

## A NEW GENUS AND SPECIES OF LEPTOPHLEBIIDAE: ATALOPHLEBIINAE FROM SOUTHERN INDIA (EPHEMEROPTERA)

K. G. Sivaramakrishnan<sup>1</sup>

*Abstract.* A new genus of Leptophlebiidae, *Petersula*, is established. One new species, *Petersula courtallensis*, is described from southern India, and biological notes are given.

Since publication of "A catalog of the Ephemeroptera of the Indian Subregion" (Hubbard & Peters 1978), 6 new species of mayflies have been described from India (Soldán 1978, Braasch 1981, Braasch & Soldán 1982, Hubbard 1982) bringing the number of recognized species to 136. However, fewer than 25% of the recognized species are known from peninsular India and an even smaller percentage is known from southern India. In the Leptophlebiidae, the 2nd largest Indian family of mayflies in terms of numbers of species, only 5 species are recorded from peninsular India. This incompleteness in species representation creates a deficiency in our knowledge of mayfly systematics and is the major obstacle to studies on the lotic fauna of southern India.

During preliminary studies on the composition and life cycle patterns of mayfly populations in the hill streams at Courtallam, Tamil Nadu (Sivaramakrishnan & Job 1981), several new genera and species of Leptophlebiidae were found. In this paper 1 new genus, *Petersula*, is established for *Petersula courtallensis*, n. sp. Descriptions are based on material collected during the study of the Courtallam streams (Sivaramakrishnan & Job 1981) and additional material collected by P.S. Nathan and F. Schmid.

The generic description is based on *Petersula courtallensis*, n. sp., as well as a male imago illustrated as *Petersula* sp. in this paper (Fig. 8, 9, 11, 13) [see Sivaramakrishnan & Hubbard (1984), immediately following]. Terminology and procedures used in the description follow those of Peters et al. (1978).

### ***Petersula* Sivaramakrishnan, new genus**

Fig. 1-26

Gen. et sp. nov. A, Sivaramakrishnan & Job, 1981: 109.

Type-species: *Petersula courtallensis* Sivaramakrishnan, n. sp.

*Imago.* Length of ♂: body, 9.0-12.7 mm; fore wings, 9.5-13.0 mm. Length of ♀: body, 10.5-13.0 mm; fore wings, 11.0-13.5 mm. Eyes of ♂ meet on meson of head, upper portion circular dorsally, lower portion  $\frac{3}{4}$  length of upper portion; eyes of ♀ separated on meson of head by

1. Department of Entomology, Florida A&M University, Tallahassee, Florida 32307, USA.

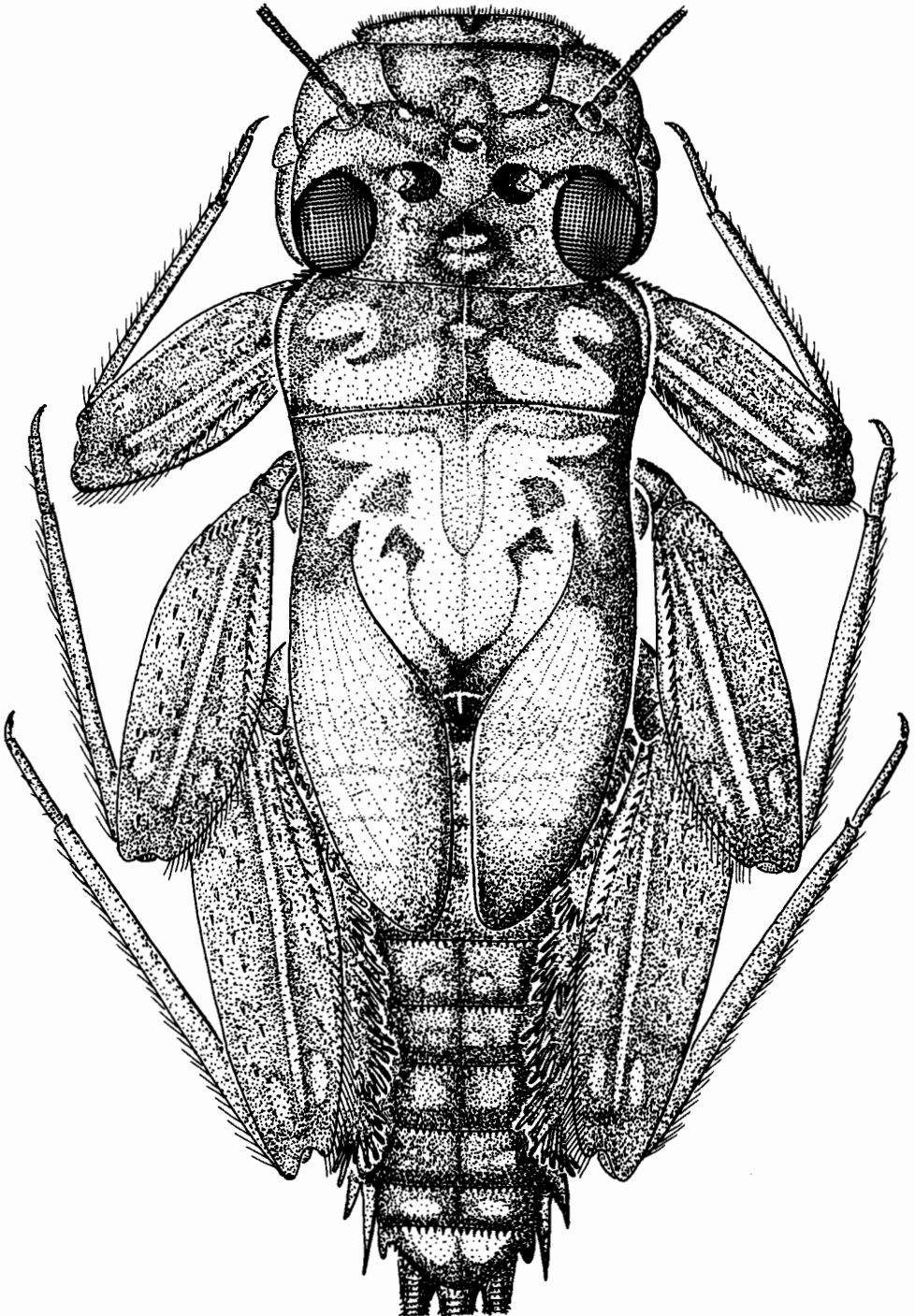
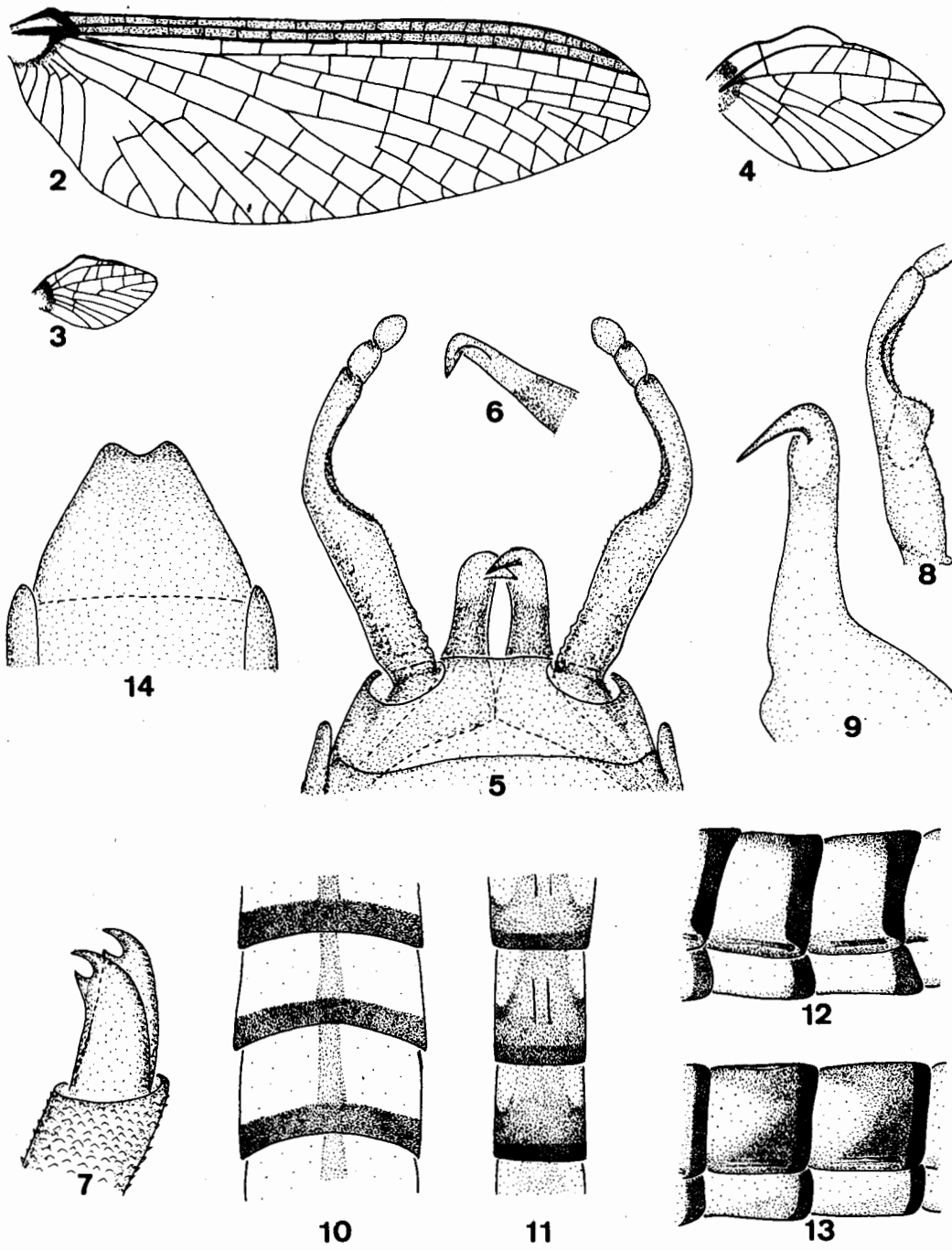


FIG. 1. *Petersula courtallensis*, dorsal view of mature ♀ nymph (body length 10 mm).

$2\frac{1}{2}$  × width of eye. Wings (Fig. 2–4): maximum width of fore wings  $\frac{1}{3}$  maximum length of fore wings; vein Rs of fore wings forked more than  $\frac{1}{4}$  to  $\frac{2}{5}$  of distance from base of wing to margin; vein MA forked a little more than  $\frac{1}{2}$  of distance from base to margin, fork symmetrical; vein  $MP_2$  attached at base to vein  $MP_1$  (and sometimes to CuA) with a crossvein (Fig. 2), attachment of vein  $MP_2$  to  $MP_1$  slightly more than  $\frac{1}{3}$  of distance from base to margin; cubital area with 2 intercalaries as in Fig. 2; crossveins few. Costal margin of hind wings convex or with a rounded costal projection (Fig. 3–4); apex of costal projection slightly less than  $\frac{1}{2}$  of distance from base; apex of wings acute, pointed; crossveins as in Fig. 4. Legs: ratios of segments of ♂ fore legs, 0.68–0.71 : 1.00 (3.83–4.62 mm) : 0.04–0.05 : 0.29–0.38 : 0.21–0.28 : 0.10–0.16 : 0.07–0.08. Claws of a pair alike, apically hooked with an opposing hook (Fig. 7). Male genitalia (Fig. 5–6, 8–9): segment 2 of forceps equal to length of segment 3, segment 2 of forceps  $\frac{1}{8}$  length of segment 1, apex of segment 3 rounded; base of forceps broad, its inner margin forming an angular bend near middle of forceps; length of styliger plate along median line a little more than  $\frac{1}{3}$  maximum width, apex of styliger plate entire; penes divided, tubular, broader at base and tapering towards apex; each penis lobe with ventromedially directed spinelike projection near apex (Fig. 6, 9). Posterior margin of sternum 7 of ♀ with very small medial extension and anterior margin of sternum 8 with well-developed egg channels (Fig. 15–16). Ninth sternum of ♀ shallowly cleft apically (Fig. 14). Terminal filament a little longer than cerci.

*Mature nymph.* Head prognathous. Antennae a little longer than maximum length of head. Mouthparts (Fig. 22–26): length of labrum approximately  $\frac{1}{3}$  × width; labrum expanded and angled laterally, dorsal hair as in Fig. 24, submedian and anterior areas of hair ventrally; anteromedian emargination broad, U-shaped and without apparent denticles (Fig. 24). Clypeus as in Fig. 24, anterior margin concave. Left mandible with outer margin of basal  $\frac{1}{2}$  smoothly curved and apical  $\frac{1}{2}$  almost straight (Fig. 25); a row of hairs from mid outer margin to near base of incisors as in Fig. 25; incisors with unserrated apical teeth; prosthecal tuft reduced (Fig. 25). Lingua of hypopharynx with well-developed lateral processes, apex of submedian lobes with short spines and racklike process (Fig. 23), anterior margin deeply cleft; superlingua as in Fig. 23, with a row of hair along anterior margin, lateral margins blunt. Maxillae: apical  $\frac{1}{2}$  of galea-lacinia broad, with a subapical row of spines (Fig. 22); segment 2 of palpi a little longer than length of segment 1, segment 3 of palpi  $\frac{2}{3}$  length of segment 2, triangular; a V-shaped ridge near ventral, inner, anterolateral margin of maxillae; hair on maxillae as in Fig. 22. Labium as in Fig. 26; segment 2 of palpi a little more than  $\frac{2}{3}$  length of segment 1; segment 3 of palpi about  $\frac{2}{3}$  length of segment 2, triangular; paraglossae ventral to glossae; lateral margins of submentum without setae as in Fig. 26. Legs (Fig. 17–20): maximum width of tibiae almost 2 × width of tarsi (Fig. 18–19); tibiae oval in cross section (Fig. 18), tarsi circular in cross section (Fig. 19); apical  $\frac{1}{2}$  of femora indented so tibiae can draw partially into femora (Fig. 17); apex of claws hooked and narrow with 8–9 denticles that are progressively larger apically (Fig. 20). Gills (Fig. 21): gills on segment 1–7 alike, dorsal and ventral portions of lamellae platelike, margins unevenly fringed with broad filamentous processes. Posterior margin of all abdominal terga with a row of fine spines. Posterolateral spines on abdominal segments 3–9, spines progressively larger posteriorly. Terminal filament a little longer than cerci.

FIG. 2–14. *Petersula*. 2–13, ♂ imago: 2–7, *P. courtallensis*: 2, fore wing; 3, hind wing; 4, hind wing enlarged; 5, genitalia, ventral view; 6, apex of penis lobe; 7, fore claw. 8–9, *Petersula* sp.: 8, dorsal view of right forceps (3rd segment broken); 9, right penis lobe (enlarged 2 ×). 10–13, abdominal segments of ♂ imago: 10–11, terga 5–6: (10) *P. courtallensis*; (11) *Petersula* sp.; 12–13, lateral view of segments 5–6: (12) *P. courtallensis*; (13) *Petersula* sp. 14, *P. courtallensis*, ♀ imago, abdominal sternum 9.



*Etymology.* *Petersula*, feminine; named for Prof. W.L. Peters in honor of his significant contribution to the study of Leptophlebiidae.

*Discussion.* *Petersula* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imagos: (1) vein  $MP_2$  of fore wings is attached at base to vein  $MP_1$  (and sometimes  $CuA$ ) with a crossvein, and attachment of vein  $MP_2$  to  $MP_1$  is more than  $\frac{1}{3}$  of the distance from base to margin (Fig. 2); (2) costal margin of hind wings is convex or with a rounded costal projection (Fig. 3–4); apex of costal projection is located less than  $\frac{1}{2}$  distance from base; (3) each penis lobe has a ventromedially directed spinelike projection near apex (Fig. 6, 9); (4) claws of a pair are alike, apically hooked with an opposing hook (Fig. 7); and (5) 9th sternum of ♀ is shallowly cleft apically (Fig. 14). In the nymph: (1) anterior margin of lingua of hypopharynx is deeply cleft; apex of submedian lobes of lingua possesses a racklike process (Fig. 23); (2) outer margin of basal  $\frac{1}{2}$  of mandibles is smoothly curved, while apical  $\frac{1}{2}$  is almost straight; a row of hairs extends from mid outer margin almost to base of incisors (Fig. 25); (3) abdominal gills occur on segments 1–7 and are platelike with margins unevenly fringed with broad filamentous processes (Fig. 21); (4) posterolateral spines occur on abdominal segments 3–9 and are progressively larger posteriorly; and (5) labrum is expanded and angled laterally (Fig. 24).

*Petersula* appears to belong to the *Meridialaris* lineage as delineated by Pescador & Peters (1980). Along with other genera in the lineage, *Petersula* possesses the following derived nymphal character states: (1) length of labrum is approximately  $\frac{1}{3} \times$  width and the labrum is expanded and angled laterally; anteromedian emargination is broad and U-shaped (Fig. 24); (2) galea-lacinia of maxillae is broad at apex (Fig. 22); and (3) lateral margins of submentum are without setae (Fig. 26).

*Petersula* appears to be most closely related to *Kimminsula* Peters & Edmunds, 1970, known only from Sri Lanka, and can be distinguished from it by the following combination of characters. In the imagos: (1) the eyes of the male meet on meson of head; (2) spinelike projection on the apex of each penis lobe is short and is ventromedially directed (Fig. 5); and (3) vein  $MP_2$  of the fore wings is attached at the base to vein  $MP_1$  (and sometimes to  $CuA$ ) by a crossvein, and attachment of vein  $MP_2$  to vein  $MP_1$  is slightly more than  $\frac{1}{3}$  of the distance from base to margin (Fig. 2). In the nymph: (1) outer margin of basal  $\frac{1}{2}$  of mandibles is smoothly curved, while apical  $\frac{1}{2}$  is almost straight (Fig. 25); (2) abdominal gills occur on segments 1–7 and are platelike with margins unevenly fringed with broad filamentous processes (Fig. 21); and (3) anteromedian emargination of labrum is broad, U-shaped, without apparent denticles (Fig. 24).

*Petersula* and *Kimminsula* belong to a complex of several undescribed genera in Sri Lanka and southern India (Hubbard & Peters, pers. commun.). Further, several genera of the *Kimminsula*-complex are known from the Malagasy Republic (Peters, pers. commun.). Apparently the *Kimminsula*-complex is a derivative of an ancient Gondwanian fauna, and drifting India played a significant role in the dispersal of the

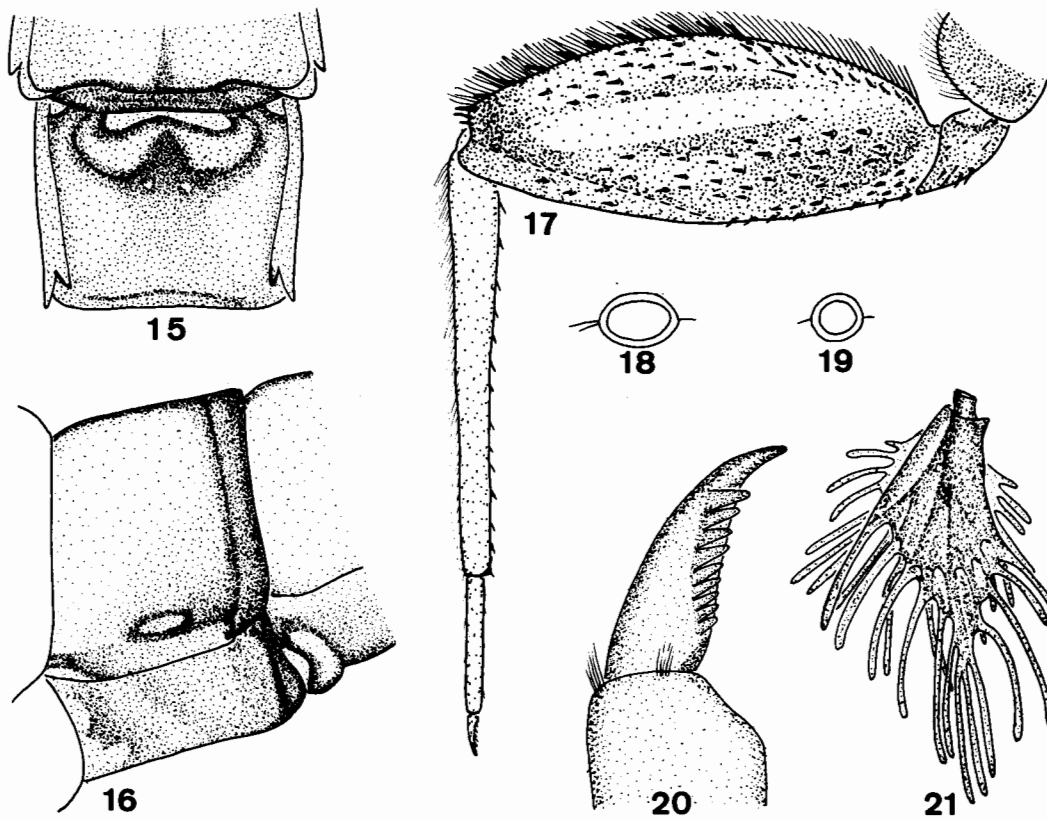


FIG. 15-21. *Petersula courtallensis*. 15-16, ♀ imago: 15, sterna 7 (posterior ½) and 8; 16, lateral view of abdominal segments 7 and 8 (anterior ½). 17-21, nymph: 17, fore leg; 18-19, cross section of tibia and tarsus of fore leg; 20, fore claw; 21, gill 4.

ancestor of the *Kimminsula*-complex to the hill streams of Sri Lanka and southern India (Edmunds 1972, 1979; Tsui & Peters 1975).

***Petersula courtallensis* Sivaramakrishnan, new species** Fig. 1-7, 10, 12, 14-26

Gen. et sp. nov. A, Sivaramakrishnan & Job, 1981: 109.

♂ imago (in alcohol). Length, 9.0-10.0 mm; fore wings, 9.5-10.2 mm. Upper portion of eyes yellowish brown, lower portion black. Head yellowish brown; anterior margin, mouthparts, and area around antennal bases washed with black. Scape and pedicel of antennae dark brown, flagellum brownish yellow. Basal ½ of ocelli black, apical ½ white. Thorax yellowish brown; carinae darker, sutures paler; pronotum brown, lateral and posterior margins washed with blackish brown; pleura and lateral margins of mesonotum and areas around base of legs and fore and hind wings washed with blackish brown; sterna uniformly washed with blackish brown. Legs yellowish brown; coxae washed with dark brown; apex and posterior edge of prothoracic femora washed with dark brown, an irregular dark brown streak dorsally; tibiae, tarsi, and

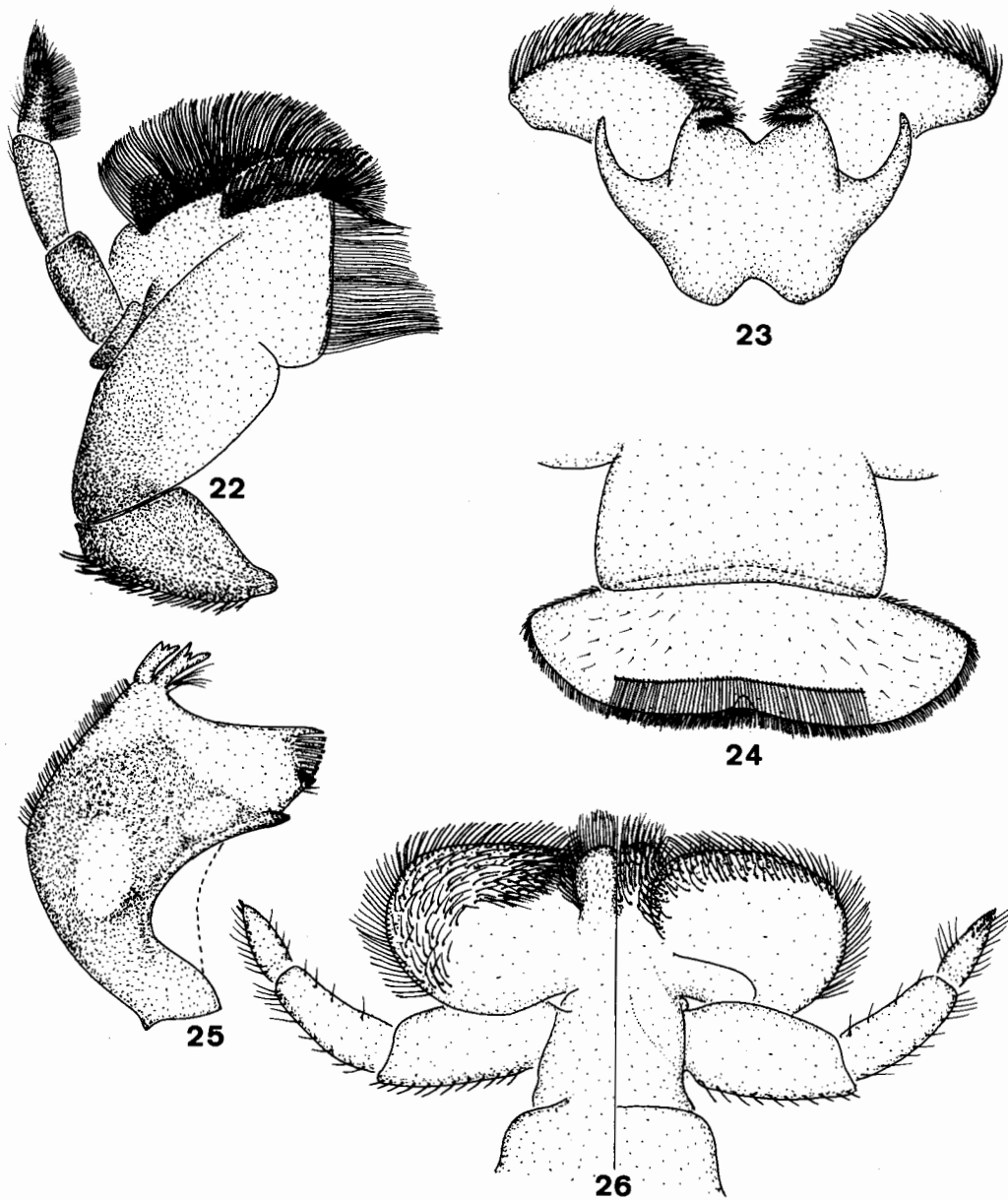


FIG. 22-26. *Petersula courtallensis*, nymph: 22, ventral view of right maxilla; 23, hypopharynx; 24, clypeus and labrum; 25, left mandible; 26, labium, dorsal (left) and ventral (right) views.

claws yellowish brown. Wings (Fig. 2-4): longitudinal and crossveins of fore and hind wings brown; membrane of fore and hind wings hyaline, except cells C and Sc of fore wings yellowish brown; costal margin of hind wings with a rounded costal projection. Abdomen: terga of segments 1-9 opaque, brownish yellow, tergum 10 opaque brown; a dark brown, narrow,

transverse band on posterior margin of all terga; faint, longitudinal, median line on terga 2–10 (Fig. 10); sternum 1 brownish black, sterna 2–7 brownish yellow, sterna 8–9 brown; a black, narrow, transverse band on posterior margin of sterna 2–9 (Fig. 12); spiracles dark brown, tracheae hyaline. Genitalia (Fig. 5–6) yellowish brown, proximal  $\frac{1}{2}$  of penes darker; length of spinelike projection arising near apex of each penis lobe  $\frac{1}{2}$  length of penes; posterior margin of styliger plate entire. Caudal filaments brown, paler annulations at articulations.

♀ *imago* (in alcohol). Length, 10.5–13.0 mm; fore wings, 11.0–13.5 mm. Eyes black. Head light yellowish brown, carinae and mouthparts black. Antennae light yellowish brown, flagellum paler. Basal  $\frac{1}{2}$  of ocelli black, apical  $\frac{1}{2}$  grayish white. Thorax and legs: color and marks as in ♂ *imago* but darker. Wings: color and marks as in ♂ *imago*, except membrane in cells C and Sc, longitudinal and crossveins of fore wings darker. Abdomen: terga of segments 1–4 and 10 opaque brown, terga 5–9 light brown, other details of coloration as in ♂ *imago*, except dark median line on terga 2–10 much broader; genital extension dark brown. Color and marks of caudal filaments as in ♂ *imago*.

♂ *subimago* (in alcohol). Color of ocelli and eyes as in ♂ *imago*. Head and antennae light brownish yellow. Thorax: terga yellowish brown, paler medially; pleura and sterna washed with blackish brown. Legs as in ♂ *imago*. Wings: membrane of fore and hind wings translucent white, except cells C and Sc of fore wings dark brown; other details of coloration as in ♂ *imago*. Abdomen: terga pale yellowish brown; marks on terga as in ♂ *imago* except dark median line on terga faint; color and marks of sterna as in ♂ *imago*. ♂ genitalia pale yellow. Caudal filaments brownish yellow.

♀ *subimago* (in alcohol). Color of antennae, ocelli, and eyes as in ♀ *imago*. Head light brownish yellow. Color and marks of thorax and legs as in ♀ *imago* but paler. Wings: color of membrane and veins of fore and hind wings as in ♂ *subimago*. Abdomen: terga opaque yellowish brown, sterna pale brown; marks as in ♀ *imago*. Caudal filaments brown.

*Mature nymph* (in alcohol). Head: dorsum dark brown; venter pale. Thorax: dorsum yellowish brown, washed with dark brown at margins; venter pale; marks on nota as in Fig. 1. Legs: dorsum of femora washed with blackish brown, with a median, longitudinal clear brownish yellow area as in Fig. 17; apex of femora washed with blackish brown; tibiae and tarsi dark brown; spines and hairs on legs as in Fig. 17; brownish black maculae on outer  $\frac{1}{2}$  of venter of femora. Abdomen: terga 1–2 and 10 yellowish brown except dark brown medially, tergum 9 dark brown with yellowish brown submedian maculae, terga 3–8 brown to dark brown, darker medially, paler submedially as in Fig. 1; posterior margin of terga 1–10 with a narrow, brownish-black, transverse band; sterna pale. Gills (Fig. 21): membrane gray, main trunk of tracheae light black, faded apically. Caudal filaments yellowish brown.

*Holotype* ♂ *imago*, INDIA: Tamil Nadu State, Main Falls Stream, Courtallam, 200 m, 12.X.1979 (K.G. Sivaramakrishnan). Allotype ♀ *imago*, same data as holotype. Paratypes, INDIA: 1♂ *imago*, 4♂, 3♀ *subimagos*, 12 nymphs, same data as holotype; 1♀ *imago*, 1♀ *subimago* (pinned specimens), Kuttalam [Courtallam], 1000' [305 m], 23.XII.1961 (Schmid); 1♂ *subimago*, Kuttalam [Courtallam], 1000' [305 m], 23.XII.1961 (Schmid); 1♂ *subimago*, Kerala, Kalpatti, 250' [75 m], 23.I.1962 (Schmid); 1♂ *subimago*, Madras [Tamil Nadu], Balamore, 1500' [460 m], 4.I.1962 (Schmid); 1♂ *subimago*, Madras [Tamil Nadu], Kunjankuzhi, 400' [120 m], 2.I.1962 (Schmid); 3 nymphs, Kerala State, Kallada Riv, Aryankavu, 15 mi [24 km] from Courtallam, 18.XI.1970 (collector unknown); 1♂ *imago*, Anamalai Hills, Kadamparai, 3500' [1070 m], V.1963 (P.S. Nathan). All types are in alcohol except where noted. Association of the nymphs and imagos is by rearing. Holotype, allotype, and 2 nymphal paratypes are deposited in K.G. Sivaramakrishnan collections of the Entomology Institute, Loyola College, Madras; 1♂ imaginal paratype, 4♂ subimaginal paratypes, 3♀ subimaginal paratypes, and 10 nymphal paratypes are deposited in the collections of Florida A&M University; 1♀ imaginal paratype, 5♂ subimaginal paratypes,



and 3 nymphal paratypes are deposited in the collections of University of Utah; and 1♂ imaginal paratype is deposited in the collections of the B.P. Bishop Museum. This last specimen was dried in envelope and later placed into alcohol.

*Remarks.* The brownish-black band on the posterior margin of the abdominal terga is evident in nymphs of all sizes; however, the anterior and medial coloration of the terga varies with age of nymphs. In younger nymphs, the coloration is a light brown with pale, yellowish-brown submedian maculae. As nymphs mature, the light brown color darkens and obscures the submedian maculae so that on mature nymphs the maculae often are not visible on tergum 7 and are variously reduced in size and intensity of color on terga 3–5 and 8–9.

*Biology.* The nymphs cling to the underside of boulders in perennial streams where water flow is moderate to rapid. Gut contents included green and blue green algae, diatoms, mineral particles, and organic detritus.

When at rest, the nymphs move their abdomens laterally. Sometimes they bend the apex of the abdomen slightly upwards. Swimming is fairly rapid and broadly "zig-zag." The pro- and mesothoracic legs take part in swimming. The longer metathoracic legs are used to seize available objects for support.

*Etymology.* The species is named after the main locality of collection, Courtallam.

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