THE MAYFLY FAMILY LEPTOPHLEBIIDAE IN THE SOUTHEASTERN UNITED STATES[1]

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ABSTRACT

The mayfly family Leptophlebiidae is well represented in the Southeast. In this study 8 of these states, Alabama, Florida, Georgia, Louisiana, Mississippi, North and South Carolina, and Tennessee, are included. All species known to occur in the region are discussed, and a new species, *Habrophlebiodes celeteria* Berner, is described. Male and female imaginal stages of *Habrophlebia vibrans* Needham, the adult females of *Leptophlebia bradleyi* Needham, *L. intermedia* (Traver), and *Paraleptophlebia volitans* McDunnough, as well as nymphs of *H. vibrans* and *L. bradleyi*, are also described.

The importance of mayfly nymphs as an element of aquatic environments has been keenly recognized in recent years with the development of widespread interest in the preservation or restoration of excellent water quality as a necessity of life. The family Leptophlebiidae, a major segment of the order, is distributed throughout the world and its success is attested by its diversity. Dr. William L. Peters has been devoting his attention to the Leptophlebiidae for many years and, with Dr. G. F. Edmunds and others, has published extensively on the family, dealing chiefly with exotic forms.

This report is concerned with those species occurring in the Southeastern United States. I have confined my discussion to those 8 states on which I concentrated my attention during the years in which my research was supported by grants from the Public Health Service. They include Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. Were I to have included other states, often considered to be southeastern, my records would have been scanty and the difficulties of delimiting the coverage would have been compounded.

Wherever I have been able to add descriptions of stages not previously given, I have done so. These descriptions are presented only where the identification could be confirmed by rearing and associating the stages with the male adult, the only stage that can be identified with any degree of certainty at the present time.

I am particularly indebted to Dr. C. D. Hynes, California Polytechnic Institute, San Luis Obispo, who collected many of my specimens during the years 1954-1957. Dr. Peters kindly loaned me his midwestern and southeastern specimens of *Choroterpes* for study.

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CHOROTERPES EATON

The genus *Choroterpes* has a rather limited distribution in the southeastern United States with only a single species having been recorded previously. *Choroterpes hubbelli,* described in 1946, is now known to occur in all the southeastern states except North Carolina. Nine species have been described in the genus but none is well known except *C. basalis* and *C. hubbelli,* both of which are here reported to occur in the southeast.

Choroterpes basalis (Banks)

There is only a single record of this species occurring in a southeastern state (Berner, in press). The record is based on the collection of a male adult taken in Walker Co., Georgia, 3 miles west of Villanow on 14 August 1956.

The species was described by Banks (1900) from specimens collected in Sherbrooke, Canada, and Montgomery County, Pennsylvania. Subsequently the species has been reported from Ithaca, New York, and LeRoy and Kirtland, Ohio (Traver 1935). It is likely that among those specimens reported simply as *Choroterpes* species (Berner, in press) some are *C. basalis.*

The adult male of *C. basalis* has been adequately described by Traver (1935) and the nymph has been well described by Needham (1905). There is no extant description of the female nor am I able to provide one for lack of associated specimens.

Needham (1905) has written of the swarming flight of males in the Fall Creek gorge at Ithaca, New York, and Morgan (1913) has added additional brief notes about the event. Little is known of the ecology of the nymphs.

Choroterpes hubbelli Berner

This species is widely distributed throughout the southeastern United States but is not common in collections. When nymphs are taken they are seldom numerous and adults are rarely encountered.

The original description included the male and female imagoes and the mature nymph. In 1950, I treated the species fully, summarizing all that was then known about its distribution, ecology and life history. Subsequently the species has been reported by Schneider (1967) occurring in the Choctawhatchee River, Florida, both on silty and sandy bottoms. Other distributional records include Alabama, Georgia, Louisiana, and Mississippi (Berner, in press).

HABROPHLEBIA EATON

After careful study of a large series of *Habrophlebia* adults from various parts of the eastern United States, I have reached the conclusion that there exists only a single species, *Habrophlebia vibrans* Needham. Following Banks' (1914) description of *H. jacosa,* McDunnough (1925) placed Banks' species in synonymy with *vibrans.* I have prepared a slide of the genitalia of a paratype of *H. jacosa* and can find no difference between them and those of *vibrans.* Additionally, I have examined numerous specimens from North Carolina from the vicinity in which the types of *H. pusilla* Traver were collected. I have also had the privilege of examining Traver's slide of the genitalia of the holotype. I have reached the conclu-

sion that in the preparation of the slide, the genitalia were compressed so that they were distorted. In all respects *H. pusilla* resembles *H. vibrans* and I am, therefore, placing the 2 species in synonymy. It appears, then, that the genus *Habrophlebia* has only a single North American species, *Habrophlebia vibrans.*

Habrophlebia vibrans was first taken in the northeastern part of New York State by Needham (1907) where he captured them by the "hundreds near the outlet of Bald Mountain pond, where the brook crosses the road and begins its descent among the fern clad boulders. White winged companies of them were dancing up and down under the birch canopies, the lowest of them within reach of my net." All of Needham's specimens were males taken on 1 July 1905. His description of the species was based on these specimens. His slide of male genitalia, from which his drawing was made, includes those of the holotype as well as of three paratypes, all mounted together.

Banks' description of *Habrophlebia jacosa* was based on specimens from Asheville and Black Mountain, North Fork of the Swannanoa River, North Carolina, taken in May. When McDunnough synonymyzed *jacosa* with *vibrans,* he commented that the species was very common in late June in the vicinity of Covey Hill in the southwest corner of Quebec Province, about one mile north of the International Boundary.

Habrophlebia was next recorded from the United States by Traver in 1932 when she described *H. pusilla* from specimens taken at the Cascades near Danbury, on a tributary of the Dan River, North Carolina. Her holotype was a male subimago. In 1935, Traver reported *H. pusilla* from Greenville, South Carolina, and a few other specimens not clearly assignable to a species, from Greenville and from the Great Smoky Mountains, North Carolina. I have examined Traver's slides of the genitalia of the Greenville specimens, taken on the same day as that which she identified as *H. pusilla.* Based on that examination and my failure to collect, over many years, other specimens which can be identified as *pusilla* I am convinced that she was dealing with a single species, *H. vibrans.*

In 1950, I reported the occurrence of *H. vibrans* in Florida and summarized all that was then known about the genus in North America and in 1958 I listed the known locality records for the species in the Apalachicola River drainage. In 1953 Burks redescribed the adult male and provided a brief description of the nymph. His illustration of the male genitalia of *H. vibrans* is, however, misleading as it shows the decurrent appendages articulating with the penes; there is no such articulation as the appendages are merely long reflexed spurs. Carlson (1973) found the species occurring at Wildcat Creek, Pickens County, South Carolina and reported that adults emerge over a period of 13-17 weeks. Peters and Jones (1973) recorded the species from the Blackwater River in northwestern Florida.

To update our knowledge of *Habrophlebia vibrans,* I am redescribing the male adult and providing, for the first time, a description of the female imago and a more complete description of the nymph.

Habrophlebia vibrans Needham

Male imago (in alcohol): Measurements (mm). Body length 4-5.7; mesothoracic wings 4.5-5.7; caudal filaments: cerci 5.2-5.8, terminal filament 5.1-6.0.

Head. Deep brown; white ocelli stand out in sharp contrast to dark coloration. Antennal scape deep brown; remainder of antenna brownish. Upper portion of compound eyes orange, lower part reddish-black. Thorax. Uniformly fuscous; no special markings. Wings. Venation mostly colorless; brownish tinge in C, Sc, and R basal to humeral brace. Remainder of wing clear, hyaline except for stigmatic area which is opaque. Legs. Prothoracic leg: femur fuscous; tibia with fuscous markings only at extreme base and distal end where color is concentrated in a conspicuous dark band, remainder of tibia whitish (in some specimens entire tibia may be heavily washed with brown); tarsus whitish except distal end of fifth segment shaded with brown; claws pale. Meso and metathoracic legs: femora lightly washed with brown, with slightly heavier concentration at knees; tibiae also uniformly lightly tinged with brown although in some specimens there may be a conspicuous brown band both at distal end of femora and proximal ends of tibiae; tarsal segments with faint indications of annulations at joints. Abdomen. Dorsum mostly brown; tergites 1 and 2 completely brown, except for a pale median stripe; tergites 7-10 predominantly brown and also with a pale median stripe; tergite 7 with 2 pale, submedian dashes at anterior margin; dashes obsolescent on 8; 2 submedian pale spots at anterior margin of 10; tergite 3 has a large pale median triangle, with base resting on anterior margin and apex extending to middle of segment; tergites 4-6 with median area occupied by a very large pale triangle covering most of anterior portion of tergite with apex reaching to middle of posterior margin; there is an indication of a pale median line running the entire length of the abdomen; apparent even on those tergites where there is a large pale triangle; pale stripe accentuated in pale triangular areas by being margined with a faint brown line. Ventrally, sternites 1 and 2 fuscous with sternite 2 paler than 1; middle sternites pale, with a slight wash of brown; posterior portion of sternite 7, most of 8, and all of 9 brownish; posterior margin of sternites 3-6 narrowly brown. Ganglionic areas outlined in brown. When abdomen viewed in profile, color pattern produces a serrate appearance in middle segments. Genitalia. Basal segments of forceps brown; remainder generally pale. Penes brown; decurrent appendages of the penes extend anteriorly to lie between the bases of the forceps as shown in Fig. 16. Caudal filaments. Pale, a few of the joints in the basal part of the filaments colored with brown.

Female imago (in alcohol): Measurements (mm). Body length 5.5-5.7; mesothoracic wings 6.3-6.6; caudal filaments 5.6. Head. Brown; a dark-brown transverse band extends across face just anterior to compound eyes and intercepts median ocellus. Area above median ocellus and between lateral ocelli uniformly brown, brown coloration extending along epicranial suture. Head posterior to lateral ocelli light brown. Just medial to each compound eye there is a distinct brown spot. Antennae brownish. Thorax. Pronotum blackish brown. Mesonotum brownish, without distinctive markings except for a darker median line on scutum; scutellum blackish-brown along its edges. Pleurae brownish with darker brown pencilling along edges of sclerites. Wings. Mesothoracic wings hyaline; longitudinal veins light brown; crossveins colorless except outer few in stigmatic area and 3 or 4 immediately below stigma. C, Sc, and R more intensely colored at base; humeral brace colorless. Veins of metathoracic wings colorless. Legs. Prothoracic leg: coxa with deep brownish coloration; trochanter brown; femur deep brown; proximal and distal ends of

tibia brown, middle pale but with brownish wash; tarsus pale but tinged with brownish color. Meso and metathoracic legs: coxae deeply colored with brown; trochanters much paler; femora pale except for distal end where there is a light brownish band; tibiae and tarsi pale, tibiae with some brownish coloration at the knee; tarsal joints with faint indication of annulations. Abdomen. Brown; tergite 1 uniformly colored; distinct submedian pale lines extending from tergites 2-9 and indicated on 10 only at anterior margin; pale lines expand slightly at anterior margins of tergites 2-7 to form a pale spot; a pale median streak present on tergites 2-8, becoming obsolescent on 9; there is indication of a pale area near lateral margins of tergites 3-6, which is faint on segments 2 and 7-9. First and second sternites brown; brownish coloration concentrated in lateral areas of sternites 3-8 so that the median area is generally pale; sternite 7 brownish posteriorly, with 8 and 9 more uniformly brownish. Subanal plate deeply excavated as shown in Fig. 15. Caudal filaments. Pale but with faint brown annulations at 2 basal joints.

Mature male nymph (in alcohol): Measurements (mm). Body length 4.5-5; caudal filaments: cerci 5.2-6.6, terminal filament 7.2-8.4.

Head. Vertex brown; large pale area at anteromedial edge of each compound eye extending inward to meet the lateral ocellus; another pale area below median ocellus. Labrum and clypeus brown; a heavy brown line extends across face at fronto-clypeal suture and continues laterally above antennal base. Antenna brownish. Thorax. Brown; generally without distinctive markings; some specimens have a large U-shaped area opening posteriorly on pronotum as well as brownish stipplings on lateral margins. Central area of mesonotum may be paler than lateral parts. Legs. Prothoracic leg: femur heavily stippled with brown; tibia much paler but with a distal brown band; tarsus mostly pale. Tibia lined on its inner margin with numerous simple spines and 15-16 finely pectinate setae; claw with 10-12 teeth. Meso and metathoracic legs: femora much paler than that of foreleg; tibiae and tarsi pale with slight brownish tinge. Inner margin of tibia of middle leg with shorter spines and with 10-12 short, finely plumose hairs distributed along its distal 2/3. Hind tibia similar to middle. Claws with 11 teeth. Abdomen. Mostly brown dorsally; lateral margins pale. Faint indication of a pale median stripe on each tergite; laterally there is a pale submedian stripe running length of tergites 5-9 and obsolescent on 10; just medial to gills, a pale stripe extends the length of tergite. Sternites 1-3 brownish medially; 4-7 pale; 8-9 dark; a lateral brown line extends the length of each abdominal sternite. Postero-lateral spines on segments 8 and 9 short, being not more than 1/8 length of segment. Gills. First gill divided into 2 lobes, 1 with 2 branches, the other with 3. Gills 2-6 likewise with 2 lobes and 3 branches in each. Gill 7 as in the first with 2 branches in 1 lobe, 3 in other. Gills long and filamentous. Caudal filaments. Brownish; somewhat more deeply colored basally.

HABROPHLEBIODES ULMER

The 2 species of *Habrophlebiodes* known to occur commonly in the southeastern states are frequent inhabitants of smaller streams. A new species, described below, appears to be most restricted in its distribution while *H. americana* is the most widely dispersed.

Haprophlebiodes americana (Banks)

In 1903 Banks gave a brief description of the male adult of this species based on specimens taken in New Jersey. Just prior to the publication of Banks' paper, Berry (1903) described and illustrated the nymph of the new species, using Banks' manuscript name. His specimens were collected from "Boynton's Pond, a shallow sheet of water about 100 feet in diameter on the outskirts of Passaic, N. J." I have not collected nymphs of this species other than from streams nor do I have records of others taking them from such habitats.

Needham (1907) described (?) *Choroterpes betteni,* subsequently assigned to *Habrophlebiodes* and synonymyzed with *americana* by McDunnough. Traver (1935) did not accept McDunnough's action and included *H. betteni* as a distinct species. Burks (1953) again synonymized the 2 species and his conclusion was upheld by Edmunds and Allen (1957). I concur fully with the action and am using *H. americana* as the 1 name for my specimens fitting the criteria for distinguishing the species.

The female of *H. americana* has not been fully described although Morrison (1919) discussed this sex and described and illustrated the ovipositor. She also included a redescription of the male and the nymph. As with other females of the genus, they can only be identified with any degree of certainty when associated with the male of the species.

The species is widely dispersed and has been reported from Quebec (McDunnough 1925), Ontario (Ide 1930), New York (Needham 1907, Traver 1935), New Jersey (Berry 1903), North and South Carolina (Traver 1935, 1937), West Virginia (Traver 1935), Virginia (Pugh 1956), Tennessee (Wright and Berner 1949), and Illinois (Burks 1953). Berner (in press) has also reported the species from Alabama, Georgia, North and South Carolina, and Tennessee.

Habrophlebiodes brunneipennis Berner

The ecology, distribution, and life history of this species was reviewed in depth by Berner (1950). When the species was named in 1946, the description included the male, female, and mature nymph. No additional descriptions have been published since that time, although there have been later reports of its capture (Berner 1950, 1958; Schneider 1967; Peters and Jones 1973) with its range now extended to include Alabama, Georgia, and South Carolina, as well as Florida.

Habrophlebiodes celeteria Berner, New Species[3]

Adult males of *H. celeteria* can be separated from the closely related *H. americana* on the basis of the color pattern on the abdomen. In *H. celeteria* the pale areas of the abdomen are much more extensive than in *H. americana*; in fact, the alternation of pale and dark markings suggests that the abdomen is annulate. *H. celeteria* lacks dark bands at the middle of the hind femora, and the tibiae and tarsi of the forelegs are pale. *H. celeteria* differs from *H. annulata* in the shape of the male genitalia.

Description of the holotypic male imago (in alcohol): Measurements (mm).

[3]*celeterius* (Gr.) = charming.

Body length 4.1; mesothoracic wings 4.1; caudal filaments: cerci 5.2, terminal filament 6.

Head. Brown; carina below median ocellus clear at frontal shelf, brown in median area, brown line extending obliquely outward from median portion to antennal base. That part of head between antenna and lateral ocellus dark brown; lateral ocelli ringed with dark brown. Remainder of head lighter in color except for triangular area between lateral ocelli and median ocellus which is dark brown. Basal segment of antenna brown; flagellum paler. Upper portion of compound eyes orange-brown, lower part black. Thorax. Pronotum brown, overlaid with blackish coloring that is more intense at edges of sclerite; prosternum brownish with blackish overlay. Mesonotum brown, median line penciled in dark brown; 2 dark brown longitudinal stripes extending almost entire length of scutum; scutellum blackish; pleurae brownish with some blackish penciling; mesosternum brown. Metanotum brown, posterior border outlined in dark brown. Wings. Forewings clear, hyaline; C brown basal to humeral brace; humeral brace with only a slight tinge of brown; Sc and R slightly tinted with brown at base, colorless beyond. Hindwings with membrane clear, colorless; all longitudinal veins lightly outlined. Legs. Prothoracic leg: coxa brownish with some darker markings along anterior portion; trochanter brownish; femur dark brown along its entire length; tibia brown at extreme base, remainder pale, except at its distal end where it is brownish; tarsus whitish with very narrow annulations at joints. Mesothoracic leg: coxa brown in basal half, remainder whitish; other segments of leg pale, except for faint annulations at tarsal joints. Metathoracic leg: basal 0.66 of coxa brownish, remainder pale; trochanter pale; femur pale except for a prominent brown band at distal end which does not quite reach knee; tibia and tarsus pale, except for extremely narrow annulations at tarsal joints. Abdomen. Purplish brown but appearing to be almost annulate and resembling *Habrophlebia vibrans* in pattern. Dorsally, 1st and 10th tergites rather uniformly brown; tergite 2 with a faint, clear area near median portion and close to anterior border; segments 1-8 show a faint, pale mid-dorsal line, becoming geminate on 2 and 9; tergites 3 through 9 have rather extensive clear, pale areas in median dorsal portion; posterior half of each tergite covered with a purplish-brown band which extends to pleura and then runs anteriorly to end of segment; clear areas are somewhat smaller than the darkened ones on tergites 7-9; on tergites 3-6 dark, transverse bands and pale areas are of about equal width. Ventrally the abdomen is mostly light colored. Sternite 1 is almost entirely brown, except for extreme posterior margin in median area; sternite 2 is almost entirely brown, except for a clear area in anterior portion; 3rd and 4th sternites with brownish bands somewhat narrower than those of corresponding tergites; brown posterior markings on sternites less extensive on posterior segments, although markings are present on all sternites; only sternites 1 and 2 have dark band almost completely across segments, others are pale in middle. A strong brownish mark is present in the anterior pleural areas of segments 2-8. Genitalia. Forceps brown; penes slightly paler (Fig. 18). Caudal filaments. Pale, annulate with brown.

Description of nymph (in alcohol): Available specimens are in poor condition and contracted. One male is suitable for description but the measurements of its length are only approximate. Fragments of other nymphs are

used in the following description. The nymph is deemed to be the immature stage of *H. celeteria* by association and the similarity of coloration of the legs with those of the adult male.

Measurements. Body length approximately 3.4 mm, caudal filaments broken.

Head. Pale, marked with wide lateral purplish-brown lines extending from just above clypeus and following around antennal bases to medial edge of genae, lines extend dorsally and posteriorly to epicranial suture and along medial edge of ocelli and compound eyes to occiput. Space between ocelli and antennal bases purplish-brown; remainder of head pale. Bases of mandibles and antennal pedicels shaded with some dark coloration. Mouthparts as in Fig. 1-6, 13. Thorax. Pronotum fusco-rufous, with coloration more intense near margins of segment. Mesonotum mostly pale but with same coloration at anterolateral corners and bases of wing pads; light median line with V-shaped mark extending anteriorly from about posterior 0.33 of notum. Legs. Prothoracic leg: femur shaded with fusco-rufous coloration; tibia pale except for a band near distal end; tarsus pale. Mesothoracic legs: pale. Metathoracic leg: femur with distal 0.33 banded with fusco-rufous; tibia pale and with only a small dark mark near base on inner side; tarsus pale. Abdomen. Fusco-rufous dorsally, with tergites paler at anterior margins; a pale median line extends length of abdomen. Spinules present on posterior margins of tergites 7-10 only. Ventrally, sternites 1-3 heavily pigmented; sternites 4-9 with pigmentation confined to postero-lateral margins, remainder pale. Prominent postero-lateral spines on segments 8 and 9. Main tracheae of gills show only a few, weak branches. Caudal filaments. No specimens with complete filaments; those parts remaining are pale and unmarked.

Variations in paratype males: In some, the mid-dorsal pale line is somewhat more prominent than in the holotype. The ventral markings are also slightly more extensive, some forming triangles which meet in the middle of the segment, but with the posterior border of the segments remaining pale. Type material: Holotype. Male imago preserved in alcohol; Tennessee, Monroe Co., at edge of Cherokee National Forest and Tennessee Highway 68, 10-VIII-1956, C. D. Hynes collector. Deposited in Florida State Collection of Arthropods. Paratopotypes. 11 male adults, 1 male subimago. Paratypes: 1 male adult, Tennessee, Unicoi Co., Tumbling Creek, Erwin, 18-IX-1961, Bernard Benesch collector; 8 nymphs from same locality as holotype. One paratopotype deposited in the collection of the Laboratory of Aquatic Entomology, Florida A & M University; others in the Florida State Collection of Arthropods.

LEPTOPHLEBIA Westwood

The genus *Leptophlebia* is well represented in the southeastern United States with 6 of the 9 North American species found in the region. The characteristics presently used to differentiate the species are, for the most part, variable or difficult to observe. Particularly, the length of the decurrent appendage of the penes is often difficult to determine and the terms "scarf type" or "hooded type" (Traver 1935) to describe the appearance of the penes can be misleading. Another character used in the Traver key to the species depends on intensity of color in the stigmatic area of the mesothoracic wing. I have found this to be a very unreliable trait that can only be used in com-

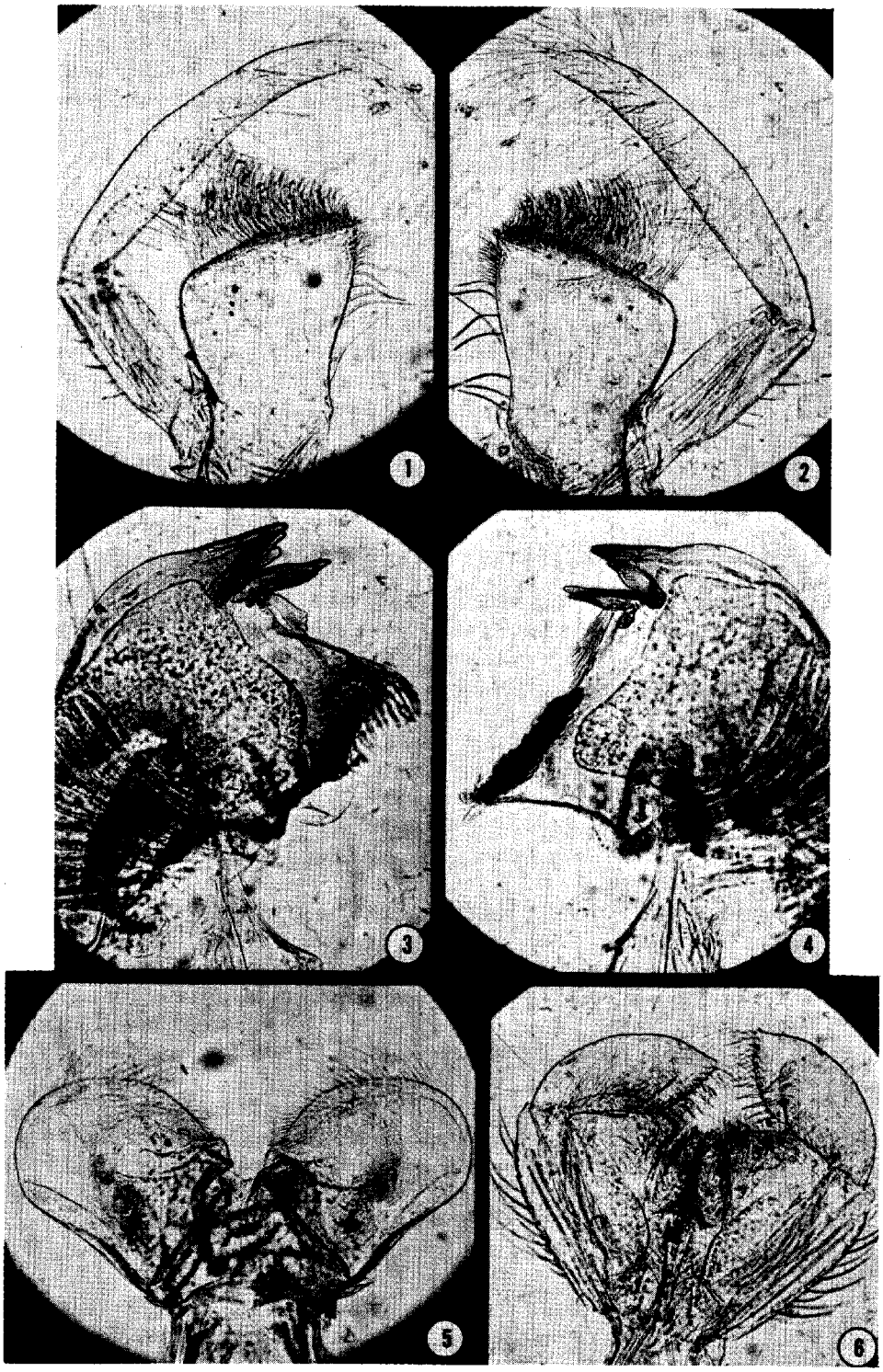

Fig. 1-6. Mouthparts of nymph, *Habrophlebiodes celeteria*. 1) left maxilla. 2) right maxilla. 3) left mandible. 4) right mandible. 5) hypopharynx. 6) labium.

bination with others to distinguish species. Nymphs and females must be identified with the utmost caution as the differentiating characteristics are not at all clearly defined. Nymphs of *Leptophlebia bradleyi* differ from all other North American species in having gills without excised lateral lobes.

Leptophlebia austrina (Traver)

During my many years of collecting mayflies in the southeastern states, I have not been successful in capturing specimens identifiable as this species although I have taken the closely related *L. collina*. The Fattig insect collection at Emory University includes a record of *L. austrina* adults identified by Traver and the Clemson University collection has 2 records indicating the identifications were made by Traver and Needham (records given in Berner, in press). I strongly suspect that *austrina* and *collina* may be identical. The Clemson collection includes specimens identified by Traver as *L. austrina* and as *L. collina* collected from the same place on the same date. Until additional specimens can be studied, I am not putting the 2 species into synonymy.

Leptophlebia bradleyi Needham

When I discussed the nymphs of *L. bradleyi* (as *Paraleptophlebia,* Berner 1950), I pointed out the difficulty of placing them generically because of their type of gills. The close similarity of the gills of *bradleyi* to those of the Eastern Hemisphere *Leptophlebia marginata* (Linn.) (Peters and Edmunds 1970, Fig. 288-289) and the European *L. vespertina* (Linn.) (Grandi 1960, Fig. 171) clearly indicates that the species was misassigned by Traver in 1935 when she transferred it to *Paraleptophlebia.*

Using 2 couplets from the keys prepared by Peters and Edmunds (1970: 169, 172) to separate adults and nymphs to classify *bradleyi* it becomes clear that the species must be assigned to *Leptophlebia.* To distinguish adult males, couplet 19 states:

> "Long slender ventral appendages arising at apex of penis lobes and usually extending to base of lobes (fig. 73)..... ..... *Leptophlebia* Westwood.
> Ventral appendages not as above, appendages usually short and stout (fig. 72)..... *Paraleptophlebia* Lestage".

By these criteria, the decurrent appendages of *bradleyi* are those of *Leptophlebia* (Fig. 19).

The nymphal key early separates *Leptophlebia* from *Paraleptophlebia* using the following differences: "Abdominal gill 1 similar to middle abdominal gills" or "Abdominal gill 1 differs in structure from middle abdominal gills." This single nymphal trait would be sufficient to assign *bradleyi* to *Leptophlebia*; together with the adult genitalial characteristic I can only conclude that Needham's original assignment was correct (Fig. 20-22).

As neither the female adult nor the nymphal stage has been described, I am including a description of each based on specimens from Florida and south Georgia.

Description of female imago (in alcohol): Measurements (mm). Body length 7.5-9; wing length 8.3-8.6; caudal filaments: cerci 8.5-10, terminal filament 7.8-9.5.

Head. Brown. Brown bar extending medially from compound eye to antennal base; epicranial suture outlined in brown; large brown submedian spot on occiput and smaller brown mark posterior to it at edge of occiput. Antennae dark brown. Thorax. Brown. Anterior margin of pronotum with

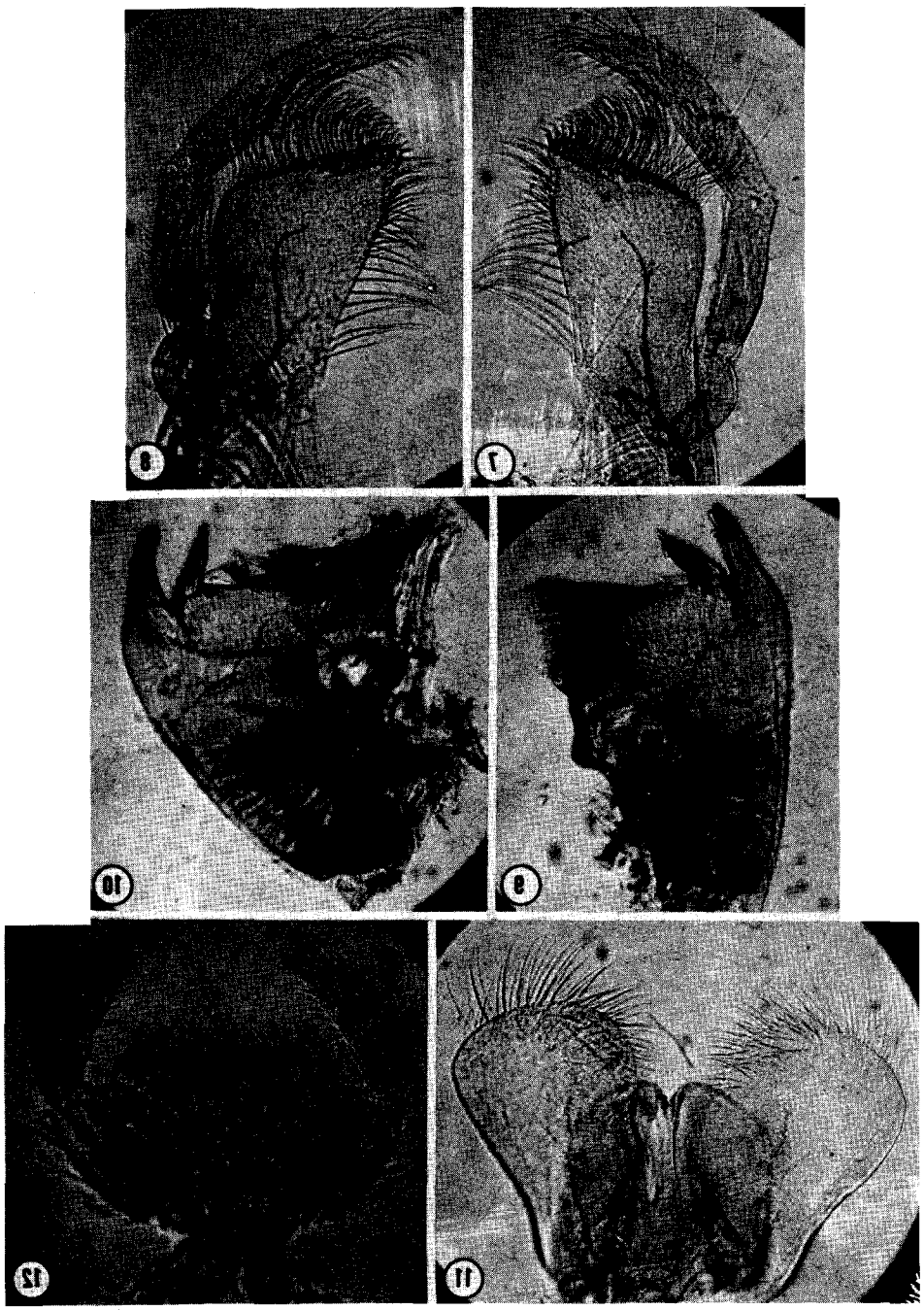

Fig. 7-12. Mouthparts of nymph, *Leptophlebia bradleyi.* 7) left maxilla. 8) right maxilla. 9) left mandible. 10) right mandible. 11) hypopharynx. 12) labium.

submedian brown markings and mid-line outlined in dark brown; posterior margin of pronotum dark brown. Mesonotum brown with dark brown shading in anterior part of scutum; scutellum with large submedian dark brown spots. Sternum unmarked. Wings. Longitudinal veins and cross-

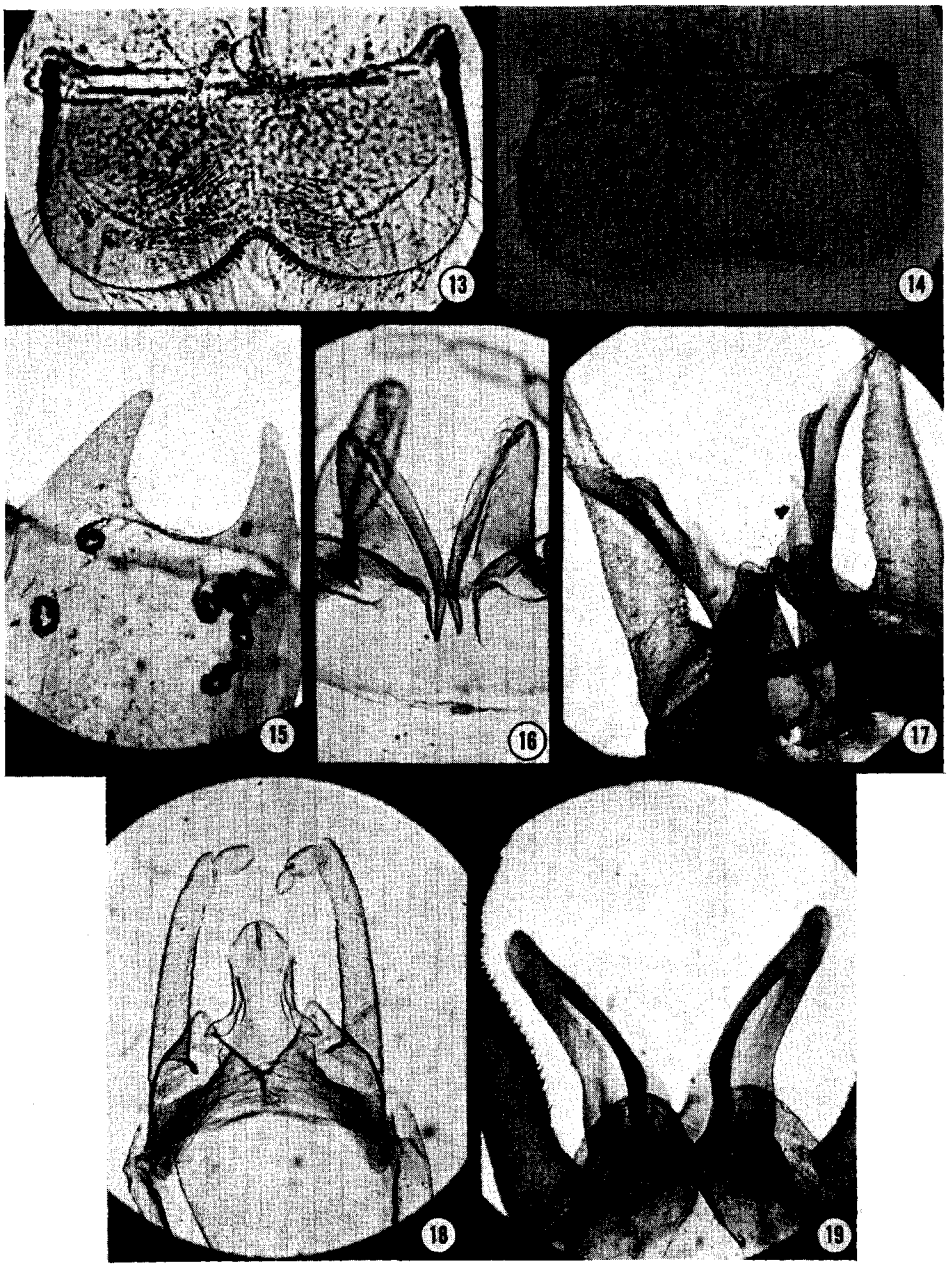

Fig. 13-14. Labrum of nymph. 13) *H. celeteria.* 14) *L. bradleyi.* Fig. 15-16. *Habrophlebia vibrans* Needham. 15) ventral view, subanal plate of female. 16) penes showing position and length of decurrent appendages. Fig. 17. *Paraleptophlebia jeanae,* ventral view of penes. Fig. 18. *H. celeteria,* ventral view of male genitalia.

Fig. 19. *L. bradleyi,* ventral view of penes and subgenital plate.

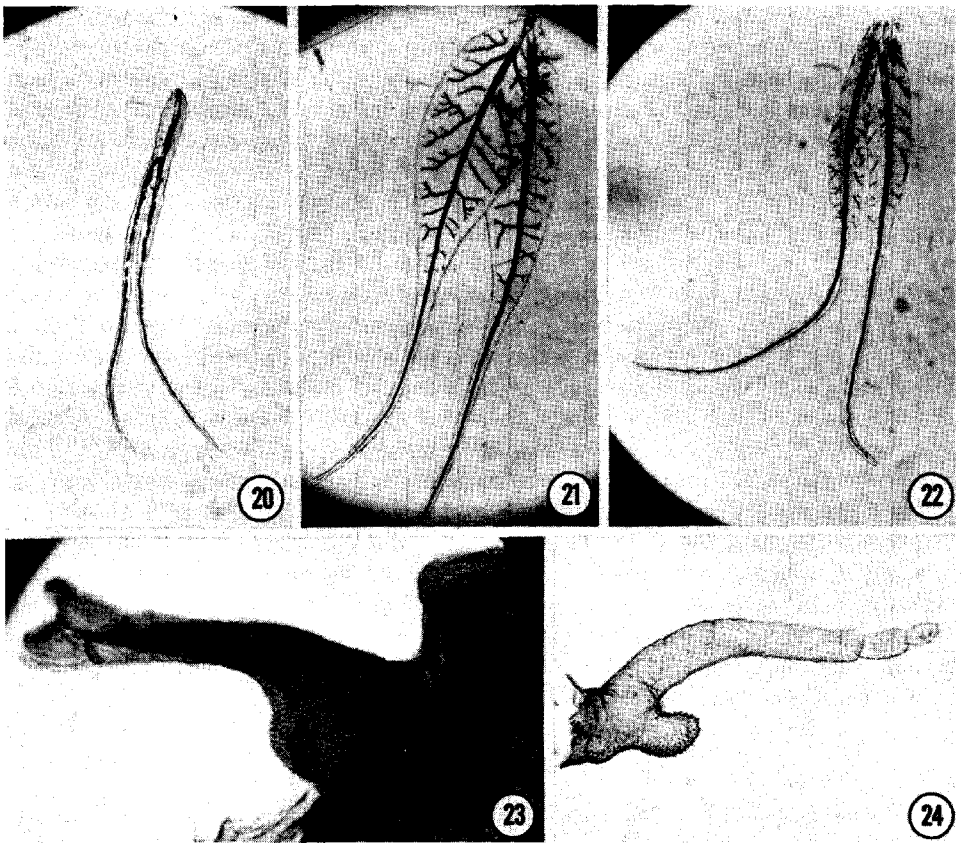

Fig. 20-22. *L. bradleyi.* 20) 1st nymphal gill. 21-22) 4th gill showing variations in blade width occurring in different populations.

Fig. 23-24. Comparison of male genital forceps to show enlargement of basal segment. 23) *Paraleptophlebia debilis.* 24) *P. moerens.*

veins brownish; crossveins in basal part of wing paler; some anastomosis of stigmatic crossveins. Membrane tinged with brown. Legs. Coxae with brown spot on outer side; remainder of legs brown. Strong, wide brown band in distal 0.33 of each femur; middle 0.33 of each tibia and all tarsal segments shaded with dark brown. Abdomen. Brown; with strong pale markings dorsally. Pale median line extends length of abdomen. Tergites 2-9 with a pair of large submedian pale spots at anterior margins; obsolescent on tergite 10; tergites 2-10 with large pale areas just above spiracular line and blackish markings at lateral margin of tergites 1-9; dark markings strongest on segments 1-7, reduced on 8 and 9. Sternites unmarked. Caudal filaments. Brown; annulate with strong brown bands.

Description of nymph (in alcohol): Measurements (mm). Body length 4.8-8.2, caudal filaments 7.5-11.

Head: Greyish-brown. Brown spot between compound eyes and antennal base; compound eyes posterior to lateral ocelli bordered with brown on medial side continuing in some specimens onto posterior border of occiput. Epicranial suture outlined in reddish brown. Antennal scape and pedicel dark brown, flagellum pale. Mouthparts shown in Fig. 7-12, 14. Thorax. Pronotum with large brown spot at anterior margin just medial to pronotal

flange. Mesonotum with large brown mark at anterolateral corner; small brown bar at posterior edge of scutum near cubito-anal area of wing pad; scutum with median suture outlined in brown and with submedian brown spot at anterior edge and another at posterior end of median line. Pleurae with brown spot above each leg. Legs. Brown spot on outer side of each coxa. Legs strongly banded with brown; femora with wide dark brown band in distal 0.33; tibiae banded basally with narrow stripe and with much wider band in middle; basal 0.5 of tarsi brown. Claws with fine teeth on inner side. Fore tibia on inner side with some hairs that are finely pectinate (can be seen only under high magnification). Abdomen. Color pattern much like that of adult. Abdomen stippled with brown pigment. Tergite 1 dark brown. Pale median stripe on tergites 2-10; a pair of prominent submedial pale triangles at anterior margin of tergites 2-8; present but obscured on 9 and 10; apex of triangle extends to about middle of each tergite; a large pale rectangle covers anterior 0.75 of lateral margin of tergites 1-9. Ventrally, sternites 1-4 and 1-5 with brownish shading at anter-lateral margin. Postero-lateral spines on segments 8 and 9 prominent; that of 9 about 0.25 length of that tergite. Gills. Gill 1 single lobed, bifurcate; 2-7 bilobed and strongly tracheate. Blades of 2-7 varying from being expanded to strongly expanded laterally as shown in Fig. 21-22 and ending in long, thin filaments; filaments of posterior gills extend well beyond the end of the abdomen. Caudal filaments. Banded with narrow rings of brown in basal half; bands become indistinct distally.

Leptophlebia collina Traver

The similarity of *L. austrina, L. collina,* and *L. intermedia* adults makes identification of these 3 species particularly difficult. I have separated my specimens on the basis of genitalial differences in the male and length of the median caudal filament, which in *collina* is significantly shorter than in *intermedia*. Further, the caudal filaments of *collina* are dark basally while those of *intermedia* are pale. Perhaps when long series of all 3 species are studied intensively it will be proved that we are dealing simply with a single rather variable form. My only specimens of *L. collina* consist of a reared series, which I collected from the Withlacoochee River in south Georgia, and 3 male imagoes from another tributary of the Suwannee River in Florida. The adult male was described by Traver (1935) and the nymph, male subimago, and female imago were treated by her in 1932.

The decurrent appendage of the penes of this species is swollen distally and turns sharply ventrally in its outer third. The appendages clearly do not reach the base of the penes and are shorter than those of *intermedia*. The appendages are rather similar to those of *L. cupida* in their shape and length.

Leptophlebia cupida (Say)

In 1932, Traver suggested that her new species, *L. austrina,* might be the species which Eaton (1883-1888) placed "under *B. cupidus* and designated as the 'variety from North Carolina' ". There is no doubt that there is a very close resemblance of several of Traver's species and perhaps they may all be variants of *L. cupida* but further study is required to clarify their validity or synonymy. The only specimens from the southeast available to me that I can identify with any degree of certainty as *L. cupida* are those which I re-

ported from Tennessee (Wright and Berner 1949) and a few other adults of that species from the same state.

The adult of *L. cupida* has been well described by Traver (1935) and the nymphs were described and figured by Berry (1903). The key constructed by Traver for separating the nymphs should be used with the full knowledge that the differentiating characteristics are subject to much variation.

Leptophlebia johnsoni McDunnough

Ide (1935) suggested that Traver's *L. gracilis* was a synonym of *L. johnsoni.* Subsequently, Burks (1953) took the definitive action of placing the 2 in synonymy and other workers have accepted his conclusions (Edmunds and Allen 1957). *L. johnsoni* has not been recorded from the southeastern United States since Traver's report when she described *L. gracilis* (now *L. johnsoni*) from North Carolina in 1932.

Leptophlebia grandis (Traver)

Leptophlebia grandis, described by Traver in 1932, has not been recorded subsequently nor have I collected or seen any specimens of this species.

Leptophlebia intermedia (Traver)

This species appears to be the most widely dispersed of any of the genus *Leptophlebia* in the southeastern coastal plain. I have collected specimens from Florida, Georgia, Alabama, and South Carolina, and Traver (1932) described the species from North Carolina. As I have indicated above, there is great similarity among *intermedia, collina* and *austrina* which may result in a certain amount of confusion in identification of nymphs and adults.

At the time Traver described the species, she had only nymphs and 1 male subimago. Subsequently, she obtained and described (1935) male adults from Bladen Co., North Carolina. To complete our knowledge of the species, I am adding a description of the female adult. The markings of males and females are very similar.

Female imago (in alcohol): Measurements (mm). Body length 7.5-10; mesothoracic wings 8-10; caudal filaments: lateral cerci 9-10, terminal filament 7-7.5.

Head. Brown; dark spot medial to compound eyes and just above frontal shelf; space between lateral and median ocelli darkened. Epicranial suture outlined in dark brown. Transverse dark bar across occiput; in some specimens reduced to 2 lateral spots. Thorax. Brown. Median line of pronotum outlined in deep brown; lateral margin narrowly dark brown. Mesonotum with median line also darkened. Dark brown bar at base of meso and metathoracic wings on pleurae. Sternum unmarked. Wings. Membrane of mesothoracic wings with light brownish tinge; longitudinal veins amber colored; crossveins in most of wing amber tinted but those of cubito-anal area only lightly or not at all colored. Metathoracic wing with C, Sc, and R strongly tinted; other main veins much lighter; crossveins shading from being lightly tinted to colorless beginning at anterior border of wing. Legs. Coxae with large brown spot laterally; femora, tibiae, and tarsi uniformly brown on all legs. Forelegs darker than others. Abdomen. Brown;

color pattern of female much like that of male. First tergite dark brown; tergites 2-9 with a pattern of light- and dark-brown markings; 3-7 with a paler median line in the anterior half of each. A W-shaped dark marking is present on tergites 2-9; most clearly shown on 4.7; postero-lateral dark rectangles on 2-8. Venter unmarked.

Male imago: Genitalia. Decurrent appendage runs anteriorly along medial edge of penis, turning slightly ventrally near the tip, and extending well below juncture of 2 penes; appendage long and thin and not swollen distally as is that of *L. collina*.

PARALEPTOPHLEBIA LESTAGE

The genus *Paraleptophlebia* is well represented in the southeastern United States with about one-third of the total North American species found in the region. Thanks to the excellent studies of Traver, Burks, McDunnough and others, the species are rather well known and for many all stages have been described. Among southeastern species only the following stages remain to be described: *P. assimilis,* female and nymph; *P. georgiana,* nymph; *P. jeanae,* nymph; and *P. volitans,* female (described below). Distributional patterns of the various species are given in a paper soon to be published (Berner, in press).

Paraleptophlebia adoptiva (McDunnough)

This species was reported from North Carolina by Traver (1937) and is also now known from Georgia (Berner, in press). It seems to be a rare form in the Southeast as it does not appear in collections made by me or by others, to my knowledge.

Paraleptophlebia assimilis (Banks)

P. assimilis is another poorly known species, with only the male adult having been described. Although I have collected extensively throughout the Southeast, I have only a very few male adults taken in North Carolina.

Paraleptophlebia debilis (Walker)

This species is well known in the northern United States and in Canada, but is scarce in the Southeast. I have a few male adults from North Carolina and the species has been reported from South Carolina by Patrick et al. (1967). The distinctive male genitalia, particularly the lobed basal segment of the forceps easily differentiates the species from others. Burks (1953) has an excellent illustration of the genitalia, but his drawing does not emphasize the lobe, although that of Gordon (1933) does. Forceps shown in Fig. 23.

Paraleptophlebia georgiana Traver

This species has not been reported since the type material was collected in June 1931, by P. W. Fattig. I have no additional records of *P. georgiana.*

Paraleptophlebia guttata (McDunnough)

P. guttata is fairly common in the mountain streams of North Carolina, Tennessee, and Georgia and I have collected specimens from small to large swarms that I have observed flying near or above bridges in bright sunlight in midsummer. The species is well known with the female having been described by McDunnough (1925) and Gordon (1933) and the nymph by Ide (1930).

Paraleptophlebia jeanae Berner

P. jeanae was described in 1955 from specimens collected in Virginia and Alabama. Subsequently, the species has been taken only once in South Carolina. The nymph remains to be discovered. Male genitalia shown in Fig. 17.

Paraleptophlebia moerens (McDunnough)

This is another species that has been collected only rarely in the southeastern United States. The very distinctive basal segment of the forceps easily differentiates the males of *P. moerens* from other species of the genus. Burks (1953) has an excellent illustration of this characteristic. I have specimens from Tennessee and Fattig collected the species in Georgia. Traver (1932) recorded it from a single locality in North Carolina. Forceps shown in Fig. 24.

Paraleptophlebia mollis (Eaton)

Traver (1937) collected this species at 3 localities in North Carolina and Eaton (1884) also listed North Carolina as an area in which the species was known to occur. I have taken no specimens that I can identify as belonging to *P. mollis*. A brief description of the female was given by Gordon (1933) and the nymph was well described by Ide (1930).

Paraleptophlebia swannanoa (Traver)

When Traver (1932) named this species she was able to include male, female and nymph in her description. Her specimens came from several mountain localities in western North Carolina; subsequently (1935), she listed specimens from South Carolina and erroneously from Timpson Creek, Georgia. Later Traver (1937) added 3 more mountain localities in North Carolina to her records. The Georgia collections of Fattig are from 2 mountain streams in the northern part of the state. I have additional specimens from South Carolina.

Paraleptophlebia volitans (McDunnough)

Paraleptophlebia volitans is widely distributed in eastern North America and is well known in the southeastern states. The adult male was the only form described by McDunnough, and the nymph was later treated by Ide (1930). As the female still remains to be characterized, I am including a description of that sex below.

Description of the female imago (in alcohol): Measurements (mm). Body

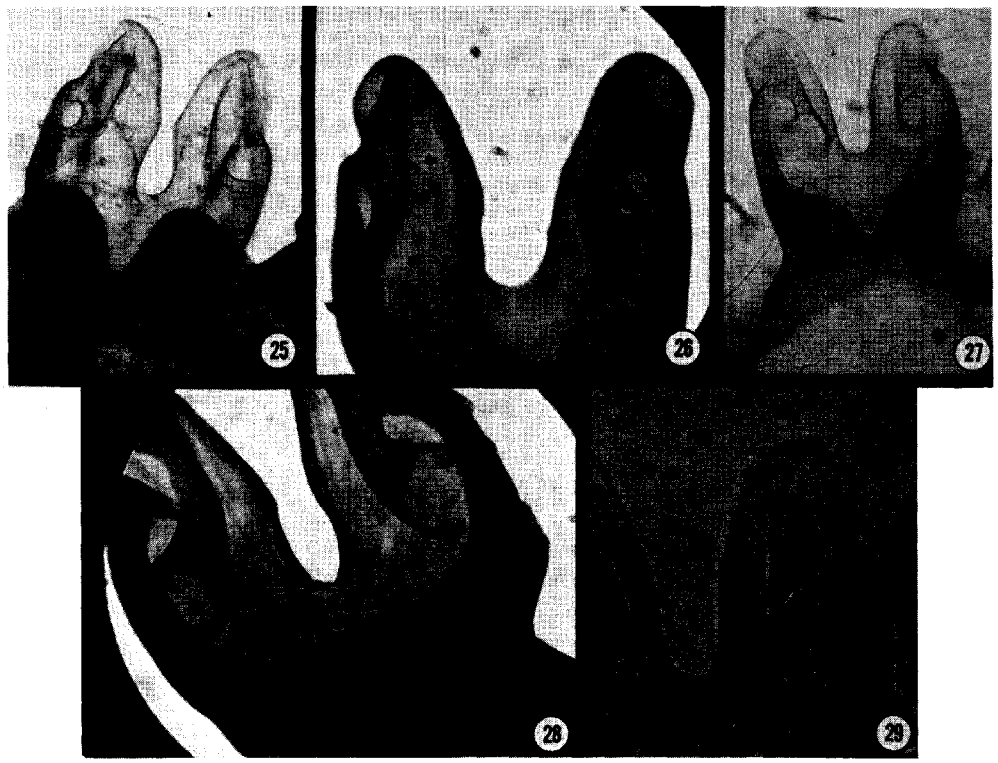

Fig. 25-29. *Paraleptophlebia volitans* (McDunnough), various appearances of decurrent appendages of penes. 25) specimen from Fort Valley, Georgia, with maximum torsion of appendages. 26) South Carolina specimen with one appendage like that of Fig. 25, the other resembling typical *volitans*. 27) usual appearance of *volitans* penes. 28) decurrent appendages of specimen from Quebec. 29) appendage to show teeth at anterior end.

length 5.3-6.5; wing length 6.1-7.3; caudal filaments: cerci 5.1-6.3, terminal filament 5.8-7.3.

Head. Brown. Epicranial suture dark brown. Antenna with scape and pedicel dark brown, flagellum dusky. Thorax. Pronotum dark brown; mesonotum lighter; pleurae dark brown around base of each coxa. Sternum lighter brown. Wings. Longitudinal veins light amber; crossveins pale. Legs. Coxae brown tinged; remainder of legs tan. Abdomen. Brown. Tergites 1 and 2 dark brown; faint pale median line on middle tergites; may extend to include tergite 9 on some specimens; lighter colored specimens with tergites 5 and 8 more deeply marked; 2-7 may have small submedian pale spots at anterior margin and in some specimens spots may be present on tergite 8; most consistent pattern appears to include large posterolateral dark marks extending from middle of each of tergites 2-8 or 2-9 to posterior border and located above spiracular line. Spiracular line strongly marked with blackish brown spots. Sternites paler than tergites. Caudal filaments. First few segments brown; remainder pale.

Male genitalia: After examining a slide of the male genitalia from a specimen collected at Mossy Creek, Fort Valley, Georgia, I was struck by the difference between them and those of typical *P. volitans*. In fact, the difference was so striking that I was tempted to erect a new species based on

what appeared to be unique decurrent appendages; in all other respects, the males resembled those showing the range of color patterns exhibited by *volitans*. Before describing the males as new, I decided to prepare slides of genitalia of specimens from Quebec, South Carolina, Georgia, and 2 areas in Florida for comparison, and a careful examination has revealed that the uniqueness of the decurrent appendage seen in the Mossy Creek specimens was the result of the position assumed by the appendage on the slide. The appendage is expanded at its anterior end and appears to be open cornucopia-like. The opening is edged inwardly on the ventral surface with a row of fine teeth. If the appendage is twisted slightly it assumes the appearance of being notched laterally and then suddenly expanding just before the opening. This characteristic is shown in all the specimens I have examined (Fig. 25-29).

The drawing given by Traver (1935, Fig. 133) is misleading as the decurrent appendage is represented as being a slender, anteriorly-directed rod that is U-shaped at its free end. Burks' figure (1953, Fig. 209) appears to be a redrawing of that of Traver. The most nearly accurate drawings of the genitalia are given in McDunnough's (1924) original description and in my 1950 paper.

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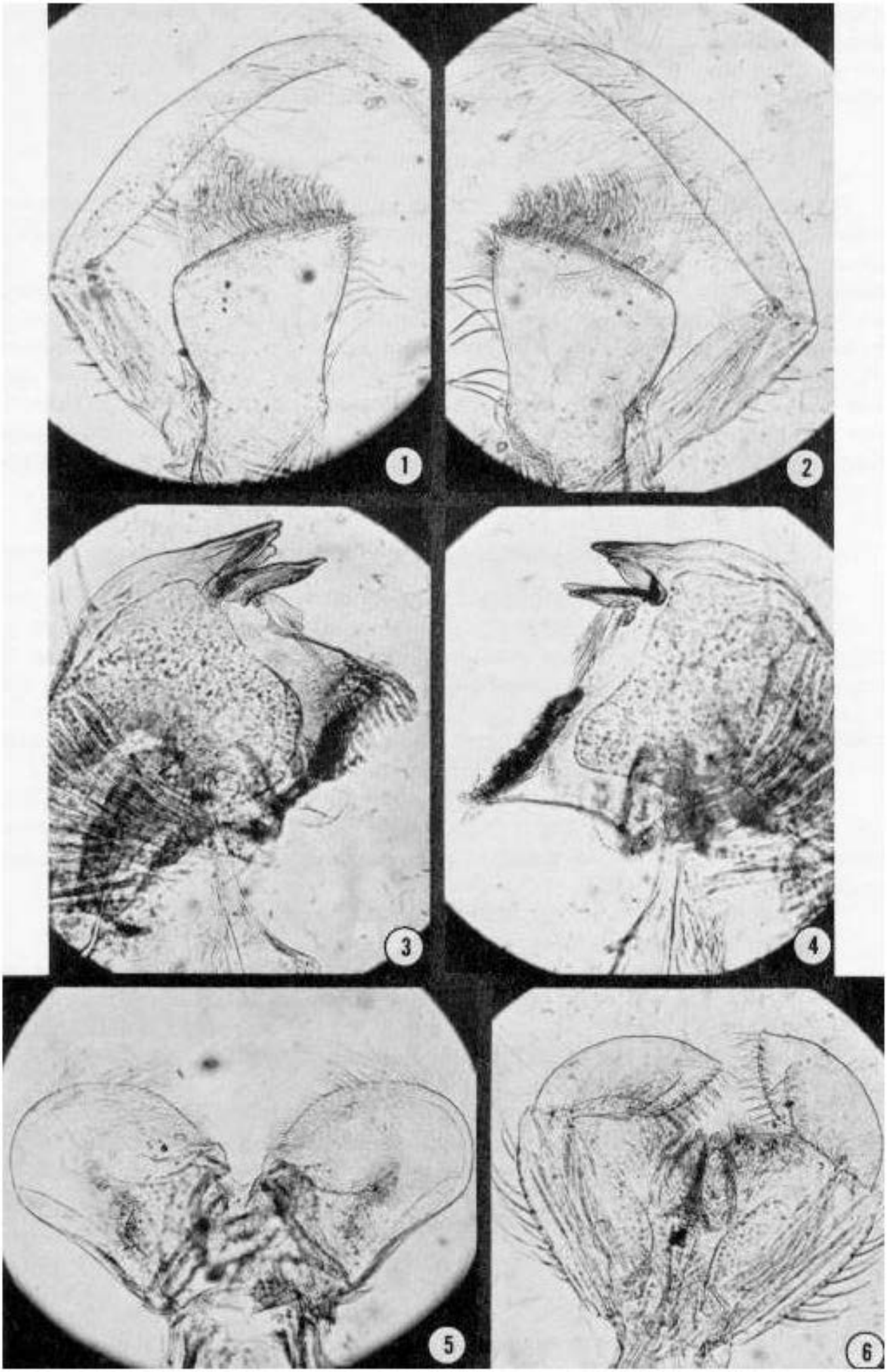
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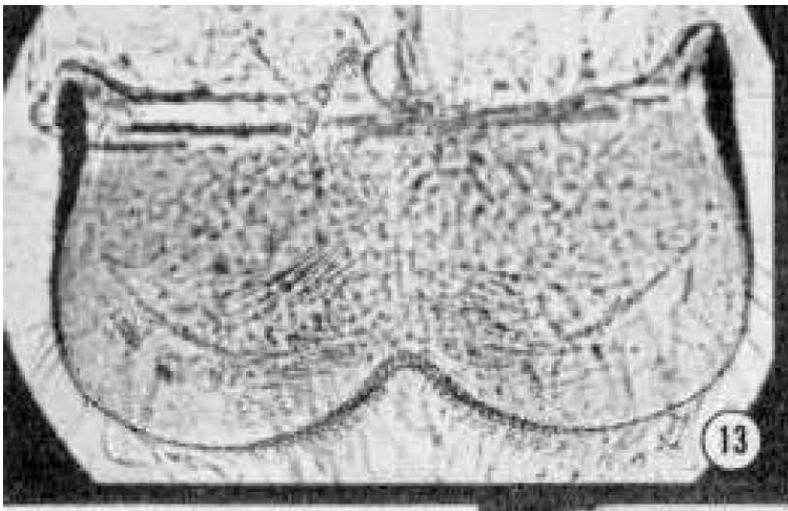
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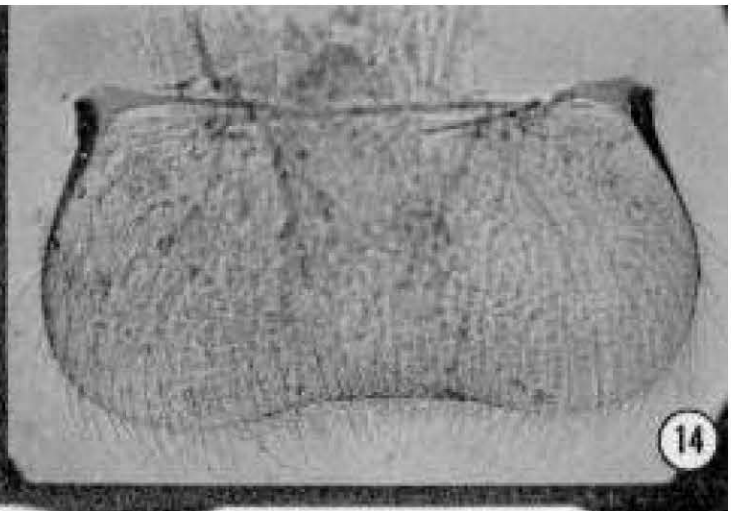
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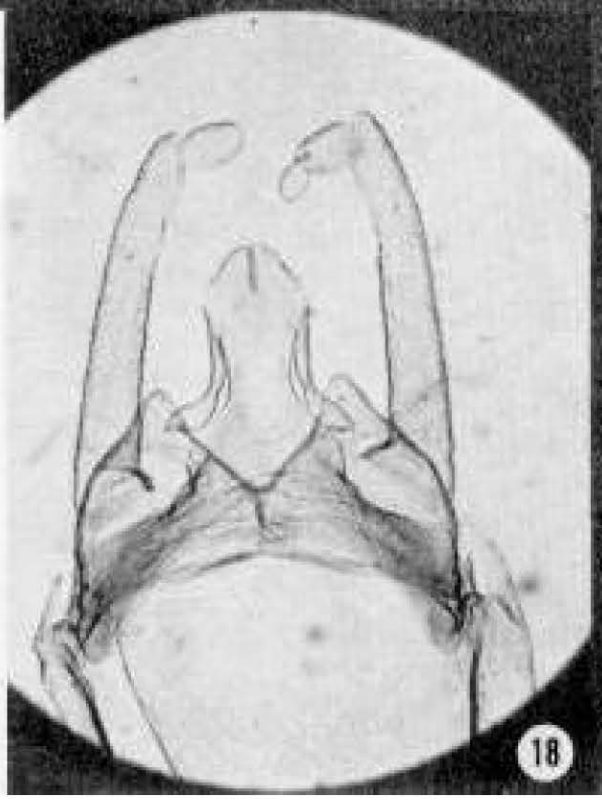
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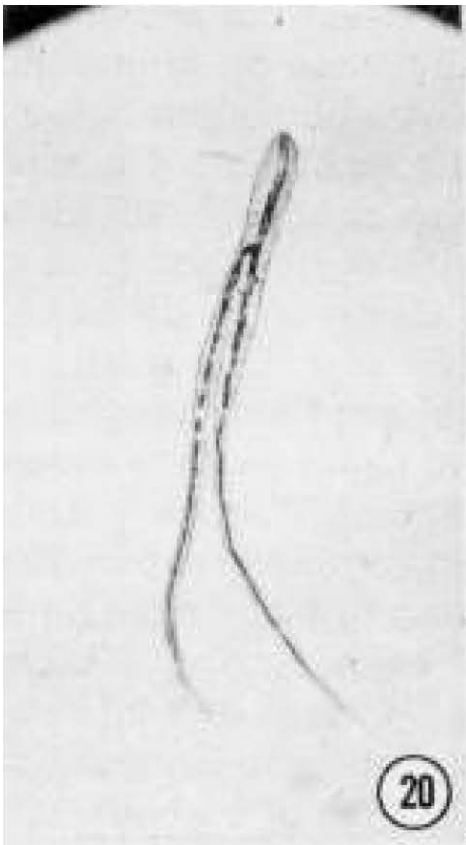
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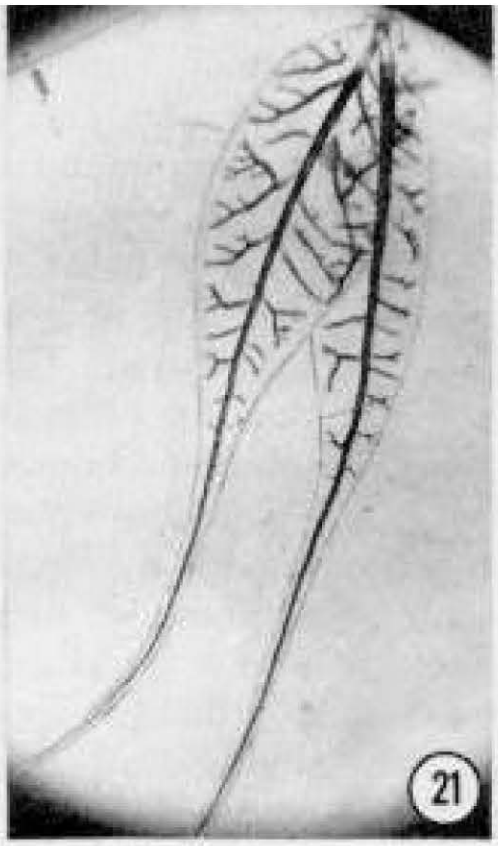
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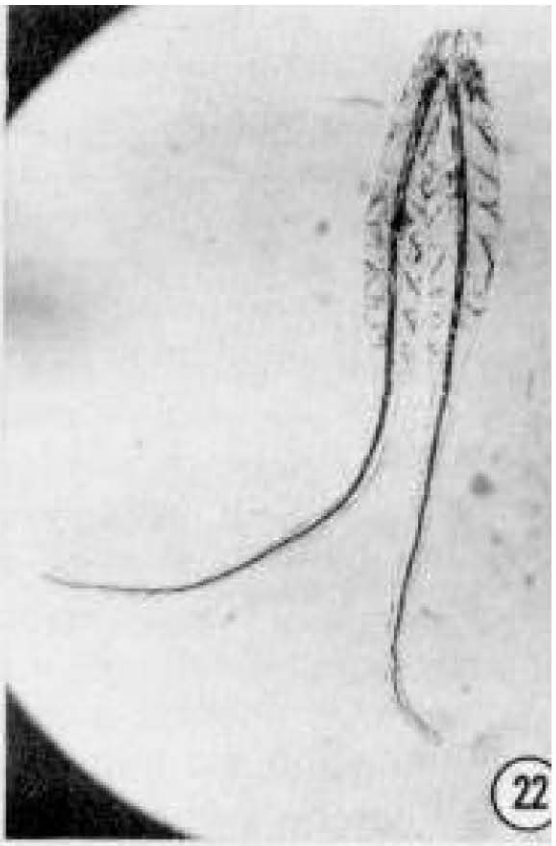
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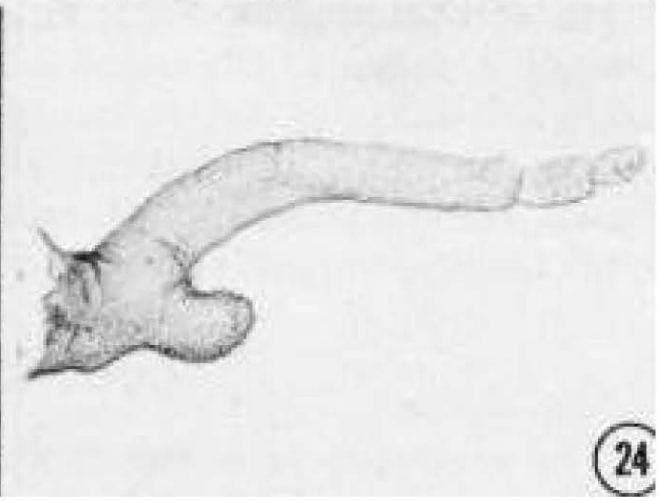
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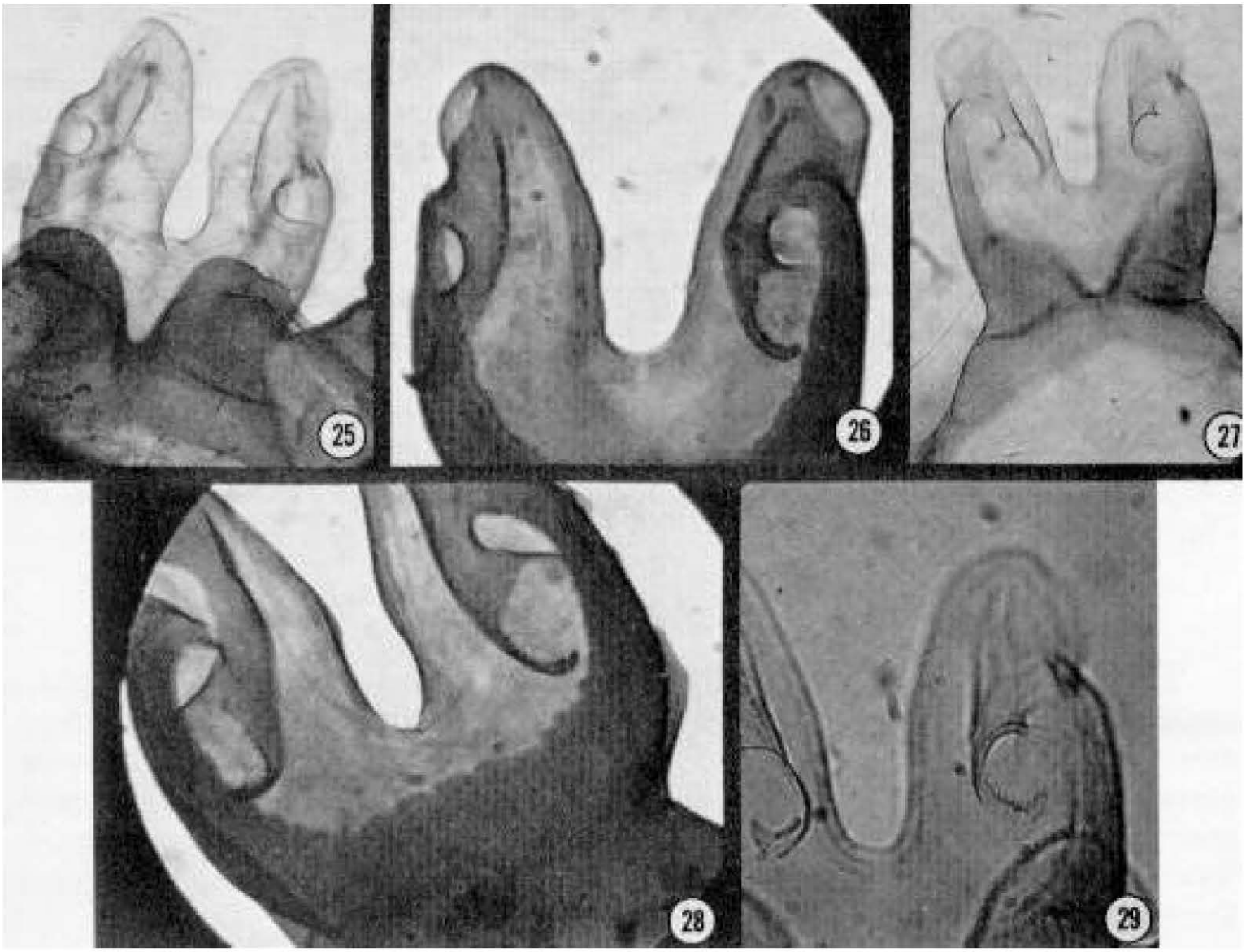
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