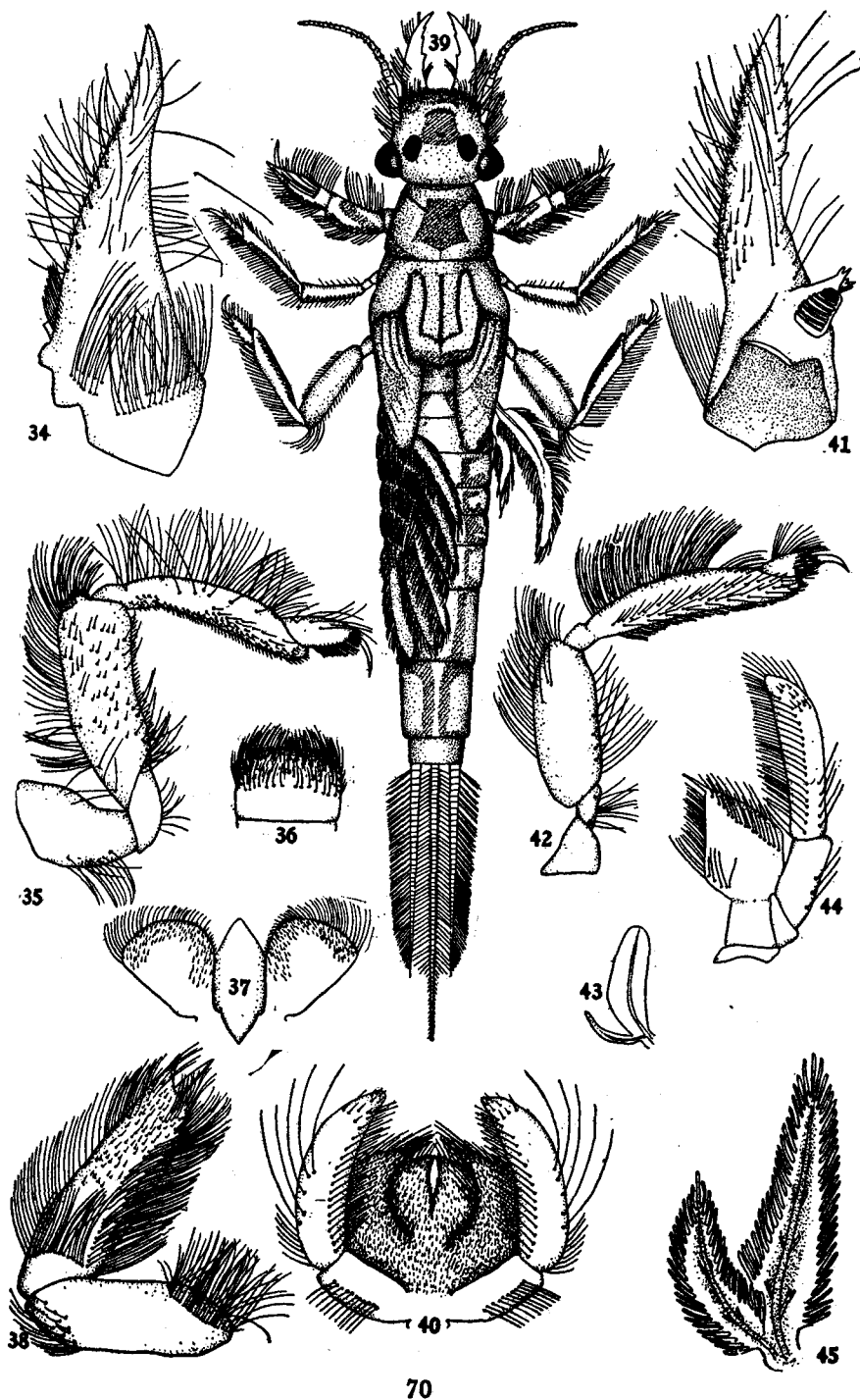


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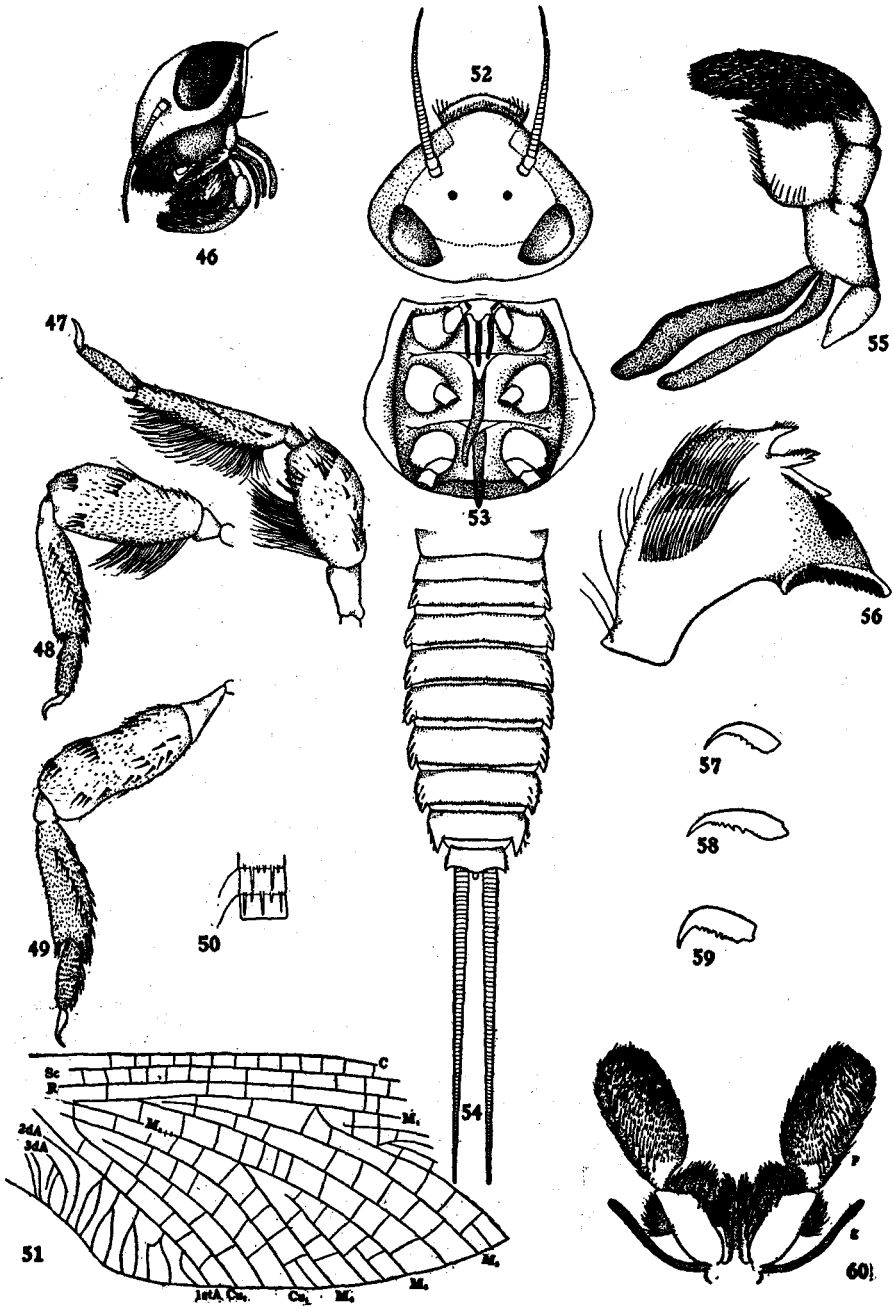


PLATE VI

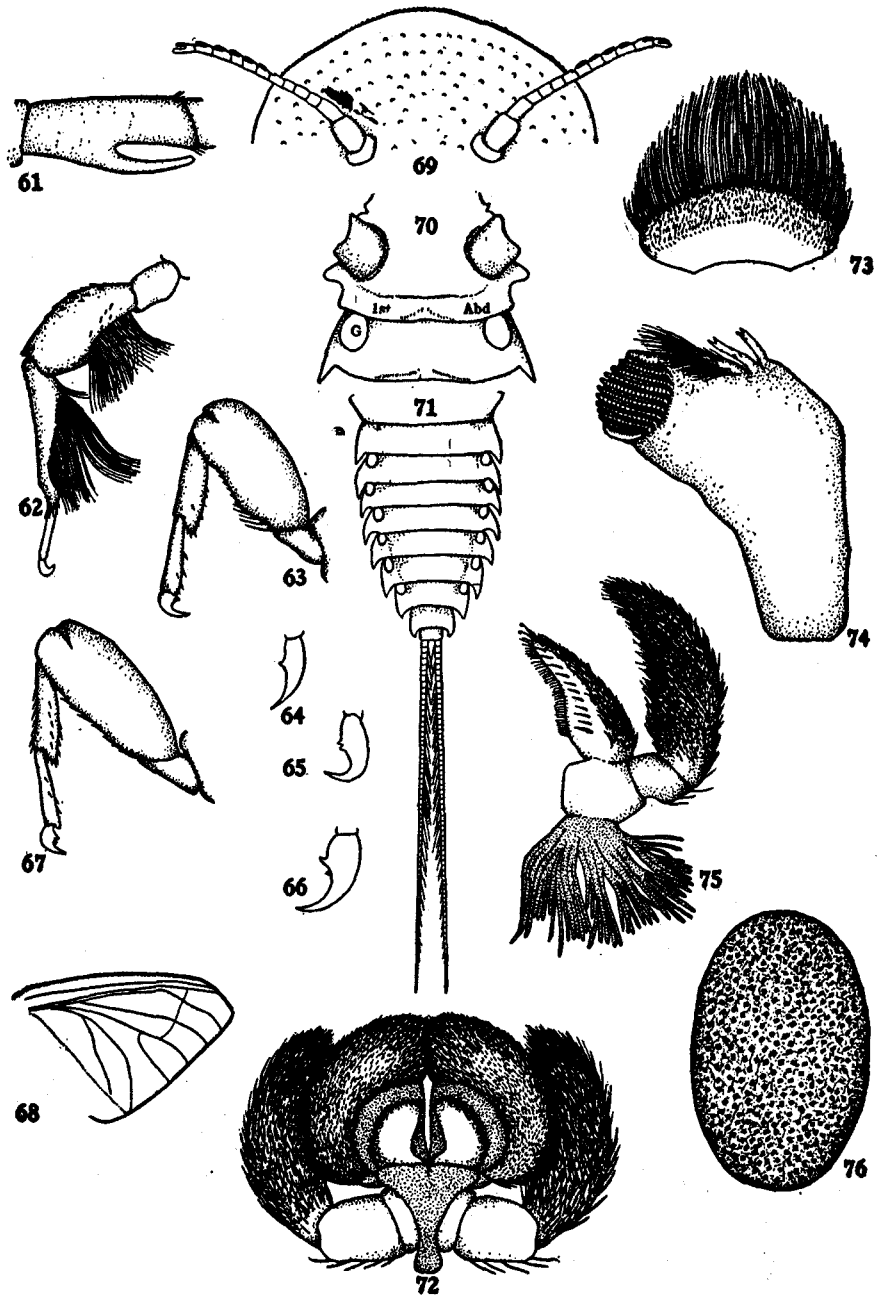




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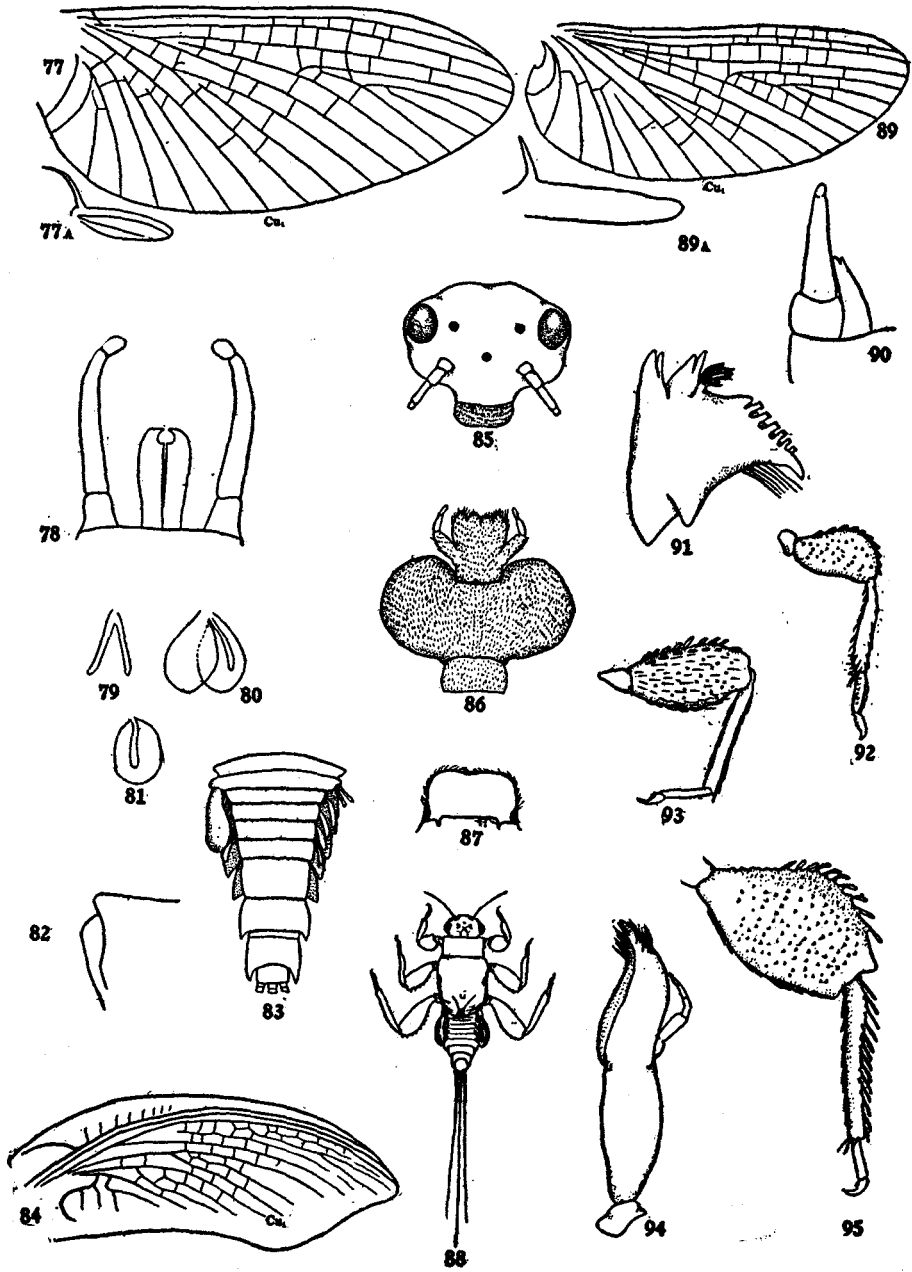


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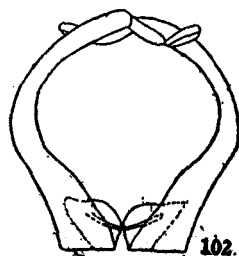
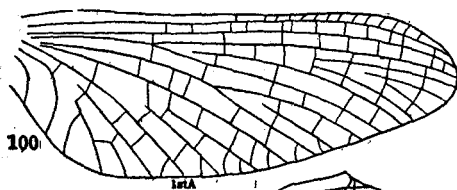
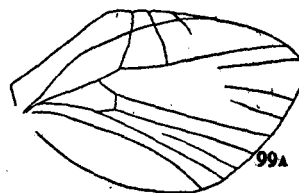
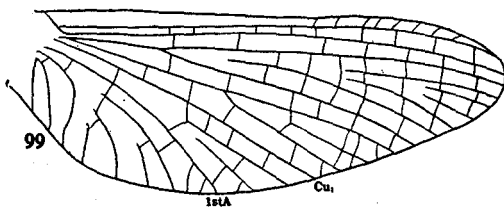
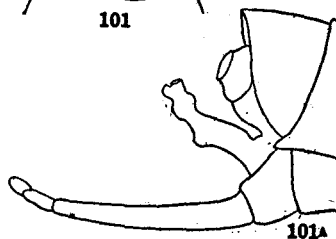
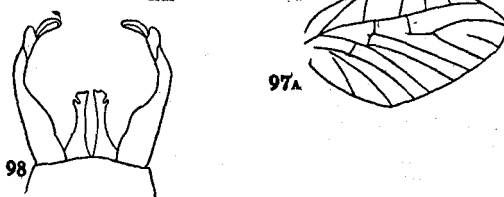
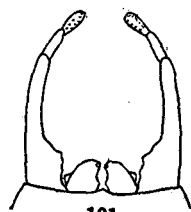
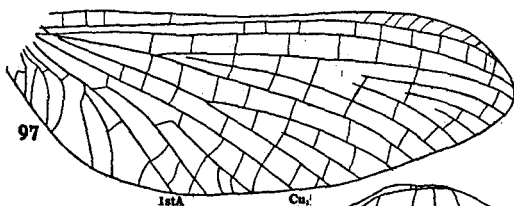
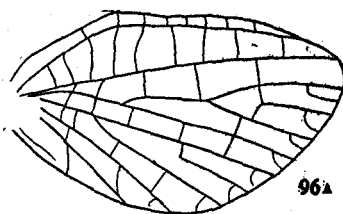
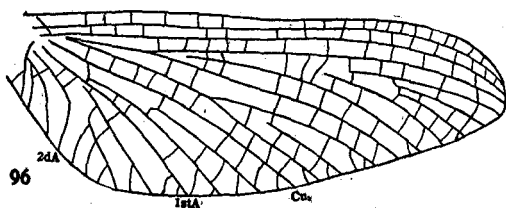


PLATE IX

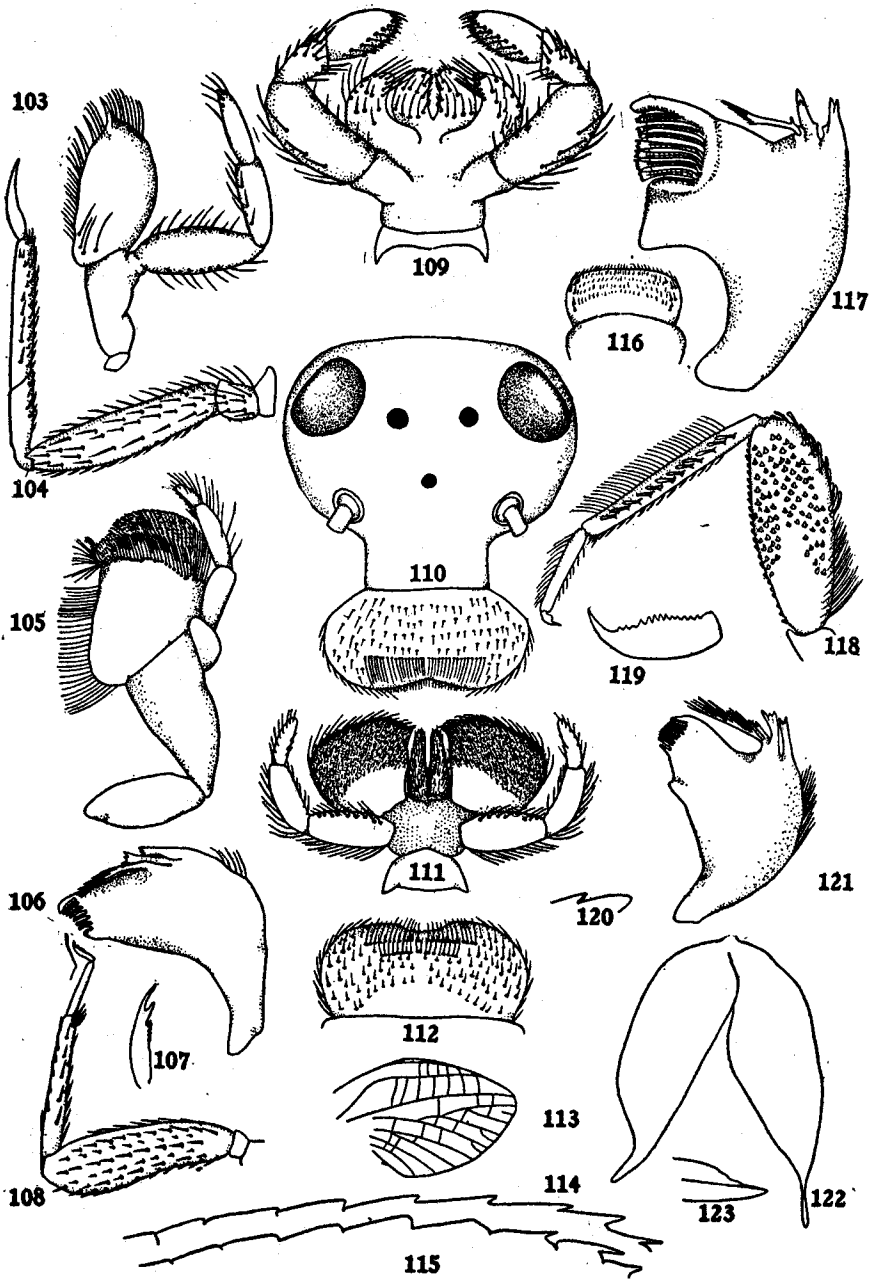


PLATE X

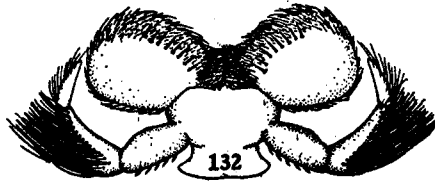
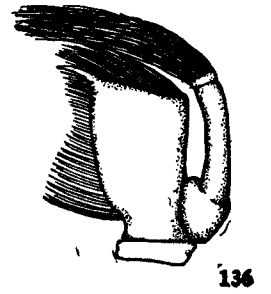
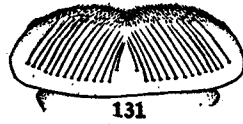
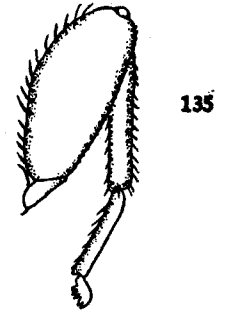
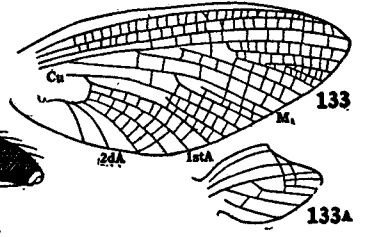
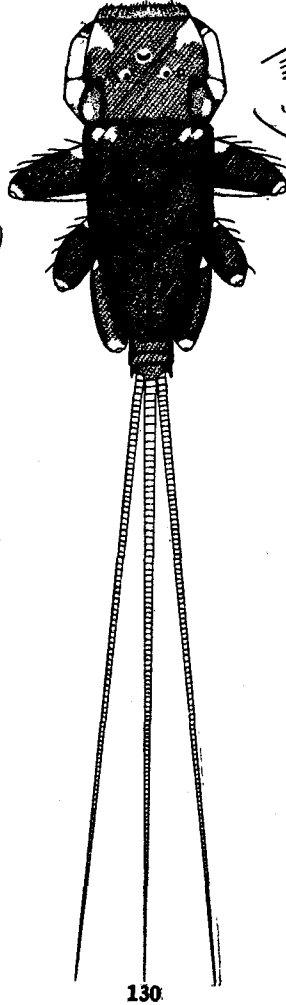
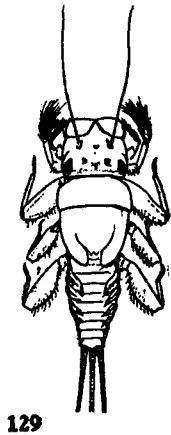
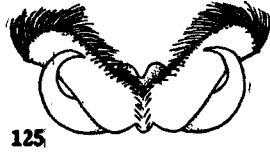
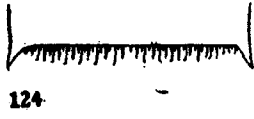


PLATE XI

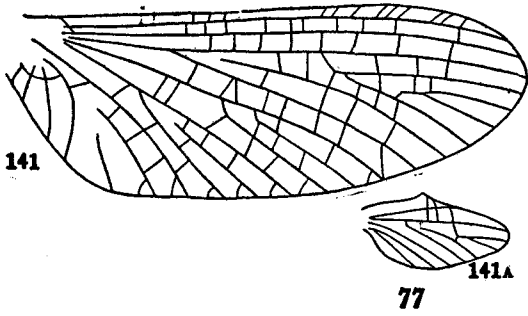
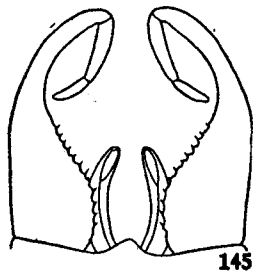
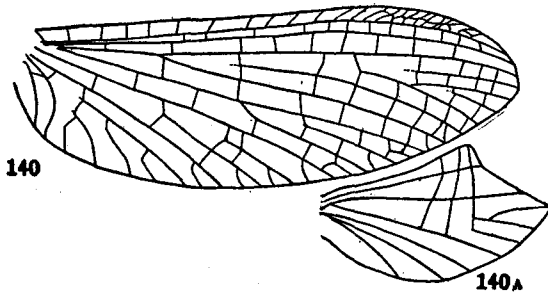
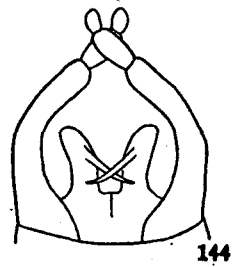
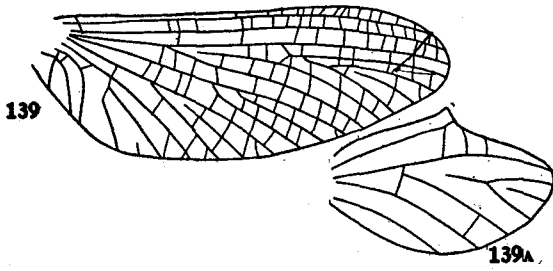
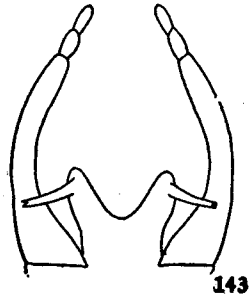
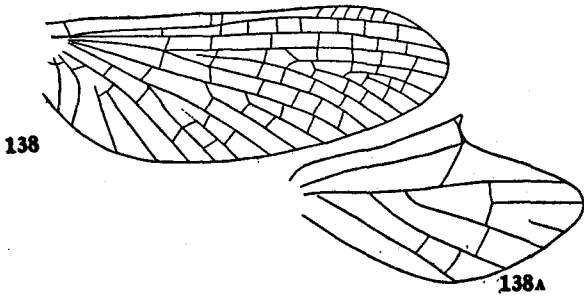
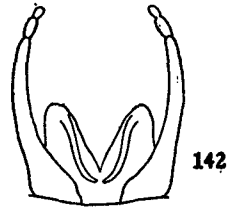
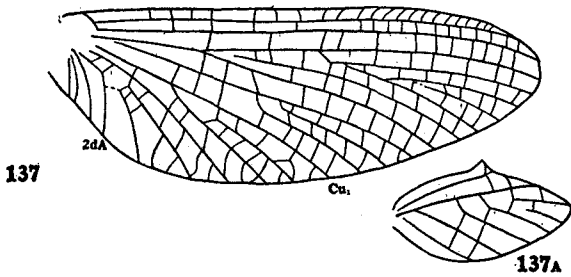


PLATE XII

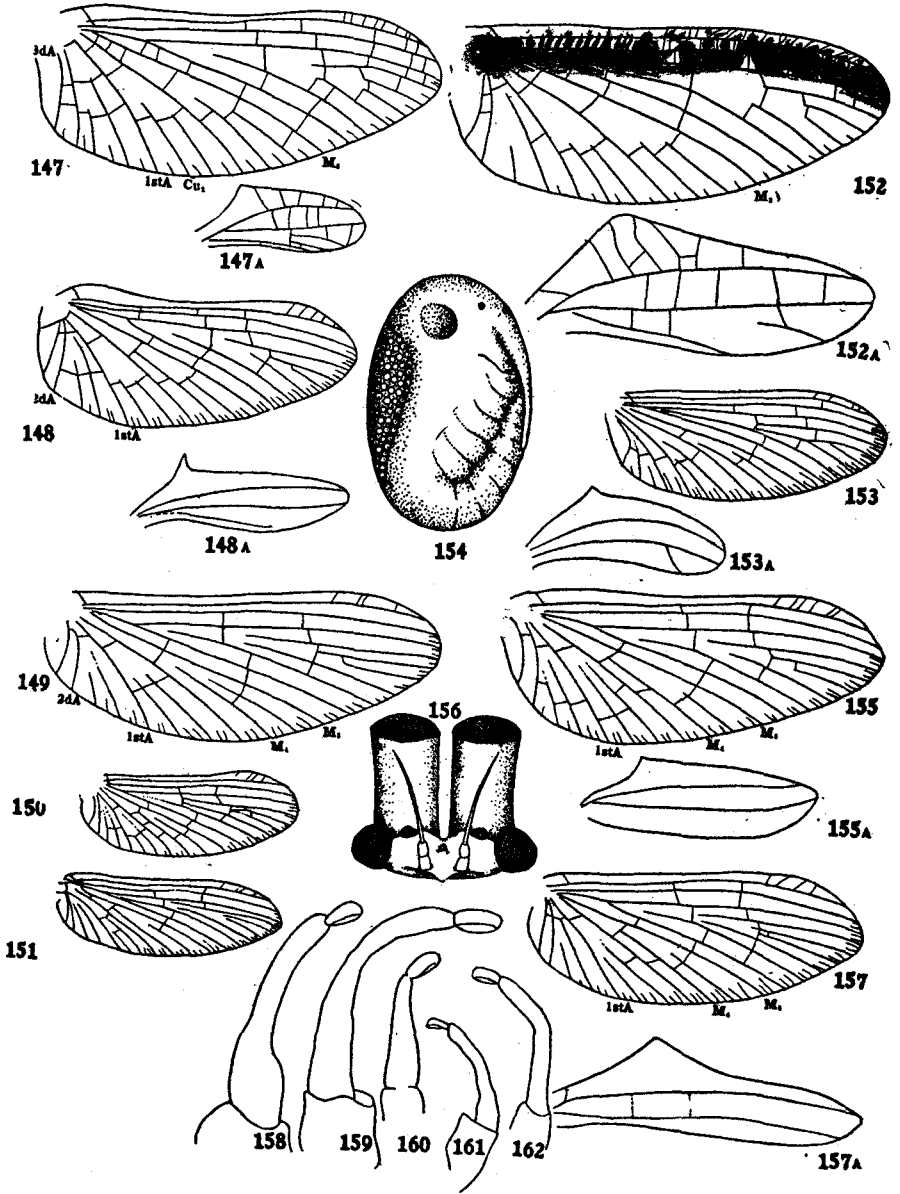


PLATE XIII

