

**Two new genera of mayflies from the Ethiopian  
and Oriental Regions (Ephemeroptera : Leptophlebiidae)\***

By WILLIAM L. PETERS

*Department of Zoology and Entomology, University of Utah, Salt Lake City, U.S.A.*

M. T. GILLIES

*Malaria Institute, Amani, Tanganyika†*

AND

GEORGE F. EDMUNDS, JR.

*Department of Zoology and Entomology, University of Utah, Salt Lake City, U.S.A.*

SYNOPSIS

A new genus of Leptophlebiidae is established for four Ethiopian and Oriental species, hitherto referred to *Hagenulus*, and one new species from Tanganyika, the male, female and immature stages of which are described. A second new genus is erected for *H. scotti* on the basis of new nymphal and adult material from Mahé Island.

THE mayfly genus *Hagenulus* was established by Eaton (1882) for the Cuban species *H. caligatus* Eaton, and subsequently seven other species have been assigned to this genus. Our studies of the Leptophlebiidae have shown that the adults of the Ethiopian and Oriental species assigned to *Hagenulus* differ from the West Indian species and are probably not congeneric with them. Unfortunately, none of the species from the Eastern Hemisphere were known in the nymphal stage, and the nymphs from Cuba questionably referred to this genus by Morrison (1919) were considered by Traver (1960) as being probably incorrectly assigned. A few years ago one of us (*M. T. G.*) collected a nymphal exuvium and the emerging adult of an undescribed African species closely related to *H. fasciatus* Kimmins from Uganda. Although adults of *Hagenulus* are widespread and common in the West Indies, no nymphs of this African type are known from the West Indies or from Central and South America. The nymphal Leptophlebiid most commonly collected in the West Indies is similar to *Thraulodes*, except that the gills are more slender and reminiscent of *Paraleptophlebia*. There is no positive evidence for establishing this as the nymph of *Hagenulus*. Indeed, since we have been unable to find nymphs that show the developing female ovipositor or characteristic wing colour pattern, it is possible that this nymph may not be *Hagenulus*. Thus in the nymphal stage, also, there is support for the view that the Ethiopian and Oriental species are not congeneric with the West Indian species. On geographical grounds it also seems unlikely that the Old World species belong to *Hagenulus*, and they are probably not even closely allied.

Therefore we are here establishing a new genus, *Masharikella*, for four of the Ethiopian and Oriental species previously assigned to *Hagenulus*. It is considered that the latter genus should be restricted to the Neotropical forms, *H. caligatus* Eaton and *H. eatoni* Banks, and to a number of apparently undescribed species present in collections recently made available to us. At the same time we are establishing another new genus, *Maheathraululus*, for *Hagenulus scotti* Eaton, on the basis of nymphal and adult material recently collected by one of us (*M. T. G.*) in the Seychelles. There remain

\* The research on which this report is based was supported in part by a grant from the National Science Foundation, U.S.A.; George F. Edmunds, Jr., Principal Investigator.

† c/o Glyn Mills & Co., 22 Whitehall, London, S.W.1.

two Oriental species, *H. monstratus* Eaton from Burma and *H. karnyi* Ulmer from Java and Sumatra, which we retain in *Hagenulus* until more is known about them.

We are grateful to Mr. D. E. Kimmins, British Museum (Natural History), for the loan of comparative specimens and drawings; to Dr. P. J. Darlington, Jr., Museum of Comparative Zoology, Cambridge, Massachusetts, for the loan of specimens of *Hagenulus* from the West Indies; and to Dr. J. Linsley Gressitt, Bernice P. Bishop Museum, Honolulu, Hawaii, for the loan of specimens from New Ireland and New Guinea. Thanks are expressed to Mr. Steve L. Jensen, University of Utah, for preparation of the illustrations under our supervision.

### *Masharikella* gen. n.

*Imago*.—Length of male: body, 5.0–7.0 mm.; fore wings, 5.5–10.0 mm. Length of female: body, 8.0–9.0 mm.; fore wings, 8.5–10.0 mm. Turbinate eyes of male flattened and contiguous. Wings (figs. 2 and 3): vein *Rs* of fore wings forked less than one-fourth of distance from base to margin; vein *MA* forked over one-half of distance from base of wings to margin, fork symmetrical; vein *MP* forked nearer to base of wings than vein *Rs* (figs. 2 and 5), fork asymmetrical; cubital area as in figures 2 and 5; cross veins numerous. Costal projection of hind wings acute and well developed; cross veins few. Fore tibiae of male about twice as long as femora and subequal to tarsi. Pretarsal claws dissimilar (fig. 13), one apically hooked, the other obtuse, pad-like. Male genitalia (fig. 10) forceps segments two and three each one-sixth or less length of segment one, segment one broad, its inner margin forming an angular bend; penes tubular, divided and simple. Ninth sternum of female entire (fig. 15). Paracercus slightly longer than cerci.

*Mature nymph*.—Antennae one and one-half times as long as maximum length of head. Mouthparts (figs. 16–20): dorsal hair on labrum as in figure 19, a band of short spines along anterior margin ventrally. Mandibles as in figure 16. Lingua of hypopharynx with well developed lateral processes (fig. 20), hair on apex of lateral processes short, anterior margin deeply cleft; superlingua of hypopharynx as in figure 20, with a row of hairs along anterior margin, lateral tips emarginate (fig. 20). Segment one of maxillary palpi one and one-fourth length of segment two; segment three equal in length to segment two, segment three triangular in shape; hairs on maxillae as in figure 18. Labium as in figure 17; segment one of labial palpi one and one-third length of segment two; segment three slightly longer than segment two; segment three pointed at apex; paraglossae ventral to glossae. Legs (fig. 1): denticles on claws progressively larger apically (fig. 15), apex of claws hooked and narrow. Gills (figs. 1 and 21): gills on segments 1–7; ventral lamella of gill one ovate with fringed margins (fig. 1), dorsal lamella slender, lanceolate (fig. 1); gills 2–7 alike (fig. 21), both lamellae ovate with fringed margins. Small posterolateral spines on abdominal segments 8 and 9. Paracercus slightly longer than cerci.

Type species, *M. fasciata* (Kimmins), originally placed in *Hagenulus*.

Etymology: from the Arabic, *masharik*, the east.

Imagos of the genus *Masharikella* can be differentiated from *Hagenulus* by the following combination of characters. In *Masharikella*, (1) the female imago has no external ovipositor, (2) the eyes of the male imago meet dorsally and (3) segments two and three of the genital forceps are each one-sixth or less the length of segment one. In *Hagenulus*, (1) the female imago has a well developed external ovipositor or egg guide, (2) the eyes of the male imago are separated dorsally and (3) segments two and three of the genital forceps are each one-fifth or more the length of segment one.

The males of the restricted genus *Hagenulus* have up to now been known only from the description of Eaton (1882) of the subimago of *H. caligatus*. The genital and eye characters of *Hagenulus* given in this paper were based on examination of the male subimago of *H. caligatus* described by Eaton and of undescribed imagos in the collections of the Museum of Comparative Zoology, Harvard.

*Masharikella* can be differentiated from all other genera of the Leptophlebiidae by the following combination of characters. In the imago, (1) the penes of the male are tubular and divided, (2) the costal projection of the hind wings is well developed, (3) the pretarsal claws are as in figure 13, (4) the ninth sternum of the female is entire and (5) the eyes of the male meet dorsally. In the nymph, (1) the ventral lamella of

gill one is ovate with fringed margins, whereas the dorsal lamella is slender and lanceolate, (2) gills 2-7 are similar to each other, the dorsal and ventral lamellae being ovate with fringed margins, (3) the denticles on the claws are progressively larger apically and (4) small posterolateral spines are present on abdominal segments 8 and 9.

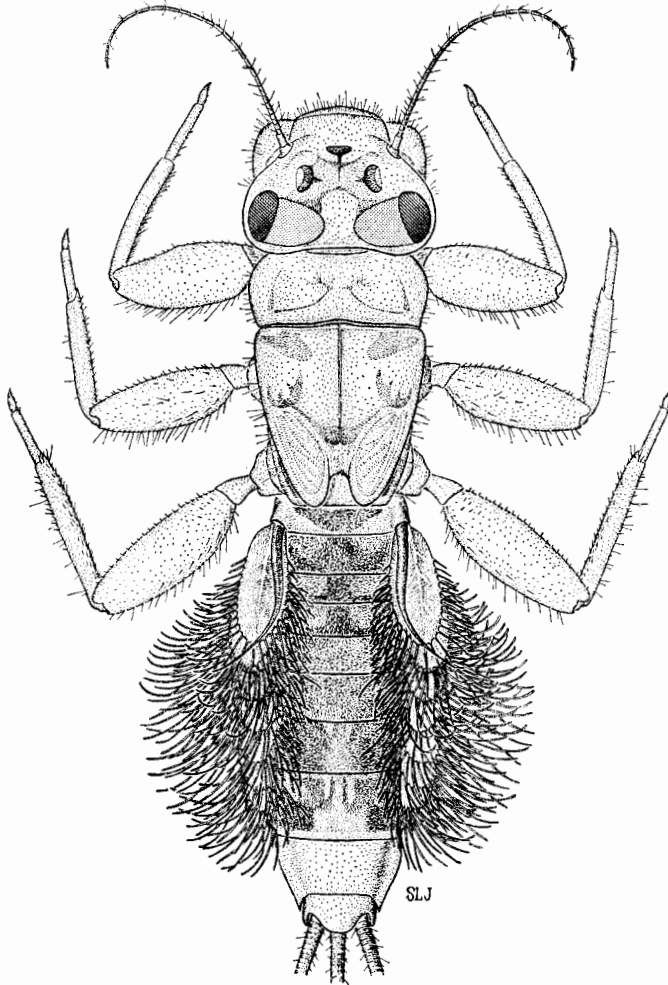


FIG. 1.—*Masharikella torrentis* sp. n., mature male nymph, dorsal view.

*Masharikella* is most closely related to the genus *Thraulius*, as indicated by the wing venation and genitalia of the imago and the gills and mouthparts of the nymph, but it can be distinguished from the latter in the nymphal stage most readily by the form of the first gill and in the adult by the costal projection of the hind wings and the form of the pretarsal claws. *Masharikella* is closely related to a number of other Old World genera that form a related complex and include *Euthraulius*, *Choroterpes* and *Thraulius*. All of these have fore and hind wings with reduced venation and the penes tubular and divided. The mature nymphs have many specialisations, but all are basically similar in the mouthparts and legs, and the forms of the gills show an apparent evolutionary adaptive sequence.

*Masharikella torrentis* sp. n. Gillies (figs. 2-3, 10, 13-22)

*Male imago* (in life).—Turbinate eyes coffee coloured. Thorax generally dark mahogany brown. Fore femora ginger, basal two-thirds of tibiae dark brown, distal one-third and tarsi colourless; mid and hind femora mainly ginger except for a narrow colourless band at base and a rather broader one subapically; extreme apex and basal two-thirds of mid and hind tibiae dark brown, rest of tibiae and tarsi colourless. Fore wings hyaline except for a narrow basal band extending from wing base to  $A_1$ , which is dark brown (fig. 2). Hind wings deeply tinted chestnut brown except for apex, which is hyaline; outer half of pigmented area darker than basal half (fig. 3). Abdominal terga 2-8 mahogany brown except for faintly pale lateral areas on 8; terga 9-10 pale ginger. Sterna 1-7 dark brown, 8 much paler, sterna 9-10 pale ginger. Forceps ginger up to behind constriction of first segment. Cerci and paracercus colourless, with broad dark bands around annulations, except at extreme base, which is mahogany brown.

*Female imago* (in life).—Body generally sherry brown, abdominal terga paler. Basal 3-4 mm. of paracercus and cerci dark brown, remainder of length white with brown annulations. Wings as in male. Fore femora pale chestnut brown, tibiae dark brown except at apex, tarsi colourless. Mid and hind legs coloured as fore legs, except for bases and apices of femora, which are colourless.

*Subimago* (in life).—Fore wings white, but base up to  $A_1$  purplish chocolate. Hind wings chocolate except for extreme apex. Body and legs as in imago.

Body.—Female, 8-9 mm.; male, 7 mm. Fore wings: 8.5-10 mm.

*Nymph* (in alcohol).—Body light brown with darker brown markings, those on sterna 2-9 forming lateral longitudinal stripes. Legs, paracercus and cerci light brown. Gills greyish-blue.

*Eggs*.—Orange, elongate oval in shape, chorion thick, terminating at each pole in 4 to 8 very long, stout, curved spinous processes (fig. 22).

*Holotype* ♂ imago, TANGANYIKA: Amani, 2000-3000 feet, East Usambara Mountains, 20.iv.58. *Paratypes*: 1 ♀ imago (allotype), vi.53, 1 ♀ imago, vi.53, 1 ♀ subimago, vi.59, 1 ♂ subimago, iv.62, 1 nymph, 13.vi.55, all above paratypes from same locality as holotype; Yongoma River, 4500 feet, South Pare Mountains, vii.54, 1 ♀ imago and nymphal pelt, 1 ♀ subimago. All types collected by M. T. Gillies and deposited in the British Museum (Natural History).

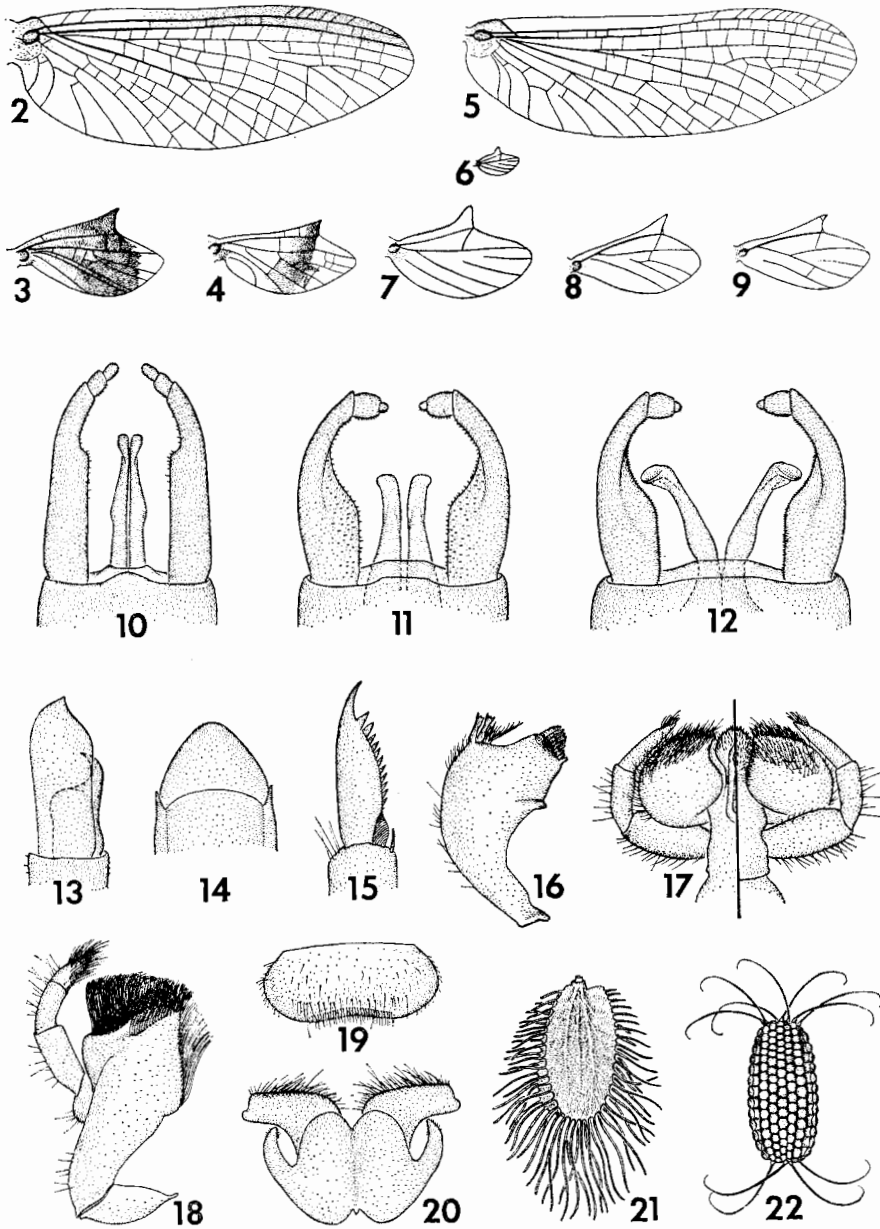
This species differs from *M. fasciata* (Kimmins) by the distribution of pigment in the wings (figs. 3 and 4), the colouring of the abdomen and legs, and by the penes of the male. *Masharikella semicastanea* (Gillies) from India has unpigmented wings. *Masharikella torrentis* occurs in fairly fast flowing mountain rivers at moderate altitudes, whereas *M. fasciata* has been recorded only from the shores of Lake Victoria.

*Masharikella duliti* (Demoulin), **comb. n.** (figs. 5-9, 11-12)

*Hagenulus* (?) *duliti* Demoulin, 1954, *Bull. (Ann.) Soc. ent. Belg.* 90 : 124.

Demoulin (1954) doubtfully placed this species from Borneo in the genus *Hagenulus*. Recently Dr. Gressitt loaned us specimens of the same species from New Ireland and New Guinea. The genitalia of one male imago from New Ireland are identical with those figured by Demoulin (fig. 12). The remaining specimens from New Ireland and New Guinea have genitalia as illustrated in figure 11. The penes of the New Ireland specimen illustrated in figure 12 are undoubtedly spread into an abnormal position and the swellings on the apical tips of the penes are in reality sperm. Except for the variation in the venation of the hind wings (figs. 6-9), all specimens from New Ireland and New Guinea are identical with *M. duliti*.

*Masharikella duliti* was described from the male imago and is represented by male imagos and by subimagos of both sexes in the Bernice P. Bishop Museum. New localities for this species are: (South-west) New Ireland: Lower Kait River, 15.vii.56 (*J. L. Gressitt*), 1 ♂ imago, in alcohol; (South-west) New Ireland: "Camp Bishop", 15 km. up Kait River, 125 metres, 7-8.vii.56 (*J. L. Gressitt*), light trap, 2 ♀ subimagos, in alcohol, 1 ♂ subimago, in alcohol, 13 ♀ subimagos, pinned; (North-east) New Guinea: Korop, Upper Jimmi Valley, 1300 metres, 12.vii.55 (*J. L. Gressitt*), 1 ♂ imago, in alcohol; (Netherlands) New Guinea: Okaitadi, Wisselmeren, 1800 metres, 8.viii.55 (*J. L. Gressitt*), 1 ♂ imago, in alcohol; (North-east) New Guinea: Tsenga, Upper Jimmi Valley, 1200 metres, 13.vii.55 (*J. L. Gressitt*), 1 ♂ imago, pinned.



FIGS. 2-22.—(2-3) *Masharikella torrentis* sp. n.: (2) fore wing; (3) hind wing, enlarged; (4) *M. fasciata* (Kimmins) comb. n., hind wing, enlarged. (5-9) *M. duliti* (Demoulin) comb. n.: (5) fore wing; (6) hind wing in proportion to fore wing; (7) hind wing, enlarged; (8) hind wing, enlarged; (9) hind wing, enlarged. (10) *M. torrentis* sp. n., male genitalia. (11-12) *M. duliti* comb. n., male genitalia. (13-22) *M. torrentis* comb. n.: (13) male fore pretarsal claw; (14) tenth sternum of female; (15) nymphal fore claw; (16) left mandible; (17) labium; (18) left maxilla; (19) labrum; (20) hypopharynx; (21) abdominal gill 4; (22) egg.

*Masharikella fasciata* (Kimmins), **comb. n.**

*Hagenulus fasciatus* Kimmins, 1956, *Bull. Brit. Mus. (nat. Hist.) Ent.* 4 : 81 (male imago); Kimmins, 1960, *ibid.* 9 : 352 (female imago).

*Masharikella fasciata* is known from the male and female imagos and has been collected from the Uganda and Tanganyika shores of Lake Victoria. Tjønneland (1960) has recorded extensive information on the flight activity of this species.

*Masharikella semicastanea* (Gillies), **comb. n.**

*Habrophlebiodes semicastanea* Gillies, 1951, *Proc. R. ent. Soc. Lond. (B)* 20 : 125.

Gillies (1951) described this species in the genus *Habrophlebiodes*, but stated that the generic position was provisional in the absence of nymphal material. The wing venation and genital structures of this species are so similar to those of the other species of *Masharikella* as to require its transfer to this genus. *Masharikella semicastanea* is reported from India and is known from the male imago only.

*Masharikella turbinata* (Ulmer), **comb. n.**

*Hagenulus turbinatus* Ulmer, 1909, *Reise in Ostafrika in den Jahren 1903-05* 2 : 367.

*Masharikella turbinata* is reported from the Comoro Islands and is known from the male and female imagos.

*Maheathraulius* gen. n.

*Imago*.—Eyes of male contiguous. Wings (figs. 23 and 24): vein  $R_5$  of fore wings forked one-sixth of distance from base to margin; vein  $MA$  forked over one-half of distance from base of wings to margin, fork symmetrical; vein  $MP_2$  independent of vein  $MP_1$  (fig. 23), except in very occasional specimens; cubital area as in figure 23; cross veins numerous. Costal projection of hind wings acute and well developed, projection located one-half distance from base of wings to margin, cross veins few. Fore tibiae of male twice as long as femora and equal to tarsi. Pretarsal claws dissimilar (fig. 29), one apically hooked, the other obtuse, pad-like. Male genitalia (fig. 26): segments two and three short, segment one long and slender; penes tubular, divided and slender. Egg guide or ovipositor of female extends to posterior margin of abdominal segment 10 (fig. 25). Ninth sternum of female elongate, entire (fig. 28). Paracercus slightly longer than cerci.

*Mature nymph*.—Antennae twice as long as maximum length of head. Mouthparts (figs. 34-38): dorsal hairs on labrum as in figure 36; a band of hairs along anterior margin and submedian areas of hairs ventrally. Mandibles as in figure 34. Lingua of hypopharynx with well developed lateral processes (fig. 37), hairs on apex of lateral processes short, anterior margin deeply cleft; superlingua of hypopharynx as in figure 37, with a row of hairs along anterior margin. Segment one of maxillary palpi equal to length of segment two; segment three one-half length of segment two; segment three triangular in shape; hairs on maxillae as in figure 35. Labium as in figure 38, segment one of labial palpi one and one-fourth length of segment two; segment three three-fourths length of segment two, segment three triangular in shape; paraglossae ventral to glossae. Legs (fig. 30): denticles on claws progressively larger apically (fig. 31), apex of claws hooked and narrow. Gills (figs. 32-33): gills on segments 1-7; gill one long, slender, consisting of one filament (fig. 32); gills 2-7 long, slender and bifurcate (fig. 33). Egg guide or ovipositor present on female nymphs (fig. 27). Posterolateral spines on abdominal segments 6-9, those on segments 8 and 9 larger. Paracercus slightly longer than cerci.

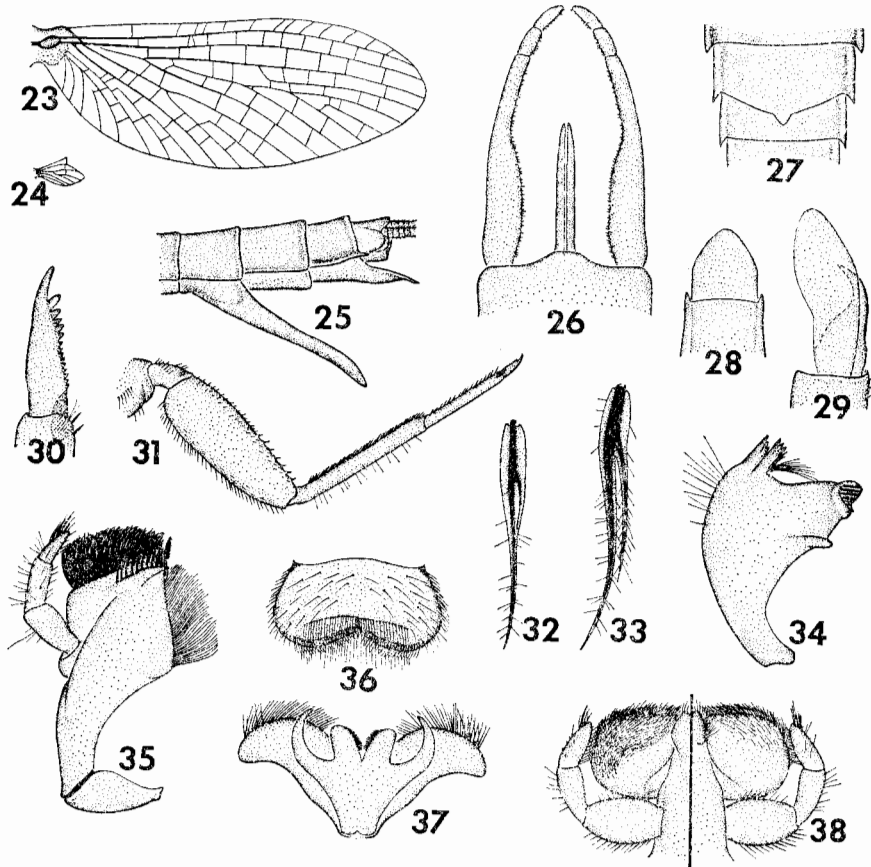
Type species, *M. scotti* (Eaton), originally placed in *Hagenulus*.

Eaton (1913) described *Hagenulus scotti* from male and female imagos. Recently one of us (*M. T. G.*) associated the adults and nymph of this species on Mahé Island. Evidence from nymphal and adult structure indicates that this species should be placed in a separate genus.

*Maheathraulius* can be differentiated from all other genera of the Leptophlebiidae by the following combination of characters. In the imago, (1) vein  $MP_2$  of fore wings is independent of vein  $MP_1$  except in very occasional specimens, (2) female imago possesses a long egg guide or ovipositor extending to posterior margin of abdominal segment ten, (3) forceps segment one of male genitalia is long (fig. 26) and (4) tarsal claws are dissimilar, one apically hooked, the other obtuse, pad-like. In the nymph,

(1) abdominal gill one is long, slender and consisting of one filament. (2) abdominal gills 2-7 are long, slender and bifurcate, (3) segment three of the labial palpi is three-fourths length of segment two and (4) posterolateral spines present on abdominal segments 6-9, those on segments 8 and 9 larger.

*Maheathraulius* is most closely related to the *Masharikella-Thraulius* complex; in the adult stages it can be distinguished from the complex by the venation of the fore wings,



FIGS. 23-38.—*Maheathraulius scotti* (Eaton) comb. n.: (23) fore wing; (24) hind wing in proportion to fore wing; (25) adult female ovipositor, lateral view; (26) male genitalia; (27) nymphal female ovipositor, ventral view; (28) tenth sternum of female; (29) male fore pretarsal claw; (30) nymphal fore claw; (31) nymphal fore leg; (32) abdominal gill 1; (33) abdominal gill 4; (34) left mandible; (35) left maxilla; (36) labrum; (37) hypopharynx; (38) labium.

the female egg guide or ovipositor and the male genital forceps. The mouthparts of *Maheathraulius* resemble those of the *Masharikella-Thraulius* complex, but the gills are reminiscent of those of the *Hagenulus*-type genera in the West Indies. *Maheathraulius* can be differentiated from the West Indian genera by the form of the first abdominal gills and mouthparts and from the *Masharikella-Thraulius* complex by the form of the gills and the posterolateral spines.

*Maheathraulius scotti* (Eaton), **comb. n.** (figs. 23-38)

*Hagenulus scotti* Eaton, 1913, *Trans. Linn. Soc. Lond. (Zool.)* 15 : 433.

*Male imago* (in alcohol).—Upper portion of eyes orange-brown, lower portion dark grey. Thorax light brown, sutures paler, fuscous markings on pleurae near leg bases. Coxae of legs brown; femora and trochanters pale yellowish-brown, femora with a fuscous band near middle and at apex; remainder *Proc. R. ent. Soc. Lond. (B)*. 33 (7-8). Pp. 117-124, 38 figs. 1964. 4§§

of fore legs pale, except for an apical fuscous band on tibiae; remainder of mid and hind legs pale, except for a median and apical fuscous spot near middle on femora, and with dark dorsal and ventral edges at apex. Membrane of wings hyaline; veins light brown, darker at base. Abdominal segments 1-6 hyaline, 7-10 opaque; a fuscous posterior band and fuscous lateral margins on terga 1-7; terga 8 and 9 washed with fuscous; submedian fuscous triangles on sterna 1-3. Genitalia, paracercus and cerci pale.

*Female imago* (in alcohol).—Eyes black. Head fuscous. Thorax light brown, sutures paler, but darker at bases of legs. Coxae of legs fuscous, remainder of legs light brown except for a median and apical fuscous band on femora, apex of tibiae fuscous on fore legs. Membrane of wings hyaline, veins brown. Abdominal terga fuscous, posterior and lateral margins darker; sterna pale brown, with light submedian fuscous triangles on sterna 1-3, ovipositor brown, extending to posterior margin of segment ten. Paracercus and cerci pale.

*Body*.—Female, 3.4 mm.; male, 3.8 mm. Fore wings: female and male, 3.8 mm.

*Nymph* (in alcohol).—Body fuscous, sterna paler. Legs, paracercus and cerci pale, markings on legs as in imago. Gills greyish-blue.

New localities for this species are: Seychelles: Mahé Island, Le Niolle, c. 1000 feet, 15-19.viii.62; Seychelles: Mahé Island, Beau Vallon, 100 feet, 16.viii.62. One nymph is in the collections of the British Museum (Natural History) and four nymphs in the collections of University of Utah.

The specimens collected by *M. T. G.* are darker in colour than those from which Eaton (1913) described the species. They were caught as subimagos at rest on vegetation and in flight over the Le Niolle River in the late afternoon. Nymphs were abundant on the underside of small rocks and stones. They run actively over the stones when removed from the water, in much the same way as *Euthraulius*. No other Ephemeroptera, either adults or nymphs, were seen, despite systematic collecting in this river and in a small number of other streams. Thus the known mayfly fauna of the Seychelles is confined to the single family, Leptophlebiidae, with two endemic genera, *Maheathraulius* and *Hagenulodes*.

#### REFERENCES

- BRINCK, P., 1957, Reproductive system and mating in Ephemeroptera. *Opusc. Ent.* **22** : 1-37.
- DEMOULIN, G., 1954, Les Éphéméroptères Leptophlebiidae de Bornéo. *Bull. (Ann.) Soc. ent. Belg.* **90** : 123-31, 4 figs.
- EATON, A. E., 1882, An announcement of new genera of the Ephemeridae. *Ent. mon. Mag.* **18** : 207-8.
- 1913, The Percy Sladen Trust Expedition to the Indian Ocean in 1905, under the leadership of Mr. Stanley Gardiner, M.A. No. 26, Ephemerida. *Trans. Linn. Soc. Lond. (Zool.)* **15** : 433-4, 1 fig.
- GILLIES, M. T., 1951, Further notes on Ephemeroptera from India and South East Asia. *Proc. R. ent. Soc. Lond. (B)* **20** : 121-30, 22 figs.
- KIMMINS, D. E., 1956, New species of Ephemeroptera from Uganda. *Bull. Brit. Mus. (nat. Hist.) Ent.* **4** : 69-87, 31 figs.
- 1960, Notes on East African Ephemeroptera, with descriptions of new species. *Ibid.* **9** : 339-55, 10 figs.
- MORRISON, E. R., 1919, The mayfly ovipositor, with notes on *Leptophlebia* and *Hagenulus*. *Canad. Ent.* **51** : 139-46, pls. 10-11.
- TJØNNELAND, A., 1960, The flight activity of mayflies as expressed in some East African species. *Arb. Univ. Bergen, Mat.-Naturv.* **1** : 1-88, 49 figs., 11 tables.
- TRAYER, J. R., 1960, Uruguayan mayflies. Family Leptophlebiidae: Part II. *Rev. Soc. Uruguayana Ent.* **4** : 19-28, 20 figs.
- ULMER, G., 1909, *Ephemeriden von Madagaskar und den Comoren. Reise in Ostafrika in den Jahren 1903-05* **2** : 365-8, 7 figs.



FROM  
**THE PROCEEDINGS OF THE  
ROYAL ENTOMOLOGICAL  
SOCIETY OF LONDON**

**The Royal Entomological Society of London,  
41, Queen's Gate, S.W.7**