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MAYFLIES OF PUERTO RICO

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The mayfly fauna of this island has not been studied, up to the present time. There seem to be but two references to a specimen of this order from Puerto Rico, in the published literature of the group. The first of these may be found in Dr. Hagen's *Synopsis,* (**9**) pg. 54, under *Cloe unicolor* Hagen: "I have seen a female specimen from Puerto Rico, similar to this, with the thorax fulvo-aeneous: is it a different species?" The second reference occurs in Kolbe's (**13**) *Die geographische Verbreitung der Neuropteren und Pseudoneuropteren der Antillen,* pg. 172: "II. Ephemerida, Von dieser Abtheilung liegt nur ein verdorbenes Exemplar vor, welches vielleicht eine Spezies von Calibaetis ist."

During the spring of 1935, Prof. James G. Needham of Cornell University, and Dean García-Díaz of the University of Puerto Rico, collected many mayfly nymphs and imagos on the island. Later, in the summer of 1935, Dean García-Díaz made many further collections and reared many specimens from nymphs. As a result of this work, twenty species of mayflies, representing six genera in three subfamilies, have been found to inhabit Puerto Rico. An account of these twenty species is herewith presented; three new genera and nine new species are described, along with keys for the determination of imagos and nymphs, and notes on several unnamed species. The designation of the wing veins is that of Tillyard, 1923 (**18**) and Needham, Traver, Hsu, 1935 (**17**).

SUBFAMILY LEPTOPHLEBIINAE

Two new genera of this subfamily are considered to be present in the material from Puerto Rico, each represented by two or more species. Both genera are allied to Hagenulus,—one of these may, in fact, be the true Hagenulus. Since, however, the nymph of Hagenulus is not known, and males of the Antillean species (including

the type species) are unknown or known incompletely, it is considered better to discuss the two Puerto Rican genera under new generic names.

Discussion of the genus Hagenulus and allied forms

The genus Hagenulus Eaton (1882) (4), type *caligatus* Etn., from Cuba, was described from female imagos and a male subimago. Genitalia of the male, and wings (presumably of female) are figured, in the Revisional Monograph (5). Wings of the female have distinctly margined cross veins; outer fork of radial sector normal,—i. e., with no tendency to sag toward the rear margin; penes of male are straight, rod-like, structures, divided near the base, wholly without spines or bristles. A note following the original description states that four male imagos, "of, perhaps, another species", differing from the male subimago of *caligatus* in numbers of cross veins in costal space, are present in the Hagen collection, from Cuba. These males have spotless wings. In the Revisional Monograph, it is stated that these specimens are females. Dr. Banks (1) says that these four specimens are males, and thinks they may be *caligatus*. Another Antillean species of this genus, *H. eatoni* Bks. (1), from Haiti, is known from females only. In these, the fore wings are similar to those of *caligatus* Etn., but the hind wing differs somewhat in shape. Three other species have been described in Hagenulus: *monstratus* Etn., (8) from Bermuda; *scotti* Etn., (7) from Seychelles; and *turbinatus* Ulm., (22) from East Africa. Hind wings are figured for two of these species, genitalia for one of them. In two of these (*scotti* Etn. and *turbinatus* Ulm.) the wings of both sexes are wholly lacking in darkened cross veins, but in *monstratus* Etn., dark-margined veins are present in both male and female. The hind wings are not typical of Hagenulus as represented by *coligatus,* in the two species figured. Nymphs of all five of these species are unknown.

Peculiar Leptophlebiine nymphs taken in Cuba (C. F. Baker, J. G. Needham) were described by Mrs. Emily R. Morrison (15) as Hagenulus. Cross veins in wing-pads of female nymphs are dark-margined; those of the males have a few spots only. The hind wing somewhat resembles Hagenulus. Mouthparts of the nymphs are peculiar, in that the labrum is much wider than the head. Gills filamentous, each pair bifurcate, the divisions unequal in size. Genitalia removed from a mature male nymph are seen to possess distinct inwardly-directed spines on the penes, much as in Neohagenulus. Are these the nymphs of the genus Hagenulus? If so,

the presence of spines on the penes must be a specific character. Wing-pads of female nymphs are normal as to the outer fork of the radial sector; in the males, however, there is a slight rearward sag in this fork. Other nymphs, taken in Jamaica by Prof. E. L. Palmer of Cornell University, resemble those of Neohagenulus in mouth-parts and structure of gills. The wing-pads of the females are dark-spotted, those of the males are spotless. Outer fork of radial sector normal in females, slightly sagged in males.

Nymphs of the two Puerto Rican genera have been reared, and both sexes are represented. Until *Hagenulus caligatus* Etn. has been reared from nymphs, and males and females correctly associated, so that the type of the genus may be fully known in its several stages, the Puerto Rican forms are held under the names Neohagenulus and Borinquena (new generic names). The differences in the gills of the nymphs seem to indicate clearly that two genera are involved.

Under the genus Borinquena are placed two species, apparently rather closely allied except in the form of the hind wing. In *B. contradicens* n. sp., the hind wing is like that of *Hagenulus caligatus,* but genitalia resemble *B. carmencita* n. sp., the genotype. Thus *B. contradicens* has characters of Borinquena and also of Hagenulus. It is tentatively placed in Borinquena, because of the type of the male genitalia and the gills of the nymph. By structure of hind wing and presence of ovipositor in the female, it would fall into Hagenulus. Gills of nymph filamentous, single, in both species. In fore wing of male as well as of female, the outer fork is distinctly sagged to rearward. No dark-margined cross veins, in either sex.

The three species placed in Neohagenulus resemble one another quite closely. Gills of nymphs filamentous, bifurcate, the two parts of each unequal in size and length. Genitalia somewhat as figured by Eaton for *H. caligatus,* but with distinct spines on the penes. Hind wing reduced in size, but not quite like that of *H. caligatus.* No true ovipositor present, in female. Outer fork of radial sector in wing of male distinctly sagged, almost normal in female. No dark-margined cross veins, in either sex.

Key to Antillean Genera of Leptophlebiinae

ADULTS

1. Cross veins of fore wing of female dark-margined; no spine-like processes on penes, which are slender and rod-like; long ovipositor present--*Hagenulus*
   Cross veins in fore wing of both sexes without dark margins; a pair of short, spine-like, processes present on penes; ovipositor present or absent---------- 2

2. Outer fork of radial sector in fore wing distinctly sagged to rearward, in both sexes; female with very long ovipositor; long joint of forceps of male almost straight ---------- *Borinquena*
Outer fork of radial sector in fore wing almost normal in female, distinctly sagged in male; no true ovipositor present; long joint of forceps of male strongly bowed ---------- *Neohagenulus*

NYMPHS

1. Gills single, each a slender filament ---------- *Borinquena*
Gills double, filaments of each pair unequal ---------- 2
2. Labrum greatly extended laterally, being wider than head; outer margin of mandible angulate at postero-lateral angle ---------- ? *Hagenulus* (Cuba)
Labrum only slightly wider than clypeus, about one-half the width of the head; outer margin of mandible rounded, convex ---------- 3
3. Wing-pads of female nymph dark-spotted ---------- Jamaican species
Wing-pads of both sexes with no dark spots ---------- *Neohagenulus*

Genus **Neohagenulus** gen. nov.

Small dark-colored mayflies. Eyes of male very large, contiguous apically, almost concealing the pronotum. Median ocellus much smaller than the laterals. Posterior margin of head of female slightly emarginate. Posterior margin of pronotum excavated in median area. Fore leg of male slightly shorter than the body. Femur slightly more than half as long as tibia; tarsus about ¾ the length of the tibia. Basal fore tarsal joint very short; 2nd joint longest, other joints progressively shorter, the fourth about ½ the length of the 2nd. Fore femur of female ⅞ as long as tibia; tarsus about ½ the length of the tibia; distal tarsal joint the longest. In hind leg of both sexes, the four basal tarsal joints are subequal; distal joint about as long as any two of the preceding; in male, somewhat longer than in female. Claws dissimilar on all tarsi.

Fore wing as shown in figure 1. Basal cross veins of costal and subcostal spaces faint; stigmatic cross veins well developed, somewhat aslant. Outer fork of radial sector in fore wing of male distinctly sagged to rearward (less distinctly so in female). Cubital intercalary and first anal veins united at base. Hind wing much reduced in size (fig. 11); drawn out into a sharp point at apex, but this point not bent over. Two well-developed longitudinal veins in wing of male, three in female; behind these, two or three others, faint and incomplete. Several faint cross veins; one at apex well developed.

Forceps three-jointed; long basal joint swollen in proximal half. Forceps base entire. Penes somewhat rod-like; each bears a forward-projecting spine, about ⅓ of the distance from the apex (fig. 3). Apical margin of subanal plate of female with a deep V-shaped cleft. A short egg valve, not a true ovipositor, is borne on the seventh sternite, as shown in figure 7.

Body form of nymph reminiscent of Choroterpes, and very similar to that of Borinquena. Mouthparts as in Borinquena, except that distal joint of labial palp is shorter (figs. 48, 49). Rather long spines on posterior margins of femora; numerous spines on hind tibia, rather generally distributed (figs. 14, 16). Claws pectinate (fig. 46). Short postero-lateral spines on abdominal seg-

ments 3–9; very short on 3–6, longest on 9. Gills double, filamentous; the inner member of each pair is more slender and slightly shorter than the outer one. Each filament contains a single main trachea, often with minute, lateral, branches (fig. 18). Tails three, considerably longer than the body; middle tail longer and slightly stouter than the laterals.

Genotype—**Neohagenulus julio** sp. nov.

Key to Species of Neohagenulus

ADULTS

1. Wings of both sexes distinctly brown-tinged throughout; cross veins prominent ---------- *tinctus*
   Wings not distinctly brown-tinged throughout; cross veins less prominent, except along costal margin ---------- 2
2. Longitudinal veins in wing of male yellowish along costal margin, elsewhere paler; costal band in wing of female rather dark red-brown ---------- *luteolus*
   Longitudinal veins, also cross veins of costal area and apical third of wing, brown; costal band in wing of female pale brown, usually paler toward apex ---------- *julio*

NYMPHS

1. Pale areas on head between eyes and ocelli distinctly divided by a greyish black line; spines on fore femur and on hind tibia relatively short (see figs. 15, 17) ---------- *luteolus*
   Pale areas on head between eyes and ocelli not divided by a dark line; spines on fore femur and hind tibia longer (see figs. 14, 16) ---------- 2
2. Second joint of antenna pale; ventral markings, when present, usually confined to lateral part of posterior margins of sternites ---------- 3
   Second joint of antenna blackish, at least in apical half; ventral markings more extensive ---------- 4
3. Ventral markings usually absent; abdominal tergites of female largely yellowish ---------- *sp. No. 2*
   Ventral markings usually present; abdominal tergites of female largely reddish brown ---------- *julio*
4. Body (female) 7 to 8 mm. in length ---------- *sp. No. 1*
   Body (female) 6–6½ mm. in length ---------- *tinctus*

Neohagenulus julio sp. nov.

A dark brown species, having middle and hind legs pale; entire wing *not* distinctly brown-tinged.

Male imago.—Body 5–6 mm.; wing 5½–6 mm.

Head dark red-brown, (see fig. 21, lateral aspect). Lateral ocelli pearly white, deep red-brown at base. Black, transverse, line along frontal margin; black markings around bases of antennae, between antennae and eyes, on frontal carina and below antennae. Upper portion of compound eyes deep red-brown, lower portion blackish. Thorax dark red-brown; mesonotum and sternum somewhat brighter than pleura and pronotum. Pronotum dark-margined; postero-

lateral angle with heavy black shading; a longitudinal, black, streak, on each side between median line and lateral margin. Mesonotal scutellum blackish; transverse sutures pale reddish, likewise median area directly anterior to scutellum; median area of anterior and middle portion intermediate in color between sutures and remainder of segment. Anterior to wing roots, a wide, whitish, streak margined with black; below wings, another whitish area with dark margins below and to rearward. Dark streaks above coxae on each side. Fore femur reddish brown; black at apex, deep red-brown median streak, black line along each margin. Tibia yellowish, tinged with reddish brown; deep smoky pre-apical area; lower margin blackish. Tarsus pale smoky. Middle and hind legs yellowish; black, apical, band on each femur; dark line along margin of each tibia; apical margin of tibiae tinged with pale smoky. Wings hyaline; very faint brownish tinge along costal margin. Venation deep red-brown. 6 or 7 strong stigmatic cross veins, distinctly aslant; other costal cross veins weak. All veins and cross veins in apical angle of wing heavier than elsewhere. Costa, *subcosta and radius margined with dark brown at base; brown shading around* bases of other main veins. Hind wing outlined in dark brown. Basal portion of costal margin and of the two main longitudinal veins dark brown. Wings as in figures 1 and 11.

Abdomen blackish brown dorsally, somewhat paler ventrally. Posterior margins of all segments narrowly black. A hyaline whitish dorsal patch on each of tergites 3–8, larger on apical than on basal segments; traces of a black, median, geminate, line on each pale area. A black, longitudinal, streak, usually interrupted, lies halfway between median line and lateral margin; laterad of this, another small, hyaline, whitish, spot, near anterior margin in basal tergites, but lengthened into a pale streak on tergites 6–8; on 8, this streak and the pale, dorsal, patch are confluent posteriorly. Tergites 9 and 10 red-brown like thorax. Hyaline areas on sternites next to pleural fold in antero-lateral angle, and along anterior margins. From the latter area short, irregular, pale, triangles may extend backward into the darker portions of the sternites; anterior half of median line likewise hyaline. Forceps base, penes, and basal joint of forceps reddish brown; distal portion of forceps pale (fig. 3). Basal forceps joint widened at base, suddenly narrowed and bowed near the middle of its length, much as in Choroterpes. Genitalia as in figure 3. A long, slender, spine seems to be present on inner margin of penes (fig. 44). Tails pale, the segments irregularly tinged with smoky; joinings purplish black, alternately wide and narrow.

Female imago.—Body 5–5½ mm.; wing 5–6 mm.

Head very light reddish brown. Dark markings as in male; also a wide, black, band across head between ocelli, another back of ocelli along posterior margin; usually two small, pale, submedian, spots on posterior margin. Basal joints of antennae smoky. Pronotum concolorous with head; wide, black, margins, and a triangular black mark on each side of median line. Mesonotum darker red-brown; scutellum and median line directly anterior to it, blackish. Pleura and sternum largely yellow, the former tinged with red-brown, and marked with black as in male. Legs much as in male; a longitudinal, black, hair-line on each, from coxa to tip of femur. Entire costal space in fore wing very light red-brown, hyaline; wing may be slightly tinged with brown elsewhere. Outer fork of radial sector much less distinctly sagged than that of male; venation deeper in color and more conspicuous. Abdominal tergites with essentially

the same coloring and pattern as in male, but pale areas more or less completely suffused with reddish brown. Usually a pale, lateral, triangle, a narrow, median, line, margined with black, and two small, submedian, marks on the anterior margins remain, in tergites 1–7. Pale areas more extensive on tergites 8–10. Sternites yellowish; posterior margins of all very narrowly darkened, that of sternite 1 most prominent. Sternites 2–7 marked as follows. Dark mark or streak in postero-lateral angle; dark line extends laterad of this toward median area, where it is conjoined to the posterior end of a dark submedian curved mark: ( ). Sternite 8 with dark shading around margin of the egg valve. Sternite 9 unmarked. Tails pale brownish; joinings as in male.

Nymph—Head reddish brown; small pale areas before median ocellus and at bases of antennae; a large, pale, area on each side, between eye and lateral ocellus. Vertex and occiput heavily shaded with blackish, leaving four pale, sub-median, spots, those nearer the posterior margin being larger. Antennae wholly pale. Pronotum yellowish; lateral margins and antero-lateral angles blackish. A trident-shaped, blackish, marking in median area, points of trident directed laterad and caudad. Mesonotum yellowish, shaded with black in antero-lateral area and above wing roots. Sternum yellowish. Legs yellow. Femora may be tinged with red-brown; narrow black line at apex of each, and black, longitudinal, hair-line basally on inner surface. Basal fourth of fore femur pale. Basal abdominal tergites of female nymph largely blackish brown; lateral margins yellowish, occasionally also the anterior portion of median line, and narrow, lateral, streaks. Tegrites 4–7 blackish brown, but with more extensive pale markings, located thus: median line (except at posterior margin) and areas on each side of it at anterior margin; oblique, lateral, streaks halfway from median line to pleural fold. Tergites 8–10 largely yellowish; posterior margin brown, likewise a wide, lateral, streak next to pale, outer, margin, and short, submedian, dashes at anterior margin. Posterior margins of all tergites darker. Male nymph has more extensive pale, median, areas on each tergite. Sternites yellowish, sometimes with faint red-brown tinge, most noticeable in male. Posterior margins narrowly darkened, in median area, but with wider and darker mark near lateral margin. Gills greyish, or with yellowish tinge; trachea and its minute branches black. Tails yellow; joinings opaque in young nymphs, red-brown in mature specimens. Tails of a partly-grown nymph are more than twice the length of the body, median tail longer than the laterals.

There seem to be no structural differences between this species and *N. tinctus,* so that it is difficult to distinguish the species represented, from the nymph slough. The slightly larger size and darker ventral markings of the nymph which is here treated as *tinctus,* plus the darkened second antennal joint, serve to distinguish the nymphs of *tinctus* and *julio.* Because of the size and ventral markings, it seems probable that the two species of nymphs treated as *tinctus* and *julio* have been correctly associated.

Holotype—Male imago. Río Cidra, Adjuntas, P. R., Mch. 24, 1935 (J. G. Needham, J. García-Díaz). No. 1398.1 in Cornell University collection.

Allotype—Female imago. Yunez River, P. R., June 21, 1935. No. 1398.2 in Cornell collection.

Paratypes—36 male imagos, 3 female imagos; Río Cidra, Adjuntas, P. R., Mch. 24, 1935; Luquillo Mts., P. R., Feb. 18, and June 9–14, 1935; Yunez River, P. R., June 21–22, 1935 (J. G. Needham, J. García-Díaz). Nos. 1398.3–41 in Cornell collection. Of these, four were reared from nymphs.

Other specimens of imagos were taken from the following localities, during 1935, by Dean García-Díaz. Lares, Guajataca Creek, Mch. 23; Luquillo Mts., June 7–14; Hicaco River, Mch. 7; Yunez River, June 21–22, and Aug. 12–15; El Yunque Trail, June 12, and July 27; Trout's Creek No. 1, June 9; and La Mina Recreational Area, July 14. Nymphs were collected at Maricao, Mch. 23; Guaynabo River, Feb. 21; Hicaco River, Río Blanco, Mch. 7; Trout's Creek No. 1, June 9; Tallaboa Alta River, Feb. 25; Yunez River, Feb. 27; and El Yunque, Luquillo Mts., Feb. 18 and June 9.

Neohagenulus tinctus, sp. nov.

Distinguished from *N. julio* by the distinctly brown-tinged wings and more prominent cross veins.

Male imago.—Body 5–6 mm.; wing 5½–6 mm.

Head dark red-brown; black markings on frontal margin, at bases of antennae, and around ocelli. Upper part of eyes red-brown (in some of the paratypes, dark purplish brown). Ocelli milky white. Basal joint of antenna blackish at apex. Thorax dark red-brown. Pronotum, mesonotal scutellum, and pleura heavily shaded with black. A paler area anterior to wing roots, enclosed by black shading. Legs as in *N. julio;* however, the dark, apical band on each femur is narrower, less conspicuous. Fore wings distinctly, hind wings faintly, brown-tinged throughout; color slightly deeper in apical third of fore wing. All veins red-brown; those in costal margin of fore wing (costal, subcostal and next succeeding space) somewhat thickened. 8 to 9 stigmatic cross veins, very prominent, somewhat aslant; this area most deeply stained with brown. In holotype and most of the paratypes, all cross veins in fore wing distinct (in *julio,* those back of radial sector usually invisible).

Abdomen as in *N. julio.* In holotype, entire abdomen rather paler, dark bands on posterior margins of segments slightly wider; several of the paratypes are as dark as *julio,* the posterior bands not wider. Tails and genitalia as in *julio* (in both species, slight variations occur in shape of penes).

No apparent structural differences between this species and *N. julio* have been noted, either in the imago or the nymph. Thus, *tinctus* might be treated as a dark form of *julio.* The two species may bear much the same relation to one another as do *Blasturus cupidus* and *Blasturus nebulosus,* among the Nearctic members of this subfamily.

Female imago.—Body 5½–6 mm.; wing 5½–6¼ mm.

Very similar to *N. julio*. Wings distinctly brown tinged; costal band on fore wing red-brown, darker than in *julio*; cross veins somewhat more prominent. Abdominal tergites reddish brown rather than the blackish brown of *julio*. Thus, in the female of *julio*, thorax and abdomen are dissimilar in color, while in *tinctus* these areas are essentially similar. Apical tergites relatively lighter in color than in *julio*, in allotype and some of the paratypes. Abdominal sternites suffused with reddish brown, paler than tergites, but distinctly more reddish than same region in *julio*, thus showing less contrast between dorsum and venter. Dark markings of venter usually confined to the narrow, dark, posterior, margin of each sternite.

Nymph—Very similar to that of *N. julio*, with these differences. Second joint of antenna blackish (dark area confined to apical half of segment, in some specimens). Ventral abdominal markings more extensive; dark, posterior, margins of sternites wider and darker, often bordered by reddish brown shading; entire venter may be tinged with reddish brown. In some specimens, the gills have a faint reddish or purplish tinge.

Holotype—Male imago reared from nymph. Camp Lab. 48, Luquillo Mts., P. R., June 13, 1935 (J. García-Díaz). No. 1438.1 in Cornell University collection.

Allotype—Female imago. Río Cidra, Adjuntas, P. R. March 24, 1935 (J. G. Needham, J. García-Díaz). No. 1438.2 in Cornell collection.

Paratypes—18 male imagos, 34 female imagos. Luquillo Mts., P. R., June 8–14, 1935 (J. García Díaz); Río Cidra, Adjuntas, P. R. Mch. 24, 1935 (J. G. Needham, J. García-Díaz). No 1438.3–54 in Cornell collection. Of these, one female was reared from the nymph.

Other imagos of this species were taken by Dean García-Díaz at the stations listed above; likewise at La Joba Creek, Río Blanco, P. R., Mch. 7, 1935. A speimen from the Luquillo Mts. is dated Feb. 18, 1935. Nymphs were collected at Lares, Guajataca Creek, P. R., on Mch. 22 at Río Prieto, Río Blanco, Mch. 7, 1935.

Neohagenulus luteolus, sp. nov.

Larger and paler than *N. julio* or *N. tinctus*. Wing veins amber or yellowish. Fore tibia of male whitish except tip, femur red-brown.

Male imago—Body 6½–7 mm.; wings 7 m..

Head yellowish. Black markings on frontal area, at bases of antennae, and around ocelli. Upper portion of compound eyes orange. Ocelli milky white. Antennae pale. Pronotum yellowish with reddish tinge; margins, and a curved, lateral, streak on each side, black. Mesonotum concolorous with pronotum; scutellum smoky. Pleura light reddish brown; a wide, blackish, streak anterior to wing roots, enclosing a pale line; black shading below wing roots and around bases of legs. Anterior half of metanotum red-brown, margined posteriorly with black. Posterior half yellowish; black, lateral, spot above leg base.

Sternum darker red-brown. Sutures, and lateral areas of mesosternum behind middle legs, yellowish.

Fore femur rather dark red-brown, with narrow, black, pre-apical, line; extreme tip yellowish. Tibia very pale, yellowish or whitish; a rather wide, pre-apical, purplish black, band, and a dark streak backward from this along lower margin, to about middle of segment. Tarsus pale yellowish; distal joint faintly smoky; a pale smoky streak along lower margin. Middle and hind legs pale yellowish. Two small, black, spots, unequal in size, near apex of each femur, and a faint blackish, longitudinal, hair-line above center of each. A smoky longitudinal streak near middle of hind femur, on some specimens (not present in holotype). Wings hyaline. All veins pale amber to yellowish; those in cubito-anal area often so pale as to be invisible. Cross veins distinct in first three spaces behind costal margin only. 8 to 9 stigmatic cross veins, slightly aslant, are somewhat heavier than others; entire stigmatic area very faintly amber-tinged. Extreme base of costa, to humeral cross vein, thickened and blackish; costal space before this cross vein reddish brown. Costal margin and first vein in hind wing purplish grey at base. Hind wing as in figure 47.

Abdomen pale yellowish or whitish (no reddish tinges except at base and apex), with greyish black, dorsal, markings. Posterior margins of all tergites rather widely dark; lateral area of each likewise deep grey, this dark band enclosing a pale V-shaped mark which does not reach to posterior margin. Median area of each tergite hyaline, wholly whitish except for dark posterior band; outer margin of this pale area curved, ( ). A small black spot over spiracle. Segments 8–10 opaque, tinged strongly with reddish brown. Sternites 1 and 2 likewise reddish brown with smoky tinge; 2 paler than 1; each with two hyaline submedian marks, which are dots on 1, streaks bounding the darkened ganglionic area on 2. Sternites 3–7 pale, hyaline; posterior margins, and a lateral streak paralleling the pleural fold, smoky brown. Tails (missing from holotype) pale yellowish white; joinings black, alternately wide and narrow, the narrow joinings less darkened.

One of the male paratypes differs from the above description thus: head and entire thorax reddish brown, sternites 2–7 with distinct purplish-red tinge.

Female imago.—Head purplish black; two small, pale, submedian, spots on occiput; a pale, narrow, transverse, line between lateral ocelli; pale areas along posterior margin, at bases of antennae, and on outer margin of each lateral ocellus. Antenna yellowish; second joint blackish in apical third. Thorax light reddish brown. Lateral margins, and almost the entire median area of pronotum, blackish. Mesonotal scutellum, and median streak directly anterior to it, blackish. Pleura as in male. Sternum paler than dorsum. Median area, and anterior margin of mesosternum, darker (however, posterior half of mesosternum is pale).

Fore femur dark reddish brown; tibia blackish; tarsus pale, a smoky blotch near apices of 2nd, 3rd and 4th segments, on lower margins; a reddish-black line at apex of distal segment. Middle and hind femora yellowish, with reddish tinge, most evident on hind femur and at apex of each; a longitudinal, black, hair-line extends the length of each; near apex of each, a black spot. Middle tibia deep smoky, hind tibia somewhat paler. Tarsi similar to fore leg, but smoky markings paler. Wings hyaline, brown-tinged throughout. All veins reddish brown. Costal band on fore wing reddish brown, as in *N. tinctus.*

Cross veins somewhat less distinct than in that species, especially behind the outer fork. Wing broader in proportion to its length than in *tinctus*.

Dorsum of abdomen predominantly blackish brown; pale areas yellowish, with faint reddish tinge. Dark dorsal areas much as in male, but more extensive, on tergites 1–7. The pale, lateral, mark surrounded by dark shading is wider than in the male, and curves dorsad apically. The pale, median, areas are smaller than in the male, becoming progressively larger in size from base toward apical tergites. On tergite 8, only small, lateral, areas and a narrow, posterior, margin are darkened, so that the tergite is largely pale. Tergites 9 and 10 are almost wholly yellowish; anterior margin of 9, posterior margin of 10, and lateral margins of each, blackish. Traces of dark, submedian, streaks are visible within the pale median patches, on tergites 1–7. Sternite 1 somewhat tinged with reddish brown; all other sternites yellow; posterior margins very narrowly darkened. Faint dark median markings on sternite 6, and around egg valve on sternite 7. Tails greyish brown; alternate joinings blackish.

In both paratypes, the pale, median, areas on the tergites are much reduced in size, as compared with the above description. (The middle and apical portion of abdomen is missing, in one paratype).

Nymph.—Distinguished from *N. julio* and *N. tinctus* by: 1) the somewhat larger size; 2) the shorter spines on femora and tibiae (figs. 15, 17); 3) the fact that that there is no continuous pale area between eye and ocellus; 4) the *median* dark ventral mark.

Head dark reddish brown, heavily shaded with black between and immediately anterior to eyes. Yellowish areas around antennae, at outer margin of each lateral ocellus, and at inner margin of each eye. Thus, there is no continuous pale space between eye and ocellus. Antennae wholly pale. Median portion of occipital border, and four submedian spots on occiput (the anterior pair of these the larger), are pale reddish. Labrum 2½ times as wide as long; in *tinctus, julio,* 2 times as wide. Thorax as in *julio*. Legs yellowish, distinctly tinged with pale reddish brown. Basal third of fore femur wholly pale. Two black spots, unequal in size, at apex of each femur. Spines on femora and tibiae shorter, much less prominent than in *julio* or *tinctus*. Abdomen of female nymph largely blackish brown dorsally, on tergites 1–8; pale median and lateral marks as in adult; median area of 8 more extensive than on preceding tergites. Tergites 9 and 10 almost wholly pale; lateral margins darkened, also posterior margin of 10. Dorsum of male with larger pale areas, as in adult. Venter of abdomen yellowish. A short, black, median, transverse, mark on each sternite, somewhat anterior to the posterior margin. Tails wholly yellowish, except in mature nymph. Gills with a greater number of short, lateral, branches than in *julio, tinctus*.

Holotype—Male imago, reared from nymph. Camp lab. 46, Luquillo Mts., P. R., June 9, 1935 (J. García-Díaz). No. 1439.1 in Cornell University collection.

Allotype—Female imago, reared. Same data No. 1439.2 in Cornell collection.

Paratypes—2 male imagos, 2 female imagos. Same locality same collector. June 7–14, 1935. No. 1439.3–6 in Cornell collection.

In addition to the three reared species of Neohagenulus, many specimens of nymphs of a distinctly larger size are present in the Puerto Rican material. None of these has been reared. Two different species seem to be represented; these are designated by number only.

Neohagenulus sp. No. 1

Nymph.—Body of female 7–8 mm. in length. Second joint of antenna black. Spines on femora and tibiae relatively long, as in *N. julio* and *N. tinctus*. Pale area between eye and ocellus not divided by a dark line. Head and thorax red-brown. Abdomen of mature female dark red-brown dorsally. On each tergite, dark, submedian, streaks enclose a pale, median, line; a pair of pale, submedian, spots at anterior margin; lateral markings as in *tinctus*. Venter paler red-brown; anterior margins of each sternite narrowly darkened; intersegmental areas pale; an oblique, dark, mark on each side near posterior margin, halfway between median line and lateral margin. A single large female imago, body marked as in nymph, may represent the mature form of this species.

Nymphs of this species were collected at El Rucio, P. R., in 1934 (Dr. Francisco M. Pagán). Other specimens are from Guajataca Creek, Lares, P. R., Mch. 22, 1935 (J. G. Needham, J. García-Díaz); Río Prieto, Río Blanco, P. R., Mch. 7, '35 (Needham, García-Díaz); El Yunque Trail, Luquillo Mts., June 10, '35 (J. García-Díaz). The large female imago was taken at La Catalina, Luquillo Mts., Apl. 15, 1935 (J. García-Díaz).

Neohagenulus sp. No. 2

Nymph.—Body of female 7–8 mm. in length.

Head pale red-brown. Pale area between eye and ocellus not divided by a dark line. Antenna wholly pale. Thorax yellowish to pale reddish brown; dark markings as in the species previously described. Spines on femora and tibiae about intermediate in length between those of *N. luteolus* and the other three species. Dorsum of abdomen in both sexes largely yellowish. Posterior and lateral margins of tergites, and a mark near postero-lateral angle of each, blackish. Venter yellowish. Posterior margins of sternites may be narrowly darkened throughout, or the dark area may be confined to the lateral portion of each.

Nymphs of this species are from Río Cidra, Adjuntas, P. R., Mch. 24, 1935 (J. G. Needham, J. García-Díaz); La Catalina, Luquillo Mts., Apl. 14–15, 1929 (J. García-Díaz); and El Yunque Trail, Luquillo Mts., Feb. 18, '35 (Needham, García Díaz). Other specimens taken by Dr. Francisco M. Pagán at El Rucio, Peñuelas, P. R., in 1934, may be of this species, but are too discolored to permit of certain determination.

Genus **Borinquena** gen. nov.

Allied to Hagenulus and Neohagenulus. Rather small mayflies, wings of the known species 5 to 5¾ mm. in length. Upper portion of compound eyes of male much flattened (fig. 22, lateral aspect). In dorsal view, upper portion

is oval; a small area of lower division is also visible from this aspect. Eyes not contiguous apically, separated by distance equal to width of upper portion. Lateral ocelli very large, median ocellus barely visible. Posterior margin of head of female almost straight between the eyes. Pronotum somewhat excavated in middle of posterior margin. Fore legs of male longer than body; tibia fully twice as long as femur, tarsus subequal to tibia; basal tarsal joint very short, 2nd and 3rd joints subequal, 4th about ⅔ as long as the 3rd, 5th about ⅓ as long as 4th. In hind leg of male, femur slightly more than half as long as tibia; tarsus short, about ⅓ the length of the femur. Hind femur of female three-fourths as long as tibia; tarsus as in male. Claws on all tarsi dissimilar.

Fore wing as in figure 4. Outer fork of radial sector deeply sagged at end of stem, in both sexes. Before the bulla, 3 or 4 weak costal cross veins; beyond bulla, 3 to 5 weak veins before stigmatic area, which contains 7 or 8 well developed, slanting, cross veins. Cubital intercalary and first anal vein joined near base. Hind wing very small, drawn out into a long, slender, point; two longitudinal veins only, no cross veins (fig. 10).

Forceps base entire, bearing at median area of apical margin two short, finger-like, processes (fig. 8). Forceps very distinctive; basal joint very long, somewhat narrowed at apex; the two distal joints subequal, together about equal to ¼ of length of basal joint (fig. 12). Penes elongate, rod-like, usually closely appressed on inner margin; each bears on ventral surface a small, hook-like, projection, well below the apex. A correspondingly long ovipositor is borne by the female, as a development of the 7th sternite (fig. 2). Apical margin of subanal plate of female with a deep V-shaped cleft.

Nymph reminiscent of Choroterpes in proportions of head and body and in general appearance, aside from structure of gills. Mouthparts likewise very similar to those of Choroterpes (see figs. 32, 33, 35, 38, 40). Spines on fore-femur longer and fewer in number than in *Choroterpes basalis* Bks; on hind femur, reduced to a relatively few short spines on hind margin (in *C. basalis*, these are more numerous and more widely distributed). Hind tibia likewise with relatively few spines, most of these clustered near apex (in *C. basalis*, these spines are very numerous and generally distributed). Claws pectinate. Short postero-lateral spines present on segments 6–9, that on 9 being longest. Gills single, filamentous; each contains a single, unbranched, trachea (figs. 19, 39). Tails three; median tail distinctly longer than laterals, and slightly longer than body of nymph.

Genotype—**Borinquena carmencita**, sp. nov.

The above characterization of the genus is based on the genotype, and does not hold for the abnormal species *B. contradicens* as regards shape of hind wings and length of male forceps.

KEY TO SPECIES OF BORINQUENA

ADULTS

1. Wing very much reduced, having but two longitudinal veins, no cross veins; forceps of male very long, equal to combined lengths of last three ab-

dominal segments; abdominal tergites of male yellowish, wings brown-tinged----------*carmencita*

Wing much less reduced, having four longitudinal and several cross veins; forceps of male shorter; abdominal tergites of male whitish, wings not tinged----------*contradicens*

NYMPHS

1. Gills distinctly widened in basal third of their length; abdominal tergites of male yellowish, dark posterior margins narrow----------*contradicens*

Gills tapering more uniformly, not distinctly widened at base; abdominal tergites 7 and 10 of male wholly yellow, 8 and 9 blackish; dark posterior margins of other tergites wide----------*carmencita*

Borinquena carmencita sp. nov.

Wings faintly brown-tinged; abdomen yellowish, dark-banded dorsally.

Male imago.—Body 5½ mm.; wing 5–5½ mm.

Head very dark red-brown; antennae brown; lateral ocelli pearly white; eyes blue-black. Pronotum yellowish brown; lateral margin and postero-lateral angle dusky. Anterior margin of prothoracic pleura blackish; an oblique streak across central portion. Mesonotum rather dark red-brown; anterior lobe deep orange; posterior half of median line, including middle of scutellum, and oblique, lateral, extensions forward from median line to wing roots, yellowish. Pleura pale red-brown, yellowish around leg bases. Wide, purplish black, stripe extends forward from wing roots; blackish markings below wings and near leg bases. Metanotum olive brown; posterior margin and scutellum dusky. Sternum red-brown, darkest across anterior portion of mesosternum. Coxa and trochanter red-brown. Fore femur deep purplish brown, with prominent yellow, pre-apical, band; pale brown at base. Middle and hind femora similar, but distinctly yellowish at base. Tibiae dark olive brown, with faint red-brown tinge. Fore tarsus similar to tibia but paler. On middle and hind legs, basal and distal joints of tarsi yellowish, intermediate joints light red-brown, joinings very narrowly yellow. Wings hyaline, iridescent, faintly brown-tinged (figs. 4, 10). Venation dark red-brown.

Abdomen yellowish, semi-opaque. Tergites 1–6 with wide, purplish black, posterior, margins, these bands widest at middle and at each end; at median line, a pale streak may divide the anterior half of this dark border. Anterior extensions from each end of this dark band form an elongate, dark, oval, mark enclosing a pale area; its sides are two dark lines parallel to the pleural fold, conjoined at each end, and extending forward almost to the anterior margin. The dark oval is not well defined, on tergite 6. On tergite 7, the dark posterior band is narrower, and has no lateral extensions; a round, dark, spot is present near the postero-lateral angle, another at spiracular area; on some specimens, a smaller, dark, dot may occur between these. Dusky shading also occurs along the anterior margin of each intermediate tergite, usually as small patches on each side of median line. Geminate, dark, mid-dorsal, streaks are faintly indicated on some specimens, most distinct at each margin. Tergites 8 and 9 largely deep purplish brown; anterior margin of 8, area adjoining posterior margin of 9, traces of median streak, and wide, lateral, margins are yellowish.

Tergite 10 yellow, with reddish tinge. Sternites 1–7 with posterior margins faintly dusky; sternites 8 and 9 tinged with light red-brown. Tails dark olive brown with reddish tinge; joinings darker. Genitalia as in figures 12 and 37. Forceps base light red-brown; forceps dusky, darker at apex of long joint.

Specimens taken on June 7, in the same locality as the holotype, appear much darker; pale bands on femora more or less obscured; posterior dark borders on abdominal tergites more extensive; thorax deeper red-bown; wings more strongly brown-tinged; all markings more intense in color. No structural differences are noticeable. Nymphs of these darker forms are not known, hence it its not possible to determine whether these represent another closely-allied species, or are merely darker forms of the same species.

Female imago.—Body 5½ mm.; wing 5¾ mm.

Very similar to male, aside from usual sex differences. Mesonotum paler brown than in male; a V-shaped yellow mark and an antero-lateral extension of this on each side, anterior to scutellum. Wings as in dark form of male. Abdominal tergites 1–5 largely obscured by blackish shading, leaving on each side a pale, rounded, spot; antero-lateral angles, a narrow, median, line in anterior half, and submedian streaks on each side of dark geminate lines, likewise pale. A wider, pale, band across central area of tergite 6, in dorsal portion. Tergite 7 almost wholly yellowish except for lateral, dark, oval, mark and narrow anterior and posterior margins. Tergites 8 and 9 largely blackish; pale, median, line on each; traces of pale, submedian, streaks at posterior margin of 9; lateral areas of each pale. Tergite 10 yellow. Sternites 7–9 shaded with pale red-brown. Long ovipositor on sternite 7 (fig. 2) extends beyond apex of abdomen for ⅓ of its length; pale yellowish, with dark, longitudinal, streak on each side. Tails somewhat darker than in male.

Nymph.—Frontal portion of head yellow with faint brownish markings. Wide, blackish, band across head between lateral ocelli, usually extending laterad to eyes. Remainder of vertex, and occiput, yellow, more or less obscured by lateral and transverse darker markings, leaving pale posterior margin and a pair of pale, submedian, spots. Thoracic notum yellow; in female, extensive dark markings on median and lateral areas of pronotum, antero-lateral and lateral areas of mesonotum, also dark streaks on each side of central portion of latter segment. In male, these dark areas considerably reduced in size and extent on both segments. Legs yellow; dark markings at middle and apex of femur, in mature nymph. Abdomen yellow, except tergites 8 and 9, which are largely blackish, in both sexes. Posterior margins of tergites 1–6 with wide, blackish, bands. Sternites unmarked. Gills deep purplish grey, tracheae black; more or less uniform in width throughout, *not* distinctly widened at base (fig. 19). Tails yellow, somewhat opaque at joinings. Postero-lateral spines present on segments 6–9; very small on 6, largest on 9.

Holotype—Male imago. El Yunque, P. R., Feb. 18, 1935 (J. G. Needham, J. García-Díaz). No. 1399.1 in Cornell University collection.

Allotype—Female imago. Luquillo Mts., P. R., June 7, 1935. No. 1399.2 in Cornell collection. Same collectors.

Paratypes—56 male imago, 2 female imagos; El Yunque River, P. R., Feb. 18 and June 7, 1935, and Luquillo Mts., P. R., Feb. 17, 1935. Some collectors. No. 1399.3–57 in Cornell collection.

A single male submago was reared, thus establishing the correct association between nymph and imago. Specimens of this species were taken also from the following localities, during 1935 (J. García-Díaz): Hicaco River, Río Blanco (Mch. 7); and Río Cidra, Adjuntas (Mch. 24).

Borinquena contradicens, sp. nov.

Resembles the type species of this genus in the rearward sag of the outer fork of radial sector and in the genitalia of the male, but with hind wings similar to those of *Hagenulus caligatus* (fig. 50). Female with long ovipositor (fig. 34). Nymph quite like that of *B. carmencita*. Abdomen and legs of male imago whitish; thorax and fore femur red-brown.

Male imago.—Body 5 mm.; wing 5½ mm.

Head blackish brown. Compound eyes deep purplish black in upper portion. Purplish shading on basal joints of antennae; filament silvery white. Thorax largely red-brown. Pronotum, wide strip from wing roots to pronotal margin, and pleura of pro- and mesonota, quite heavily shaded with black. Scutellum, area anterior to and laterad of it, and posterior half of median area of mesonotum, yellowish. Metathorax yellowish; purplish black markings on pleura and around wing roots and leg bases. Posterior half of mesosternum likewise yellowish.

Fore femur red-brown. Tibia and tarsus of fore leg, and entire middle and hind legs, pale yellowish white. A purplish black patch at apex of fore tibia. Apices of middle and hind femora pale reddish yellow. Purplish grey, median, patch on hind femur only. Wings hyaline; both wings red-brown at extreme base (in hind wing, largely in costal strip). Longitudinal veins very pale yellow in upper half of fore wing; in remainder of fore wing and all of hind wing, silvery white. Cross veins fine, silvery white; almost invisible except in stigmatic area. Nine to eleven cross veins in this area; slightly aslant, yellow-tinged, and more distinct than cross veins elsewhere. Outer fork of radial sector in fore wing sagged prominently to rearward. Hind wing shown in fig. 50, 50 B.

Abdomen whitish; middle segments hyaline, basal and apical ones opaque. Posterior margins of tergites 3–10 narrowly purplish black, widest at median line; on 3 and 4, dark in median area only. Oblique, lateral, streaks of the same dark color extend the length of the segment on tergites 7–10; on 5 and 6 these streaks may be incomplete at apical margin; not present on basal segments. On tergites 2–8, a purplish black, stigmatic, dot; short, black, marks from the ends of the posterior dark bands extend obliquely above these dots on tergites 4–8. A small, dark, spot on median line above the apical margin, on tergite 5; a larger, dark, blotch on antero-median area of tergite 9. Sternites unmarked. Genitalia as in figs. 36, 41. Tails silvery white; a purplish-black ring at each joining.

Female (subimago ready to transform, cuticle partially removed). Body 3½–4 mm.; wing 5 mm.

Body largely red-brown. Head and eyes blackish. Pronotum and mesothoracic pleura heavily shaded with black. Mesonotal shield and median portion of mesosternum paler, yellowish to olive brown. Tip of scutellum brown. Metanotum yellowish; black markings laterally, especially around bases of legs. Legs (cuticle not removed) red-brown; fore leg darker than hind leg. Purplish, median, blotch on hind femur; apex dark red-brown. Wings (cuticle removed from fore wing) hyaline. Costal space basad of humeral cross vein dark red-brown. Humeral cross vein, costal margin, and subcosta, red-brown; radius and first branch of radial sector same color, but less prominent. Cross veins from costal margin to first branch of radial sector light red-brown, fairly distinct, especially those in the stigmatic area, which are about 9 in number, and slightly aslant. Hind wing red-brown in basal costal space; tip, and entire outer margin, darkened.

Abdomen red-brown dorsally, mottled with black. Median areas of tergites 5–7 yellowish; pale, submedian, streaks on tergites 3 and 4. Posterior margins of all tergites purplish black, the dark band occupying about ¼ of each tergite. Sternites 1–6 pale yellowish, 7–9 tinged with reddish brown. Posterior margins darkened, very faintly across median area, distinctly next to pleural fold. Tails (cuticle not removed) greyish, all joinings black. Long ovipositor present, as in *B. carmencita* (fig. 34).

Nymph.—Body 5 mm. in length. Head yellowish. Irregular, pale brown, markings on frontal portion. A blackish, curved, mark on each side of base of antenna. Antenna yellowish; second joint may be darkened near base. A broad, blackish-brown, band extends across head between eyes, including the lateral ocelli. Posterior to this band, much grey shading; pale areas include a narrow strip behind the dark band, and three pairs of elongate-oval, submedian, spots, those nearest the posterior margin being longest. Pronotum greyish brown, with large, bilobed, yellowish, areas on each side. Mesonotum yellowish. Dark markings along postero-lateral margins; short, dark, submedian, streaks may be present. Blackish shading in antero-lateral areas, extending backward to wing roots. Metanotum yellowish; irregular brown, lateral, markings. Sternum yellowish white. Legs yellowish, in immature nymphs. Traces of dark median and apical bands, on hind femur only, in young nymphs; mature specimens may have dark shading and femoral bands on other legs also. Abdominal tergites 1–3 of female nymph blackish brown; tergites 4–8 same dark color laterally, but each with a large, pale, median area, these pale spots becoming progressively larger in size from tergite 4 toward apex. Tergites 9 and 10 largely yellow; 9 with narrow dark anterior margin. Abdominal tergites of male nymph yellowish, with narrow, dark, posterior, and oblique, lateral, dark markings, as in adult. Sternites of both sexes yellowish, unmarked. Tails of immature nymphs wholly yellowish, or silvery white; mature nymphs similar to adults. Gills distinctly widened in basal third (fig. 39); dark grey, tracheae black. Postero-lateral spines on 8 and 9 (no true processes on other segments) shorter than in *B. carmencita.*

Holotype—Male imago. La Mina Recreational Area, P. R., July 14, 1935 (J. García-Díaz). No. 1440.1 in Cornell University collection.

Allotype—Female subimago, reared from nymph. Luquillo Mts., P. R., June 8, 1935 (J. García-Díaz). No. 1440.2 in Cornell collection.

Paratypes—2 male subimagos, 1 female subimago, reared from nymphs. Luquillo Mts., P. R., June 8–14, 1935 (J. García-Díaz). No. 1440.3–5 in Cornell collection.

Nymphs of this species were taken in the Luquillo Mts. P. R., on Feb. 18, 1935 (J. G. Needham, J. García-Díaz).

SUBFAMILY CAENINAE

Genus *Caenis* Stephens

Three species of this genus are represented, one by a female imago reared from the nymph, one by a female imago and tentatively associated nymph, the other by a single nymph. These may be distinguished as follows.

KEY TO PUERTO RICAN SPECIES OF CAENIS

ADULT FEMALES

1. Five longitudinal black stripes on mesonotum; no dark markings on femur ..... *sp. No. 1*
   A single dark, median, line on mesonotum; two incomplete, blackish, bands and a longitudinal, black, hair-line on femur ..... *sp. No. 2*

NYMPHS

1. Dark area at base of antenna; abdominal tergites largely suffused with blackish ..... *sp. No. 2*
   No such dark area at base of antenna; abdominal markings somewhat more restricted 2
2. Posterior portion of head largely yellowish; numerous small yellow spots on mesonotum; dark markings on apical tergites largely restricted to lateral areas ..... *sp. No. 3*
   Posterior portion of head largely brown; mesonotal markings diffuse streaks; dark markings on abdominal tergites largely transverse bands ..... *sp. No. 1*

Caenis sp. No. 1

Female imago.—Body 3 mm.; wing 2½ mm.

Head heavily shaded with purplish black. Antennae pale. Pronotum greyish, margined and heavily shaded with black. Mesonotum reddish brown, with five longitudinal, black, stripes, one of these on median line. Pleura and sternum yellowish to light reddish brown, darker at sutures. Venation purplish grey. Legs light reddish brown; two black streaks on each coxa, no other markings. Abdomen yellow. Wide, black, bands on posterior margin of each tergite, the blackish shading often extending over half the segment. Tails missing.

Taken at Río Piedras River, P. R., May 23, 1935 (J. García-Díaz).

Two specimens, reared from nymphs. Head and thorax of nymph reddish brown with yellow markings. Black band on head between bases of antennae, another between eyes. Antennae yellowish. Two yellow spots on head, one between bases of antennae, the other along median line of vertex and occiput. Median, dark, band on femur; wide dark band basally on tibia, similar band on tarsus. Anterior margin of pronotum rather widely flaring. Abdomen yellowish with black markings as in adult.

Caenis sp. No. 2

Female (imago removed from subimaginal skin).

Body 4 mm.; wing 3½ mm.

Head yellowish; black shading between eyes. Antennae blackish at base. Pronotum light reddish brown, with much black shading. Mesonotum reddish brown; median line, and streak anterior to wing roots, blackish. Pleura and sternum light red-brown; dark markings on pleura at bases of legs. Black shading on coxa; a black dot on trochanter; two incomplete, blackish, bands on femur, one near base, the other near apex, likewise a longitudinal, black, hair-line along margin. Venation light purplish grey. Abdomen yellowish. Tergites more or less completely suffused with irregular blackish mottling, which on basal ones tends to form dark, posterior, bands. Tails yellowish at base, paler apically; not darkened at joinings.

Río Piedras River, P. R., May 23, 1935 (J. García-Díaz).

A single specimen. A last-stage nymph, about to transform, taken at same time and place, is tentatively associated with this female, because of dark area at base of antennae, the diffuse dark abdominal markings, and the single dark, median, line on the exposed mesonotum of the subimago. Anterior margin of pronotum less flaring than in nymph of *Caenis sp. No. 1;* dark markings on abdominal tergites rather more suffused. Legs missing.

Caenis sp. No. 3

This species is represented by a single nymph, taken at same time and place as other two species. Body more slender than in either of the two preceding species. Head largely yellowish, except for wide, dark, bands between bases of antennae and eyes, narrow continuations from these bands forward to the clypeus, and brownish, lateral, streaks extending forward from the narrowly dark posterior margin. Antennae yellowish. Pronotum mainly blackish, but with a large, yellowish, spot on each side and another on posterior half of median line. A series of small, yellow, spots on the red-brown mesonotum are located as follows: one large spot on each side anterior to wing roots; one large spot laterally on anterior line; four small spots between median line and wing roots; and a pale, oblique, streak on anterior margin at median line. Two small, black, submedian, spots near posterior margin of mesonotum, behind these a pale area. Costal margin of wing pad heavily shaded with blackish. Legs yellowish. Pre-apical black spot and diffuse band on each femur; dark proximal

band on each tibia, another near base of tarsus on fore leg only. Dark marks on pleura above bases of middle and hind legs; small, dark, streak at apex of trochanter on these legs. Abdominal segments yellow; basal tergites heavily suffused with blackish; tergite 10 yellow-brown with no black markings; other tergites pale in median area and along each margin, lateral areas blackish. Tails yellow, not darker at joinings.

SUBFAMILY BAETINAE

The three genera Baetis, Callibaetis, and Cloeodes are represented in this material. These may be distinguished as indicated in the following keys.

KEY TO PUERTO RICAN GENERA OF BAETINAE

ADULTS

1. Hind wing present 2
   Hind wing absent ..... *Cloeodes*
2. Fore wings usually with numerous costal cross veins before the bulla; hind wings with a moderate number of cross veins, the costal projection obtuse ..... *Callibaetis*
   Fore wings without costal cross veins before the bulla; hind wings with no cross veins, or very few of them; costal projection acute, may be hook-like ..... *Baetis*

KEY TO PUERTO RICAN GENERA OF BAETINAE

NYMPHS

1. Gills single on segments 1–7 2
   Gills double on segments 1–6, single on 7 ..... *Callibaetis*
2. Hind wing bud present ..... *Baetis*
   Hind wing bud absent ..... *Cloeodes*

Genus *Callibaetis* Eaton

Females and nymphs of this genus were collected. The nymphs were not reared, hence cannot be associated with the female except by inference.

Callibaetis completa (?) Bks. (2)

Several females taken in September 1930 (Francisco Seín), at the Experiment Station, Río Piedras, P. R., are tentatively placed in this species. The specimens are in rather poor condition, so that it is difficult to be certain of the markings on the body. No dark dots are evident on the thorax. Scutellum of mesonotum, and spine-like median process of metanotum, dark brown. In some specimens, the median area of the mesonotum likewise appears darker than other parts. The second joint of the antenna is slightly brown-shaded, in some specimens. Of this, Banks states: "second joint of antenna mostly dark brown." Legs yellowish, having no dark dots; femoro-tibial joint red-brown; tarsal joinings narrowly dark; claws dark brown.

Wings much as described by Banks: "a broad brown stripe along front margin, covering the first three veins, and on base a little more; this brown fills the costal area to base, and also at tip, it contains a number of transverse hyaline white marks, mostly over veins, very few of these pale spots in the apical fourth". In the basal half of the costal space, however, are many narrow, pale, areas along the cross veins, usually extending from costal margin to subcosta, but sometimes broken up into two pale spots narrowly separated by a brown line. These pale areas usually extend for a short distance beyond the bulla only, but in a few specimens they occur also at the tip. Pale areas around veins in the subcostal space become round spots, except in the apical fourth, where they are narrow as in the costal strip. In the space below radius appear other and larger, pale, areas around cross veins, connected behind with the hyaline portion of the wing. These large pale spots are 5 to 7 in number; the largest occur near the bulla. All veins brownish. Cross veins behind the brown band about 22 in number; none very near the margin. Marginal intercalaries occur singly.

Few or no small, dark, dots on abdomen, but larger, paired, submedian, dark, spots or marks on tergites and sternites; those of the tergites seem confined to the basal and middle segments, and the area between them appears to be darkened. Of *C. completa,* Banks says: "body of usual pale brownish, with many small, dark, dots, especially on the abdomen, beneath with larger, paired, dots, above on the abdomen the basal segments show a large, dark, spot in the middle, tending to form a stripe." Tails whitish; dark-ringed at joinings, the rings of alternate joints wider and darker.

Rather variable in size; wings ranging in length from 5 to 7½ mm. The length of *C. completa* is given as 7½ mm.; type locality, Soledad, Cuba.

Callibaetis sp.

Nymph.—Head and thorax dark red-brown. Pale areas around eyes, antennae and ocelli; vertex and occiput indistinctly mottled, median line pale. Mouthparts normal for the genus. Median line of thoracic notum pale, likewise tip of scutellum and areas anterior to wing roots. Pleura and sternum paler red-brown; darker areas on pleura above leg bases. Legs light red-brown; joinings very narrowly darker. No distinct markings. Abdominal tergites red-brown; intersegmental areas pale, so that abdomen often appears banded. A narrow, yellow, lateral, line half-way to margin extends the length of the abdomen, but is usually concealed beneath the large gills. Pale areas on flattened lateral portion along anterior margin, so that this portion of the abdomen is alternately dark and light. A darker spot at base of each pair of gills. Sternite paler; a wide, median, band, obscurely darker red-brown, extends the length of the abdomen; on each side a row of small, dark, dots, located near anterior margin of sternite. Gills double on segments 1–6, single on 7; large, with lower division of each pair (at least on intermediate segments) almost as large as the upper, and very similar in shape. Tracheation approaching the palmate condition; tracheae purplish black, prominent, numerous. Tails yellowish to pale reddish brown, joinings narrowly darker. A wide, dark, band across tail, formed by an area of long dark hairs.

Body 6–7 mm.; tails 4½ mm.

Specimens were collected during 1935 at Tortuguero Lake, west end, Mch. 9 (J. García-Díaz); Cartagena Lagoon, Feb. 23 and Aug. 10 (J. García-Díaz); Florida Road, Feb. 28 (J. G.-D.); Experiment Station, Río Piedras, May 23 (J. G.-D.). On May 5, 1931, Dean García-Díaz took other similar nymphs at Las Cabezas, Fajardo.

While it is probable that *Callibaetis sp.* is the nymph of *C. completa* (?) Bks., this can be determined only by rearing of the nymphs. In this way, too, it should be possible to obtain the male, and other specimens of females which are in better condition for determination.

Genus *Baetis* Leach

Three species of Baetis are present, one of which has been reared; the other two are represented by nymphs only. Nymphs may be separated as indicated below.

Key to Puerto Rican Species of Baetis

NYMPHS

1. Intermediate gills asymmetrical; each about as long as one abdominal segment plus half of another 2
   Intermediate gills symmetrical; each about as long as three abdominal segments together ..... *sp. No. 1*
2. Gills on segment 7 distinctly narrower and smaller than those on 6; two dark bands on tail ..... *garcianus*
   Gill on 7 very similar to that on 8; a single dark apical band on tail ..... *sp. No. 2*

Baetis garcianus sp. nov.

Male imago.—Body 3½ to 4 mm.; wing 4 to 4½ mm.

Head rather dark reddish brown; antennae and eyes the same color. Turbinate eyes oval, set on high stalks. Thorax dark reddish brown; intersegmental areas of pleura, narrow stripes on each side of mesonotum, and areas around bases of legs and wings, paler. Legs pale yellowish white; coxae largely brown; narrow, dark brown, line at apex of trochanter and at each tarsal joinings. Wings hyaline. Longitudinal veins very faintly brownish in apical and basal portions; wing margin outlined in brown. Costa and subcosta deeper brown at extreme base; a small, dark, spot at base of subcosta and radius. Cross veins colorless. Stigmatic space and parallel subcostal space semi-opaque, filled with granulations. Three or four slanting, stigmatic cross veins, incomplete toward subcosta. No marginal intercalaries in first interspace, or in anal area; between media and cubitus, these may occur singly, elsewhere paired as usual. Hind wing very slender, with strongly hooked, costal angulation, reminiscent of Centroptilum (fig. 9). Two veins only, the first of these usually incomplete at apex; a faint brownish yellow stain at extreme base.

Abdominal segments 2–6 hyaline whitish. Posterior margins of tergites narrowly deep brown, in dorsal portion only; these marks often much fainter at median line. Postero-lateral area of each tergite occupied by a large olive-brown blotch, almost square, but with its anterior margin slightly concave. Antero-lateral areas remain hyaline white. On tergite 2, the upper anterior angle of the dark blotch extends forward almost to the basal margin of the tergite. Dorsum of abdomen thus appears pale in middle area, with a wide, broken, brown, band on each side. Tergites 7–10 deep red-brown, pleural margin paler; sternites olive brown with a faint reddish tinge. Tails white, tinged with yellowish at base; joinings opaque but not darkened. Genitalia as shown in figure 5.

Female imago.—Body 3½–4½ mm.; wing 4¼–4½ mm.

Head yellowish; narrow pale median line on vertex, lateral areas mottled with dark brown. Pronotum dark red-brown; median stripe and lateral areas pale. Mesothorax light red-brown; darker brown markings anterior to wing root; tip of scutellum whitish. Two pale, longitudinal, streaks on sternum. Metathorax dark red-brown. Legs as in male. All veins distinctly brownish; stigmatic cross veins 5 or 6 in number, better developed than in male. Abdominal tergites largely chestnut brown, with creamy markings. These pale areas include the antero-lateral angles, a narrow line along the anterior margin, basal half of median line, short, submedian, dashes from anterior margin, a small dot at end of each dash, and a lateral triangle based on posterior margin. Tergites 8–10 paler than preceding ones. Pleural fold widely pale; small dark stigmatic dots, and a wavy, double, blackish, line along tracheal area. Sternites pale yellowish; dark red-brown shading next to pleural fold, and a transverse, brown, dash in each antero-lateral angle. Tails very faintly brown-tinged at base.

Nymph (described from nymph slough of allotype, with additional notes from nearly-mature nymphs). Head light reddish brown; whitish areas around eyes, ocelli, and bases of antenae; antennae likewise whitish. Maxillary palp two-jointed; labial palp three-jointed, very similar to that of *Baetis sp. No. 1*, shown in figure 25. Epicranial suture and median line of vertex whitish. Thoracic notum concolorous with head; median line whitish; diffuse darker markings and a few creamy areas anterior to wing roots. Pleura and sternum paler reddish brown; brownish semi-lunar markings above leg bases. Legs pale yellowish, femora often with faint brownish tinge; obscure brownish, pre-apical, mark on femur; a distinct dark brown "knee spot"; all joinings narrowly dark brown. Claws amber-tinged; pectinate. Abdominal tergites 1–7 slightly darker brown than thoracic notum; tergites 8–10 paler, 9 and basal half of 10 usually yellowish. All tergites paler next to dark lateral margin. A diffuse pale, median, line on anterior half of each tergite, with obscure darker areas on each side. All margins narrowly darker; posterior and lateral margins of 10 widely dark; postero-lateral angles of all segments greyish brown, with a darker spot at base of gill. Sternites slightly paler than tergites; faint dark, lateral, streaks and obscure, obliquely-directed, submedian, dashes from anterior margin are often evident. Gills single, obovate, those of intermediate pairs asymmetrical (fig. 23). Tracheation pinnate; tracheae purplish black, conspicuous; main branch not extending as far as tip of gill, lateral branches not very numerous. Tails yellowish brown, crossed by two wide, dark,

bands; middle tail about two-thirds the length of the laterals. Body 4½–5 mm.; tails 3–3½ mm.

Holotype—Male imago. Tanama River, P. R., March 13, 1935 (J. G. Needham, J. García-Díaz). No. 1400.1 in Cornell University collection.

Allotype—Female imago, reared from nymph. Yunez River, P. R., June 21, 1935 (J. García-Díaz). No 1400.2 in Cornell collection.

Paratypes—23 male imagos, same data as holotype; 4 male imagos, Tanama River, May 12 (J. García-Díaz); 17 female imagos, same data as allotype. No. 1400.3–43 in Cornell collection.

A male and female imago which seem to be of this species were collected at Isabela, P. R., April 24, 1930, and a male at Las Cruces, P. ., April 4, 1930, by Dr. M. D. Leonard. These specimens are in the Cornell collection. Nymphs similar to that from which the allotype was reared were taken during 1935 (J. García-Díaz) at Río Cidra (Mch. 23); Luquillo Mts., (Feb. 18, May 26); Quebrada Tomey (Feb. 21); La Muda River (Feb. 9); Carrera River (Mch. 9); Utuado Road (Mch. 13); Yunez River (Feb. 19, June 22 and Aug. 15; Lares, Guajataca Creek (Mch. 22); Tallaboa Alta River (Feb. 25); Cagüitas River (Mch. 4); Almirante Road (Mch. 9); and Mameyes River (Mch. 8).

The species described by Eaton (6), from the Rangel Mts., Cuba, as *Centroptilum poeyi* Etn., is probably a Baetis of the same aberrant type as *B. garcianus*. Abdominal segments 2–6 of *poeyi* are "transparent whitish", unmarked except that "the spiracles and tracheal trunks [are] darker in individual specimens". The narrow, dark, posterior, margins of the tergites, and the lateral, brownish, blotches of *garcianus*, serve as distinguishing features. Were it not that *B. garcianus* was reared from a typical Baetis nymph, it would have been very difficult to decide whether to place this species in Baetis or Centroptilum. Eaton notes: "interneural veinlets of the terminal margin mostly in pairs,"—a condition distinctly reminiscent of Baetis. The hind wing, however, appears to be that of a Centroptilum.

Baetis sp. No. 1

Disconcertingly close to *B. garcianus* in general appearance, but slightly smaller, and differing in the shape and size of the gills.

Nymph—Head very much as in *B. garcianus*. Maxillary and labial palps as in that species; labial palp shown in figure 25. Thoracic notum somewhat more conspicuously marked. Distinct paler areas anterior to wing roots, in-

terspersed with darker markings; on each side of mesonotum an oblique, paler, streak, containing a dark mark, and surrounded by darker areas. Paler mottling laterally on pronotum. Pleura and sternum paler relatively than in *B. garcianus,* the dark, semi-lunar, markings above leg bases therefore more conspicuous. Legs quite similar, but pre-apical band on femur has here become a wider, longitudinal, streak in apical half of the joint, and the dark knee spot is reduced to a narrow line at the femoro-tibial joining. Abdominal tergite 1 and the extreme base of 10 pale; remaining tergites rather uniformly dark red-brown. Marked as in *B. garcianus,* except that the posterior margins are distinctly darker; dark brown shading occurs in a crescentic area based on this margin, or in some specimens as more or less distinct wide, submedian, streaks the length of each tergite; and the pale, median, stripe is practically continuous. Sternites as in the former species, but posterior margins usually obscurely darker. Gills longer, relatively more slender, intermediate pairs more symmetrical, the tips less distinctly rounded (fig. 24). Gill on 7th segment almost as long and as wide as that on the 6th (in *B. garcianus,* this gill is shorter and distinctly narrower than the one preceding), so that its tip may extend beyond the apical margin of the 10th segment. Each intermediate gill is approximately as long as any three of the middle segments of the abdomen taken together. Tails yellowish brown, may be slightly darker at base; in distal half, each joint of lateral tails is darker brown apically, giving the appearance of an obscure darker band near the base, as in *B. garcianus.* Middle slightly more than one half as long as the laterals.

Body 3–4 mm.; tails 3–3½ mm.

Nymphs of this species were taken at the following localities during 1935 (J. G. Needham, J. García-Díaz): Utuado Road (Mch. 13); Luquillo Mts. (May 26); Caño Tiburones (Mch. 12); Cagüitas River (Mch. 4); and Quebrada Tomey (Feb. 21).

Baetis sp. No. 2

Larger than either of the preceding species. One dark apical band on tail.

Body (female) 6–7 mm. Head and thorax pale reddish brown; pale, median, line from frontal suture to posterior margin of metanotum. Pale submedian areas on mesonotum. Darker shading anterior to wing roots. Maxillary palp as in *B. garcianus;* labial palp more like that of *Baetis sp. No. 1.* Legs yellowish. Very faint pre-apical bands on femora; femoro-tibial joint dark brown; claw and tarsal joinings brownish. Tergites 1 and 9 wholly pale yellowish; tergite 4 pale except for brown, anterior, margin and two small, dark, submedian, dots; tergite 10 pale in anterior half, brown posteriorly; tergite 8 largely pale, but with four dark, submedian, marks, one pair on anterior margin, other pair (closer together) near center of tergite. Tergites 2 and 7 dark brown except for pale line near lateral margin; tergites 3, 5, and 6 largely brown, but with pale, transverse, areas, on 5 and 6 a bar near anterior margin, on 3 a more extensive area nearer center. Sternites yellowish white, unmarked.

Gills pale greyish white; tracheae and margins of gills blackish. Tracheae pinnate, intermediate in number of branches between *B. garcianus* and *Baetis sp. No. 1.* Gills slightly asymmetrical, resembling those of *B. garcianus* in shape and relative length. Tails yellowish, with single, dark, apical, band.

Three specimens were taken in the Luquillo Mts., El Yunque Trail, July 27, 1935 (J. García-Díaz).

Discussion of the genus Pseudocloeon Klapalek and allied forms

Three species of Baetine imagos, which by the absence of the hind wing and the paired marginal, intercalaries of the fore wing (these often single, in the females) would fall into the genus Pseudocloeon, are present in the Puerto Rican material. Three specimens representing two species were reared from nymphs. The nymphs possess three tails, almost equal in length and thickness; labial palp apparently two-jointed in one species, ending distally in a pointed projection, in the other species three jointed, distal joint rounded apically; claws without pectinations. The imago of one species corresponds well with characterizations of the type of Pseudocloeon as to relative lengths of leg joints; in the other species, however, the basal joint of the tarsus is very long. Thus these two species differ considerably from one another in characters of both imaginal and nymphal stages.

The genus Pseudocloeon Klapalek was described (**12**) from material collected in Java. The type species is *P. kraepelini* Klap., of which the female imago and the nymph are unknown. Figures of the legs and genitalia of the male of this species are presented by Dr. Ulmer (**23**), along with descriptions and figures of two other species of the same genus. Imagos which correspond to the generic characterization of Pseudocloeon occur commonly in the Nearctic fauna, and several species of these have been reared from nymphs by Drs. McDunnough (**14**) and Ide (**10**). These nymphs have but two tails; both labial and maxillary palps are two-jointed; gills single on all segments; claws pectinate. The two-jointed condition of the labial palp is somewhat deceptive, however, as there are some specimens from North Carolina 3(**19**) in which the fusion of the two distal joints into one is incomplete the palp thus appearing to be three-jointed. In the Cornell University collection, there are several specimens of Baetine nymphs taken in the Philippine Islands which are two-tailed; maxillary palp two-jointed; labial palp more or less distinctly three-jointed, claws pectinate; gills single. These accord well with the reared Nearctic nymphs heretofore assigned to Pseudo-

cloeon. Thus, although the type species of the genus has not been reared, nymphs which correspond to reared Nearctic nymphs are known to occur in the same faunal region as the type locality; imagos of these Nearctic nymphs agree well with the characterization of the genus Pseudocloeon. Until the type species has been reared, I propose to consider the nymphs described from the Nearctic region as representatives of the true Pseudocloeon.

South American nymphs described by Needham and Murphy (**16**) as presumably of the genus Pseudocloeon, prove on further examination to possess hind wing buds; these may be allies of Centroptilum. The nymph of a species described in Pseudocloeon has been recorded from South Africa by Barnard (**2**). This nymph has single gills, present on segments 2–7 only; both maxillary and labial palps are three-jointed; tails three in number, the middle tail somewhat shorter than the laterals. These nymphal characters, together with a tendency in the female imago for the marginal intercalaries to occur singly, (as in the Puerto Rican specimens), leads me to believe that the South African species is not a true Pseudocloeon, but an unnamed genus of the Pseudocloeon group. Another allied genus of this group is Baetiella Ueno (**21**). The nymph of the type species, *B. japonica* Iman., described in Acentrella 4(**11**), was previously described and figured by Ueno 5(**20**) as *? Acentrella sp.* It differs from described Nearctic species of Pseudocloeon only in the possession of a long, slender, filament or hair near the tip of the claw. The imago seems to accord well with the characterization given for Pseudocloeon. Other characters mentioned as separating this genus from allied genera do not seem to be distinctive of Baetiella. Is Baetiella worthy of generic rank?

Structural differences between nymphs from the several localities mentioned, are summarized in the following tabulation. Gills single; on 1–7, unless indicated.

Locality represented	Claws	Max. palp	Lab. palp	Tails
Philippine [1]	Pectinate	2 jts.	3 jts.	2
Nearctic	Pectinate	2 jts.	2 (3) jts.	2
South African [2]	?	2 jts.	3 jts.	3
Puerto Rican [3]	Not pectinate [5]	2 jts.	2 (3) jts	3
Japanese [4]	Pectinate	2 jts.	3 jts.	2

1—Nymphs in Cornell University collection; no published description.
2—Middle tail slightly shorter than laterals; gills present on segments 2-7 only.
3—Middle tail slightly shorter than laterals, in two species; much shorter, in third species.
4—Genus Baetiella. Long, slender filament near tip of claw.
5—Pectinate, in the aberrant species with very short middle tail; this probably does not belong in the same group with the other two species from Puerto Rico.

The nymphs of two of the Puerto Rican species are seen to differ from all the others in the absence of pectinations on the claws. These nymphs possess three tails, the middle one of these being slightly shorter than the laterals. In still another Puerto Rican species, represented by nymphs only, the claws are pectinate, the middle tail much shorter than the laterals, as in typical Baetis; this latter species is probably not congeneric with the other two, but is here treated tentatively under the same generic name. Since the Puerto Rican species differ so markedly from the Nearctic, Palearctic and Oriental species known, in the nymphal characters of tails and claws, it seems best to place them in a new genus, designated as Cloeodes *gen. nov.* This genus evidently does not include the South African species, which belongs in still a different category.

Genus **Cloeodes** gen. nov.

Turbinate eyes of male extraordinarily large, set on rather high stalks (fig. 20). Eyes of female larger, and set higher and closer together, than in Nearctic representatives of Pseudocloeon. Posterior margin of head of female distinctly emarginate. Fore leg of male only slightly shorter than body. Basal joint of fore tarsus of male very short; second joint longest, about equal to third and fourth combined. In decreasing length, tarsal joints rank: 2, 3, 4, 5, 1. Tarsus almost as long as tibia, which is almost twice the length of the femur. On middle and hind legs of both sexes, basal joint of tarsus very long, exceeding in length the three succeeding joints combined; this joint fully half as long as tibia on middle leg, more than half the length of the hind tibia (figs. 45, 45 A.). Tibio-tarsal joining indistinct. Hind wings absent. Marginal intercalaries of fore wing occur in pairs, which in male are well developed; in female, one member of a pair often indistinct or wholly wanting, so that some marginal spaces have but one intercalary. Cross veins arranged in three irregular series across wing: 6 in apical series, about 12 in middle series. Posterior margin of pronotum almost straight. Apical margin of sternite 9 in female *not* produced backward to form a subanal plate. Genitalia of male as in figure 13. A dome-shaped or slightly truncate "penis cover" is present between the bases of the forceps.

Genotype—**Cloeodes maculipes** sp. nov.

The genus is characterized from the type species. Other species placed in this new genus (*portoricensis, consignatus* and *sp.*) do not agree with the type as to the unusual length of the basal tarsal joint on the middle and hind legs, but conform rather to the type of Pseudocloeon in this respect. The nymphs of *consignatus* and *C. sp.* are unknown; nymphs of *C. portoricensis* are very similar to those of *C. maculipes.* Do *consignatus* and *C. sp.* represent still another genus? And what of *portoricensis?*

KEY TO PUERTO RICAN SPECIES OF CLOEODES

IMAGOS

1. Narrow longitudinal lines on femora and tibiae, dark spots at apices of fore femur and tibiae; wing 5½ mm. in length ---------- *maculipes*
   Legs without distinct markings; smaller species, wing 3–4½ mm. in length ---------- *2*
2. Wing (female) 4½ mm. in length; no marginal intercalaries in first interspaces ---------- *sp.*
   Wing 3–3½ mm. in length; marginal intercalaries in first two interspaces variable ---------- *3*
3. No marginal intercalaries in first three interspaces; abdominal tergites of female with prominent, lateral, purplish red, spots; male not known ---------- *consignatus*
   Marginal intercalaries usually present, though short, in second interspace; abdominal tergites of male and female largely pale, with no such purplish red, lateral, patches ---------- *portoricensis*

NYMPHS

1. All three tails approximately equal in length, not dark-banded; claws not pectinate ---------- *2*
   Middle tail slightly more than one half as long as laterals; tails marked with two dark bands; claws pectinate ---------- *sp. No. 1*
2. Small species, body 3–4 mm. in length; labial palp 2-jointed, distal joint as in figure 24 ---------- *portoricensis*
   Larger species, body 5 mm. in length; labial palp 3-jointed, distal joint conical, as in figure 19 ---------- *maculipes*

Cloeodes maculipes sp. nov.

A creamy white species, with distinctive black markings on femora and tibiae.

Male imago.—Body 5 mm.; wing 5½ mm.

Turbinate eyes very large, set on rather high stalks; upper surfaces almost circular (fig. 20). Stalk deep orange, upper surface pale orange. Head creamy white; faint blackish shading on median line ventrad of lateral ocelli. A broken, reddish, ring at base of antenna; basal antennal joint white; base of filament reddish black, remainder silvery white. Thorax opaque whitish, meso- and metathorax with faint pinkish tinge. Faint brownish markings on antero-lateral areas of mesonotum; scutellum alabaster white. A short, black, mark laterally, directly above base of wing; faint smoky pencilings on pleura, along courses of tracheae. An olive-brown, transverse, band on mesosternum, between middle legs, traces of a similar band on prosternum; ventrad of hind legs, on metasternum, a narrower, blackish, streak.

Legs creamy white; femora and apical portion of tarsi tinged with yellowish. A narrow, black, hair-line extends the length of each femur, on inner surface; a small, reddish, black basal spot on upper surface and a larger preapical one on inner surface; on fore femur, a small red-brown spot at apex.

A narrow, red-brown, line extends the length of the fore tibia; at the apex is a small black spot. Two longitudinal, black, dashes on middle and hind tibiae, one near base, one at center (fig. 45). Tibio-tarsal joining black. Wings hyaline; venation light brown, paler in the wing disc. Subcosta and radius dark brown at extreme base. Paired marginal intercalaries distinct. Cross veins arranged in three irregular series across wing; none near margin. Stigmatic cross veins 3 or 4 in number, simple, somewhat aslant; white next to subcosta, so that they appear incomplete.

Abdomen creamy white. Segments 2–6, also sternites 1 and 7, semi-translucent; tergite 1, and segments 8–10, largely opaque. A narrow, dark, red-brown, line marks the posterior margin of each tergite. Posterior margins of sternites opaque, but not darkened. A black line follows the tracheal trunk above pleural fold on each side; short, lateral, branches extend in both directions from this line. Tails silvery white; in proximal half, joinings narrowly purple-brown, alternately wide and narrow at extreme base. Genitalia as in figure 13. It should be noted that the genitalia of the paratype seem to possess a backwardly-directed truncate process between the bases of the forceps; in the holotype this process is lower and somewhat dome-shaped. Genitalia of both specimens were treated in potash before mounting.

Female imago—Body 5 mm.; wings 5½ mm.

Head and thorax light yellowish brown. A reddish black spot at apex of basal joint of antenna; apical margin of second joint similar in color; both of these joints yellowish. Antennal filament dusky brown, black at base. V-shaped maroon mark on vertex, above median ocellus. Two wide, purplish red, submedian, stripes extend from lateral ocellus to posterior margin of head. Eyes blackish. Posterior margin of pronotum black; purplish red markings consist of: antero-median triangle; small submedian dots; lateral markings, about four on each side. A wide purplish red streak on prothorax behind fore leg; this extends forward on to the coxa; a transverse band between legs, on sternum. On mesothorax, a broken band of purplish red extends forward from wing roots, to anterior margin of mesonotum; below this, at anterior margin, a shorter band of same color; from wing roots to base of middle leg, a longer band. Reddish markings also, around leg bases; laterally on mesosternum; a transverse band across sternum, between middle legs. Ruddy shading on each side of scutellum. Tip of scutellum yellowish. Spine-like process of metanotum purplish red, likewise streaks extending laterad from it. Purplish markings around leg base; a transverse band on sternum, between hind legs.

Legs yellowish. Each femur marked with a basal cross-band of purplish red on upper surface, and a pre-apical band of same color on lower surface. Tibiae marked as in male. Tarsi pale brownish in apical half; joinings narrowly darker. Costal margin of wing, to humeral cross vein, and bases of subcosta and radius, deep purplish red. All veins, and outer margin of wing, brownish; cross veins heavier than longitudinals; 4 or 5 stigmatic cross veins, slightly aslant. Marginal intercalaries as indicated in account of genus.

Abdominal segments 2–7 semi-hyaline, yellowish with extensive purplish red markings; segments 8–10 opaque, heavily shaded with reddish. Posterior margins of all tergites with a wide purplish band; this band reduced to a narrow line on tergites 3 and 4. Tergite 2 largely purplish; a small, pale, spot at median area of posterior margin; lateral pale area next to pleural fold. Me-

dian areas of tergites 3 and 4 almost wholly pale. On tergites 2–7, a wide, oblique, lateral, stripe, deep purplish red in color, extends the length of the segment (on 4, this may be indistinct in posterior half). Pale areas laterally, on all tergites, next to pleural fold; a blackish line follows course of tracheae the length of the abdomen. Sternite 9 yellowish; sternites 6–8 overlaid with red shading. Sternites 1–5 pale yellowish; wedge-shaped, purplish, markings in postero-lateral areas of sternite 1 and 2; traces of same, on sternite 3. Tails missing, except a few basal joints. The two basal joints shaded with purplish red, next two yellowish; wide black band at each joining.

Nymph—(described from slough of type specimen, with additional notes from nearly-matured nymphs).

Head brown, with pale markings. Antennae whitish, at least basally. Pale markings on median and lateral areas of frons: a pale band between eyes and bases of antennae; median line of vertex pale. Maxillary palp 2-jointed, apparently without hairs or spines (fig. 29). Labial palp 3-jointed; distal joint conical at apex (fig. 27). Thoracic notum smoky brown; pale markings on mesonotum anterior to wing roots, the median line pale. Pleura and sternum pale; the former with prominent dark brown semi-lunar markings above base of each leg. Coxa and trochanter pale, often a brown band across coxa. Femur brownish, with wide, pale, longitudinal, streaks at base and apex. Tibia and tarsus pale smoky; in certain lights, a dark, median, band is seen on tibia. All joinings narrowly darker brown. Claws without pectinations. Abdominal tergite 8 largely yellowish; tergites 4 and 7, and basal half of 9, yellowish with brown markings. Other tergites smoky brown; 5, 6, and apical half of 9 often darker than basal ones. A pair of minute, pale, dots at median line, near center of segment, on tergites 1 to 3. Sternites paler than tergites, usually yellowish, more or less distinctly brown-tinged. Brownish shading near pleural fold; posterior margins often narrowly brown. Gills present on segments 1–7; simple, obovate (fig. 42). Tracheation pinnate; blackish, very distinct. Tails three, the middle one only slightly shorter than the laterals; yellowish brown without darker markings. Tufts of very short hairs on each segment (on both sides of middle tail, on inner side only of laterals) appear like stubby bristles.

Length: body 5 mm.; tails 2 mm.

Holotype—Male imago, reared from nymph; Luquillo Mts., P. R., June 14, 1935 (J. García-Díaz). No. 1402.1 in Cornell University collection.

Allotype—Female imago, Trout's pool, El Yunque Trail, Luquillo Mts., P. R. June 12, 1935 (J. García-Díaz). No. 1402.2 in Cornell University collection.

Paratype—Male imago, reared; same data. No. 1402.3 in Cornell collection.

Nearly-mature nymphs of this species were taken during 1935 (J. García-Díaz) in the Sabana River and the Hicaco River, Río Blanco (Mch. 7); in La Coca Creek, the Luquillo Mts. (May 26); and at Guajataca Creek (Mch. 22).

Cloeodes portoricensis sp. nov.

Thorax and tip of abdomen dark red-brown; middle abdominal segments hyaline, white.

Male imago.—Body 3–3½ mm.; wing 3½ mm.

Head red-brown; antennae faintly tinged with reddish. Turbinate eyes very large, prominent; upper surface oval; orange-brown in color, outer rim of upper surface dark brown. Thorax dark red-brown. Mesonotal scutellum and a small spot on each side of it, alabaster white; a similar white patch on scutellum of metanotum. Light tan markings on pleura, near sutures. Legs wholly pale, whitish. Wings hyaline; cross veins practically invisible. Costa, subcosta and radius reddish brown at extreme base; a small brown spot at base of wing. Stigmatic cross veins 4 to 6 in number, simple, somewhat aslant, often incomplete except at the costal margin. Granulations in stigmatic area, extending over apical portions of costal and subcostal spaces, give appearance of a milky cloud. No intercalaries in first interspace; 1 or 2 may be present in second interspace, very weakly developed; in remaining spaces, well developed but rather short.

Abdominal segments 2–6 hyaline, white; joinings opaque. A double, blackish, wavy, line extends along the spiracular area of tergites; a tiny, dark, dot on each line, at spiracle. Tergites 7–10 dark red-brown, but somewhat brighter and paler than thorax. Sternites 7–9 creamy white, faintly tinged with brownish, especially near pleural fold. Tails silvery white. Genitalia as in figure 6.

Holotype—Male imago; Lares, P. R., March 23, 1935 (J. G. Needham, J. García-Díaz). No. 1401.1 in Cornell University collection.

Paratype—21 male imagos, same data. No. 1401.3–20 in Cornell collection.

Seven female imagos, taken in the Luquillo Mts. on Feb. 18, 1935, by the same collectors, may be of this species. Body flesh-colored, head and mesonotum paler than abdomen and remainder of thorax. Abdominal tergites rose-tinged; posterior margins of segments purplish rose on each side of pleural fold, not elsewhere. Longitudinal veins faintly brownish. Othewise similar to males.

Sub mago males were taken at Lares, the Guajataca River, on March 22, 1935 (J. G. Needham, J. García-Díaz). The following day, one male and several female subimagos were captured at Adjuntas, (J. García-Díaz).

One male imago was reared, thus making it possible to correlate the imagos with certain strikingly-colored nymphs which had been taken at several stations.

Nymph—Head yellow; faint brown shading on vertex and occiput on each side of pale median line, also above antennae and median ocellus. Antennae pale, faintly darker at joinings. Maxillary palp two-jointed (fig. 30); labial

palp two-jointed, the distal joint expanded into a lobe on the inner margin and terminating in a sharp point (fig. 28). Thoracic notum yellowish brown with darker markings in female, darker brown with pale markings in mature male. A well-marked male show a pale thoracic median line; yellow submedian blotches on posterior margin of pronotum; a trident-shaped pale marking at middle of mesonotum, the points directed forward; a pale band across the scutellum; large, diffuse, yellow, markings between the wing pads, and a few small spots anterior to wing roots. In some specimens, the arms of the pale trident become much widened, so that a large area on each side of center of mesonotum is yellow. Pleura and sternum yellowish. Prominent dark brown semi-lunar markings above bases of legs, and a small, dark, median, spot on anterior portion of mesosternum. Dark, median, and lateral, patches on metanotum. Legs yellow. A small, dark brown, "knee spot" and similar dark spot at tip of tarsus; other joinings narrowly darker. Claws not pectinate.

Abdominal tergites 1, 4, 8 and 10 almost wholly yellowish; tergite 5 yellowish in median area, brown laterally; remaining tergites largely brown, except for round, yellow, median, spot on 2, 3 and 6. Crescentic brown mark on anterior portion of tergite 4; similar but wider mark on 10. Posterior margins of all tergites narrowly dark brown; a small, dark, mark at base of each gill. Sternites pale yellowish; posterior margins of apical segments very narrowly brown. Gills single, obovate, broadly rounded at free end; tracheation pinnate (fig. 43). Tracheae greyish purple, rather indistinct; main trunk often forked near tip, lateral branches few and weak. Tails three, approximately equal in length and thickness. Whitish, with an amber tinge which becomes deeper toward apex. Joinings opaque, faintly amber.

Length: body 3–4 mm.; tails 1½–2 mm.

Specimens of this species were collected during 1935 (J. G. Needham, J. García-Díaz) at the following places: Lares, Guajataca Creek, Mch. 22; Quebrada Tomey, Feb. 21; Río Cidra, Adjuntas, Mch. 24; Utuado Road, Mch. 13; and Hicaco River, Mch. 7.

Cloeodes consignatus sp. nov.

Female imago.—Body 3½ mm.; wing 3 mm.

Head largely suffused with purplish red. Thorax creamy yellow. Lateral and anterior areas of pronotum with extensive purplish red-markings; pleura largely purplish red. Scutella of meso- and metanota, and all elevations of notum, alabaster white. Sternum yellowish with alabaster white markings laterally. Fore and middle legs missing. Hind legs very pale yellow, unmarked. Wings hyaline; longitudinal veins very pale amber; a small, purplish red, spot on humeral cross vein, and brown shading at extreme base of costa, subcosta, and radius. No marginal intercalaries in first three interspaces; none in any space beyond media, usually a single intercalary only in spaces between branches of media; elsewhere intercalaries are normal, paired. Stigmatic cross veins 4 to 5 in number, strongly aslant, usually incomplete toward costa. Abdomen white; segments 1–7 hyaline, 8–10 semi-opaque with distinct yellow tinge. A faint, blackish, double, line extends the length of the spiracular area.

Above this, on each tergite, a prominent rhomboidal purplish red spot; below it, on each sternite, a curved, purplish red mark. Tails missing.

Holotype—Female imago; Yunez River, P. R., June 21, 1935 (J. García Díaz). No. 1403.1 in Cornell University collection.

Cloeodes sp.

Female imago.—Body shrunken; wing 4½ mm.

Head yellowish; posterior margin blackish. Antennae yellow; joinings of basal segments reddish. Thorax yellowish, shaded rather heavily with reddish on pronotum and pleura. Legs yellowish white, unmarked. Wings hyaline, venation very pale brown. Humeral cross vein, extreme basal portions of costa, subcosta and radius, and small area at base of middle veins, reddish brown. Stigmatic cross veins 3 or 4 in number, aslant. No marginal intercalaries in first two interspaces; behind media these intercalaries single or absent. Abdomen heavily shaded with reddish, except middle of venter and dorsum, which are yellowish, hyaline; posterior margins of tergites, and of sternites near pleural fold, reddish black. Two black lines extend the length of the pleural fold. Tails missing.

Taken in Luquillo Mts., P. R., Feb. 18, 1935 (J. G. Needham, J. García-Díaz). It is quite possible that this is the female of *C. portoricensis*, rather than the paler specimens taken on the same date, which are briefly described under that species.

?? **Cloeodes** sp. No. 1

Nymphs which superficially resemble those of *Baetis garcianus*, but with hind wing buds wholly lacking, and distal joint of labial palp lobed, as in figure 16. Probably do not belong in this genus.

Nymph.—Head pale reddish brown; median line of vertex and occiput, and epicranial suture, faintly pale; a dark brown spot on each of first two basal joints of antenna. Maxillary palp two-jointed (fig. 31); labial palp likewise two-jointed, distal joint mitten-shaped, as in figure 26. Thoracic notum light reddish brown, median line paler; indistinct, paler, markings laterally on pronotum, and on mesonotum anterior to wing roots. Pleura and sternum paler than notum; dark areas on pleura above leg bases. Legs yellowish. Femora faintly tinged with smoky, and with a brown spot at apex; claws pectinate. Abdominal tergites quite uniformly light red-brown, somewhat paler next to pleural fold; in some specimens, tergites 9 and 10 are slightly paler. Intersegmental areas yellowish. Posterior margins dark brown; postero-lateral angles shaded with smoky brown, and with a dark dash at base of each gill. Indistinct, paler, markings are visible on some specimens, as follows: anterior portion of median line; spot on anterior margin halfway between median line and pleural fold; round, submedian, spot on each side, at about center of tergite. Two short, dark, transverse, dashes on anterior margin, one on each side of median line. Sternites somewhat paler than tergites; on each, a narrow,

dark, transverse, line on anterior margin, in median area only. A distinct, dark, spot at each spiracle, and a dark line leading forward from this to anterior margin, are faintly seen from dorsal view, but are much more evident on ventral surface. Gills single, obovate, intermediate ones asymmetrical as in *Baetis garcianus*, but slightly longer and less rounded at apex. Tracheation pinnate, very indistinct; only the basal portion of main trunk is clearly evident. Tails three; yellowish, crossed by two prominent black bands, the distal of these being the wider. Middle tail slightly more than half as long as the laterals.

Length: body 4–5 mm.; tails 3 mm.

Specimens of this species were taken during 1935 (J. G. Needham, J. García-Díaz) at Utuado Road (Mch. 13); Río Blanco (Mch. 6); La Joba Creek at Río Blanco (Mch. 8); Cagüitas River (Mch. 4); Carreres River (Mch. 9); small creek near Jayuya Road (Mch. 24); and the Luquillo Mts. (Feb. 18, May 26).

Cornell University, Nov. 30, 1936.

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Explanation of Plates

Plate I

Fig. 1.—*Neohagenulus julio.* Male imago; wings.

Fig. 2.—*Borinquena carmencita.* Female imago; tip of abdomen, showing long ovipositor.

Fig. 3.—*Neohagenulus julio.* Male imago; genitalia.

Fig. 4.—*Borinquena carmencita.* Male imago; wings.

Fig. 5.—*Baetis garcianus.* Male imago; genitalia.

Fig. 6.—*Cloeodes portoricensis.* Male imago; genitalia.

Fig. 7.—*Neohagenulus tinctus.* Female imago; tip of abdomen, ventral aspect, showing egg valve and subanal plate.

Fig. 8.—*Borinquena carmencita.* Male imago; forceps base and portion of basal joint of forceps.

Fig. 9.—*Baetis garcianus.* Male imago; hind wing.

Fig. 10.—*Borinquena carmencita.* Male imago; hind wing.

Fig. 11.—*Neohagenulus julio.* Male imago; hind wing.

Fig. 12.—*Borinquena carmencita.* Male imago; genitalia.

Fig. 13.—*Cloeodes maculipes.* Male imago; genitalia.

Plate II

Fig. 14.—*Neohagenulus julio.* Nymph; tibia of third leg.

Fig. 15.—*Neohagenulus luteolus.* Nymph; tibia of third leg.

Fig. 16.—*Neohagenulus julio.* Nymph; femur of fore leg.

Fig. 17.—*Neohagenulus luteolus.* Nymph; femur of fore leg.

Fig. 18.—*Neohagenulus luteolus.* Nymph ; gill from third abdominal segment.

Fig. 19.—*Borinquena carmencita.* Nymph; gill from third abdominal segment.

Fig. 20.—*Cloeodes maculipes.* Male imago; lateral view of head.

Fig. 21.—*Neohagenulus julio.* Male imago; lateral view of head.

Fig. 22.—*Borinquena carmencita.* Male imago; lateral view of head.

Fig. 23.—*Baetis garcianus.* Nymph; gill from fourth abdominal segment.

Fig. 24.—*Baetis sp. No. 1.* Nymph; gill from fourth abdominal segment.

Fig. 25.—*Baetis sp. No. 1.* Nymph; labial palp.

Fig. 26.—? *Cloeodes sp. No. 1.* Nymph; labial palp.

Fig. 27.—*Cloeodes maculipes.* Nymph; labial palp.

Fig. 28.—*Cloeodes portoricensis.* Nymph; labial palp.

Fig. 29.—*Cloeodes maculipes.* Nymph; maxillary palp.
Fig. 30.—*Cloeodes portoricensis.* Nymph; maxillary palp.
Fig. 31.—? *Cloeodes sp. No. 1.*—Nymph; maxillary palp.

Plate III

Fig. 32.—*Borinquena carmencita.* Nymph; labium.
Fig. 33.—*Borinquena contradicens.* Nymph; detail of canines of mandible.
Fig. 34.—*Borinquena contradicens.* Female subimago; tip of abdomen, lateral view. Ovipositor somewhat flattened out.
Fig. 35.—*Borinquena contradicens.* Nymph; maxilla.
Fig. 36.—*Borinquena contradicens.* Male imago; penes, enlarged.
Fig. 37.—*Borinquena carmencita.* Male imago; tip of abdomen, lateral aspect, showing the very long forceps. One tail omitted.
Fig. 38.—*Borinquena contradicens.* Nymph; hypopharynx.
Fig. 39.—*Borinquena contradicens.* Nymph; gill from third abdominal segment.
Fig. 40.—*Borinquena contradicens.* Nymph; labrum.
Fig. 41.—*Borinquena contradicens.* Male imago; genitalia.
Fig. 42.—*Cloeodes maculipes.* Nymph; gills of second and third abdominal segments; showing abdominal segments three, four, and five.
Fig. 43.—*Cloeodes portoricensis.* Nymph; gills of second, third, and fourth abdominal segments; showing abdominal segments three to seven.
Fig. 44.—*Neohagenulus julio.* Male imago; penes, enlarged, one side distorted, showing what appears to be long, slender, spine on inner margin.
Fig. 45.—*Cloeodes maculipes.* Male imago; third leg. A; same, enlarged.
Fig. 46.—*Neohagenulus luteolus.* Nymph; claw of fore leg.
Fig. 47.—*Neohagenulus luteolus.* Female imago; hind wing.
Fig. 48.—*Neohagenulus luteolus.* Nymph; labium.
Fig. 49.—*Neohagenulus luteolus.* Nymph; mandible.
Fig. 50.—*Borinquena contradicens.* Male imago; hind wing. B; same species, female subimago, showing tip of wing folded over.

PLATE I

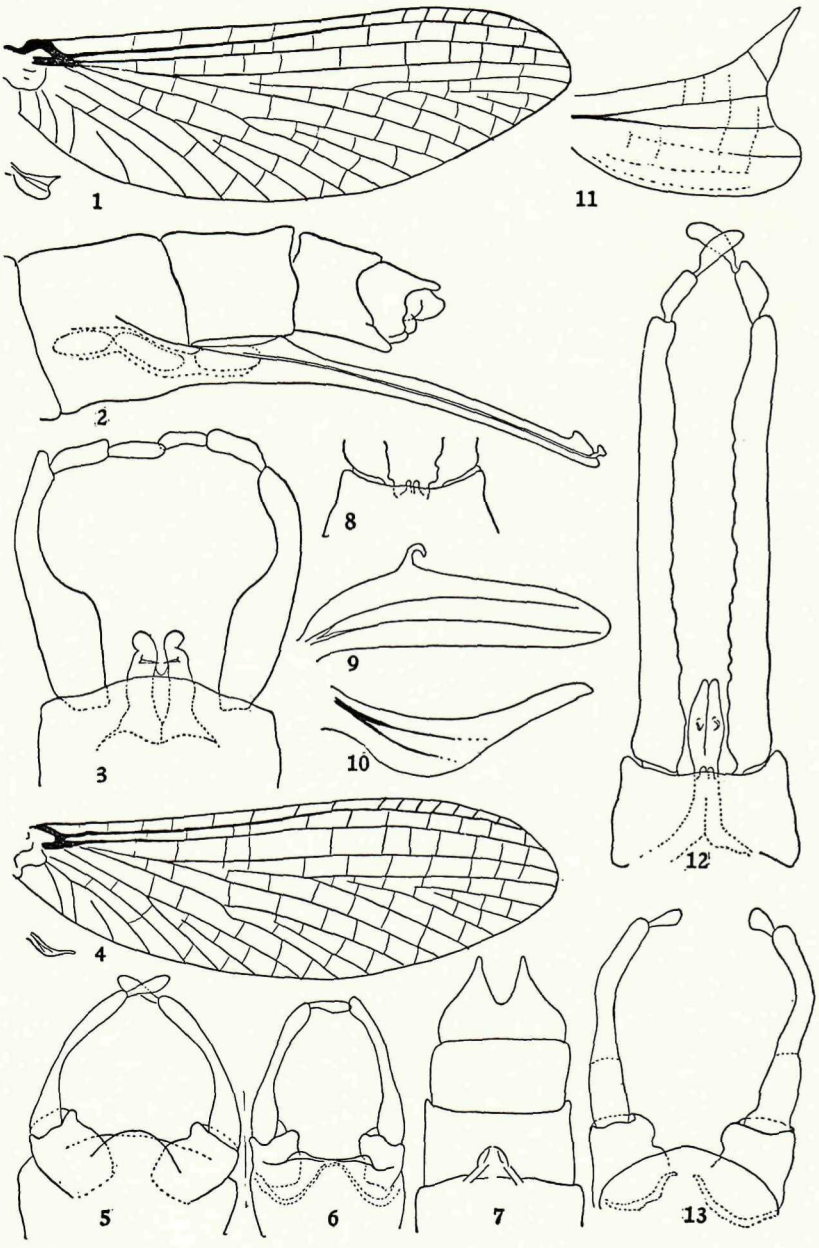

PLATE II

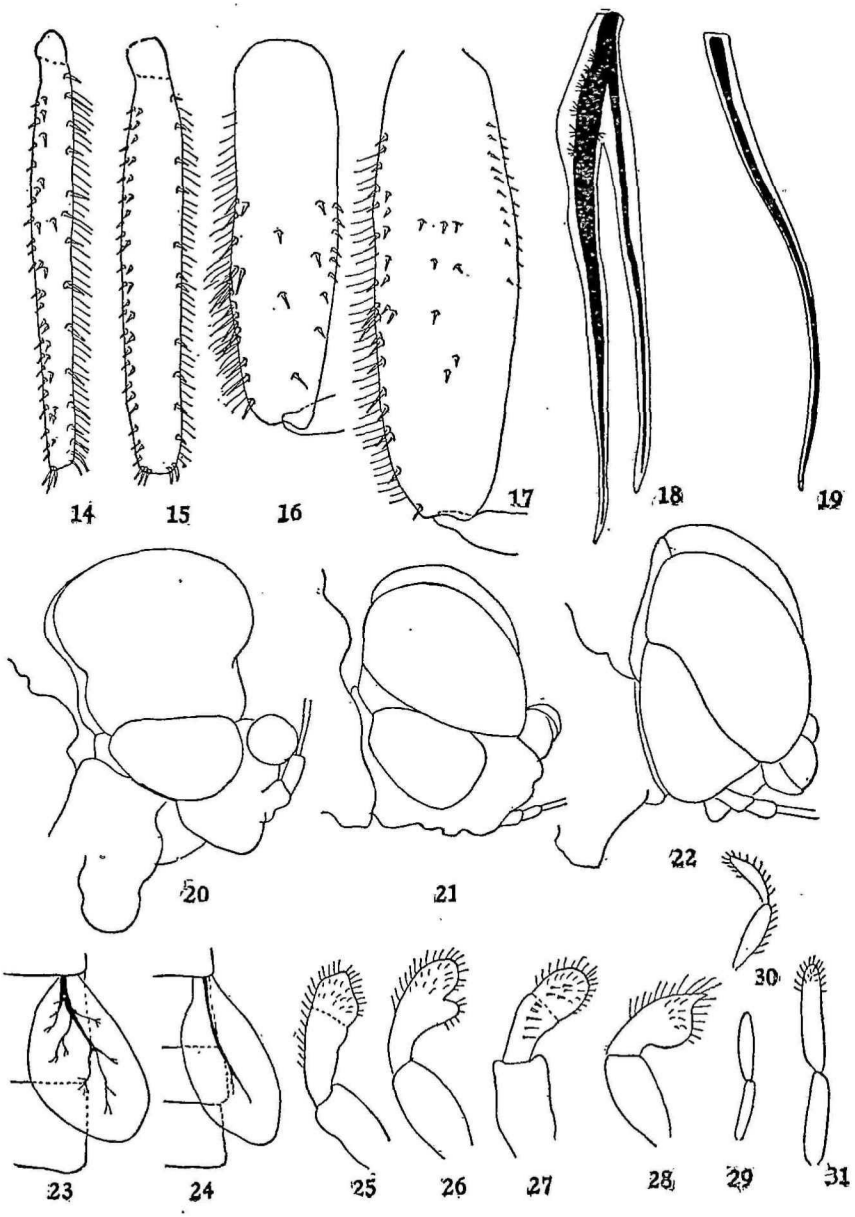

PLATE III