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New Genera and Species of the Family Baetidae from West-Malaysia (River Gombak)

(Insecta: Ephemeroptera)

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Abstract

The nymphs of 15 new species of Baetidae from the River Gombak, West-Malaysia are described; characteristics are illustrated. Thirteen of the species belong to the genus *Baetis*, and two form monotypic genera. Some of the *Baetis* species are morphologically similar to European species groups. Six of the thirteen *Baetis* species have a number of morphological characteristics in common with the four species of the European *atrebatinus* group and with the North American *propinquus* group. To distinguish the Malaysian species geographically from the European *atrebatinus* group and the North American *propinquus* group they are placed in the newly proposed Oriental *molawinensis* group (p. 274). The new Genus No. 1 sp. 1 appears to be related to the genus complex *Procloeon* Bengtsson-*Centroptilum* Eaton, whereas, Genus No. 2 sp. 1 appears close to the genus *Centroptella* Braasch & Soldán (1980). Longitudinal distribution of the Baetidae in the River Gombak is given. The relationships of the newly described species to known species groups are discussed and a key is given for the nymphs of the 13 *Baetis* species treated in this paper.

Introduction

The beatid species described here were collected by Dr. J. E. Bishop during his comprehensive investigation of a small Malaysian River, Sungai Gombak (Sungai = River), during 1969–1971 (Bishop 1973). Nymphs of 15 new species, included in three genera of Baetidae are described: 13 of the genus *Baetis* and one species each of two new genera. Some of the *Baetis* species show a close relationship to European and North American species groups of this genus. The new Genus No. 1 sp. 1 appears most closely related to the genus *Centroptilum* Eaton and Gen. No. 2 sp. 1 shows a number of morphological characteristics similar to the genus *Centroptella* Braasch & Soldán (1980). – From the same material a new genus and species, *Raptobaetopus orientalis*, was previously described (Müller-Liebenau 1978a, 1978b, 1980a). Two more species of known genera are also described in advance, viz. *Platybaetis bishopi* (Müller-Liebenau 1980c) and *Pseudocloeon verum* (Müller-Liebenau 1981).

According to the Catalogue of the Ephemeroptera of the Indian Subregion of the Oriental Region published by Hubbard & Peters in 1978, no species of the genera *Baetis* or *Pseudocloeon* were known from the Malayan Peninsula. According to that catalogue the distribution of *Cloeon bicolor* Kimmins (♂, ♀) and *C. kimminsi* Hubbard (♀) in Malaysia is doubtful. *Cloeon marginale* Hagen (♀) occurs in the neighbouring islands of Java and Sumatra and *Procloeon bimaculatum* Eaton (♂, ♀) in Java, Sumatra and Thailand. *Procloeon harveyi* Kimmins (♂, ♀) is known from Thailand and Malaysia. From these species either both male and female or only the female is known, no nymphs are described.

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In addition to the previously described species from Dr. Bishop's collection – *Raptobaetopus orientalis, Platybaetis bishopi, Pseudocloeon verum* – the 15 species studied here are the first nymphal descriptions of Baetidae from Malaysia.

The holotypes and some paratypes are deposited in Zoologische Staatssammlung, München. Some paratypes are deposited in Laboratory of Aquatic Entomology, Florida A & M University, Tallahassee, Florida.

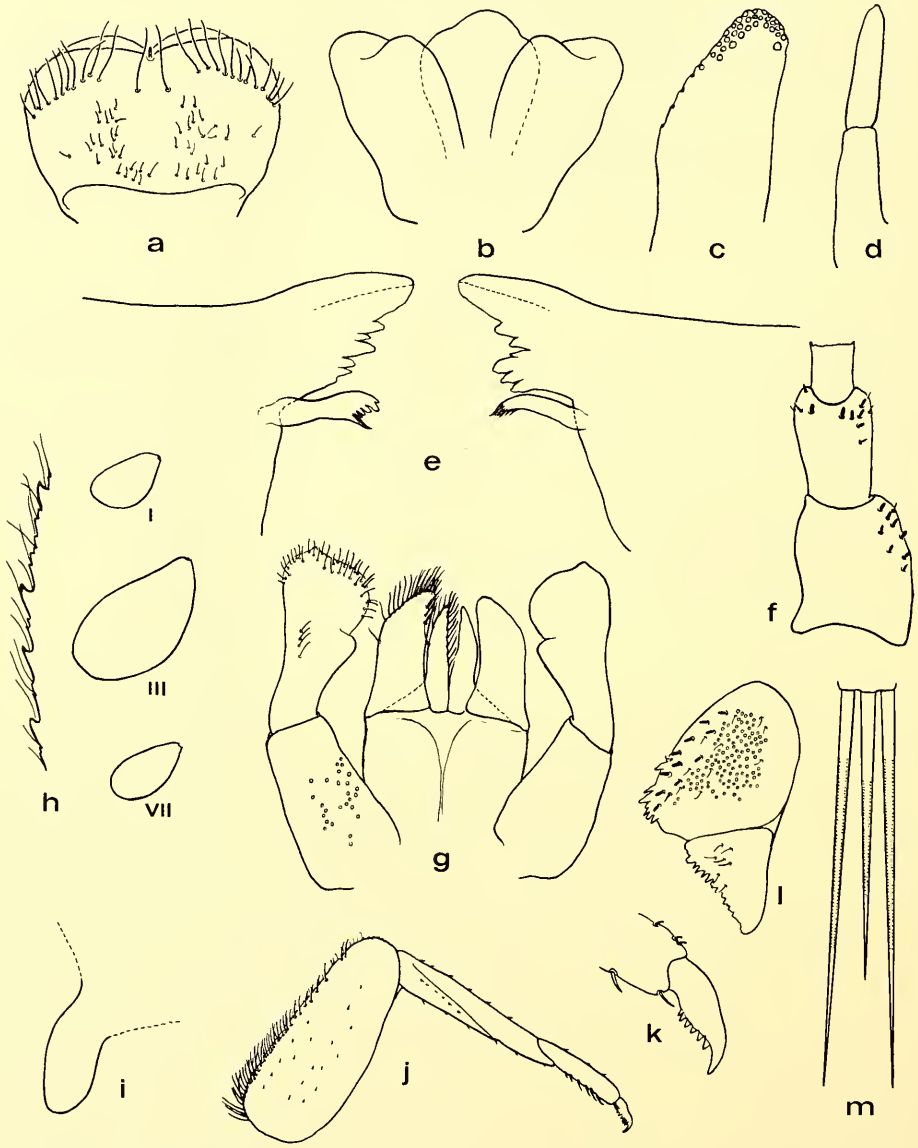

Fig. 1: Nymph of *Baetis illiesi* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin and gills I, III and VII; i) left hind wing pad; j) leg; k) claw; l) paraproct; m) caudal filaments

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Descriptions

1. *Baetis illiesi* sp. n. (Figs. 1, 16, 34)

Material: 20 nymphs; station I + U. T.[1]), II.

Body length ca. 6,5 mm, cerci ca. 3,2 mm, terminal filament ca. $^3/_4$ the length of cerci. – Colour pattern, surface and posterior margin of terga as in Figs. 16, 34. Caudal filaments light brownish with darker band near middle (bristles are darker than caudal filaments). – Hind wing pads of general size (Fig. 1i). – 7 pairs of abdominal gills.

The morphological characters show that *B. illiesi* sp. n. can be placed in the European *rhodani*-group. These characters include the stout bristles on the basal segments of the antennae (Fig. 1f), the same kind of bristles on the paraprocts (Fig. 1l), terga and posterior margins of the terga, no spines on posterior margin of terga (Fig. 34). The colour pattern on the surface of the abdomen (Fig. 16) also resembles the European *B. rhodani*. – *B. illiesi* sp. n. differs from *B. rhodani* mainly by the labial palpus and the lack of pointed bristles on outer margin of abdominal gills.

Holotype: 1 dissected nymph on slide preparation. Malaysia: Trib. of Gombak Riv., 13 $^1/_4$ mi. N. of Kuala Lumpur on Bentong road. 30.10.1969, leg. J. E. Bishop.

Paratypes: 2 slide preparations (mouth-parts and legs), 18 nymphs in alcohol: trib. of Gombak Riv., 13$^1/_2$ mi. N. of Kuala Lumpur on Bentong road; Sta I, trib. of Gombak Riv., 16$^1/_2$ mi. N. of Kuala Lumpur on Bentong road; Sta II, Gombak Riv., 16$^1/_2$ mi. N. of Kuala Lumpur; trib. of Gombak Riv., 21 mi. N. of Kuala Lumpur.

Baetis illiesi sp. n. is dedicated to the late friend and colleague Prof. Dr. J. Illies.

2. *Baetis minutus* sp. n. (Figs. 2, 17, 35)

Material: 7 nymphs, station IV.

Body length: ca. 3,5 mm, cerci ca. 1,7 mm, terminal filament only a little shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 17, 35. Caudal filaments with dark band near the middle. – Hind wing pads lacking. – Gills: 7 pairs present. – Legs: front leg as in Fig. 2i, outer margin of tibia of mid and hind leg with comparatively more bristles than tibia of front leg, claws comparatively narrow and elongate. All three segments of legs densely covered with scales and scale bases.

The shape and bristle formation of the mouthparts, the shape of the scales and scale bases on the terga, the hind margins of the terga (Fig. 35) and the dorsal colour pattern of the pronotum and abdomen (Fig. 17) indicate a close relationship to the European *niger*-group. *B. minutus* sp. n. differs mainly from these species (*B. niger* and *B. digitatus*, Müller-Liebenau 1974) by the presence of seven pairs of abdominal gills and by the lack of hind wing pads.

Holotype: 1 dissected nymph on slide preparation: Malaysia: Gombak Riv. 6$^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road. 8.3.1969, leg. J. E. Bishop.

Paratypes: 2 dissected nymphs on slide preparation (1 partly dissected), 5 nymphs in alcohol, same location as Holotype.

3. *Baetis laetificus* sp. n. (Figs. 3, 18, 36, 36a)

Material: 2 nymphs, station I, II.

Body length: ca. 4,4 mm, cerci ca. 2,5 mm, terminal filament slightly shorter than cerci. – Colour pattern as in Fig. 18. Surface and posterior margin of terga as in Fig. 36; posterior margin of terga I–V without or with tiny spines, terga VI–X with spines, increasing in size. Legs and caudal filaments light

1) Here and in the following descriptions "U. T." means Upper Tributaries (also refers to Bishop, 1979)

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brownish. – Glossa on dorsal surface with apical group of several bristles (Fig. 3g). – Hind wing pads of normal size. – Gills: lost on both specimens. This species probably has only 6 pairs of gills because gill bases only of pairs II–VII are clearly sclerotized (Fig. 18). Legs: numerous scales and scale bases as on terga on all leg segments. Paraproct with tongue-like prolongation at inner apical edge (Fig. 3k).

Baetis laetificus sp. n. is closely related to both species of the European *muticus*-group (*B. muticus* and *B. navasi,* MÜLLER-LIEBENAU 1974) according to the right prostheca, 6 pairs of abdominal gills, paraprocts with posterior projection at apex of inner margin. *B. laetificus* sp. n. differs from both European species mostly by the lack of spines on posterior margin of terga I–V, by the pronotum which is comparatively straight on the frontal and lateral margins (Fig. 18); whereas, these are more curved in *B. muticus* and *B. navasi,* and by the colour pattern.

Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., Univ. of Malaya Studies Center, $16^1/_2$ mi. N. of Kuala Lumpur on Bentong road. 16.10.1969, leg. J. E. Bishop.

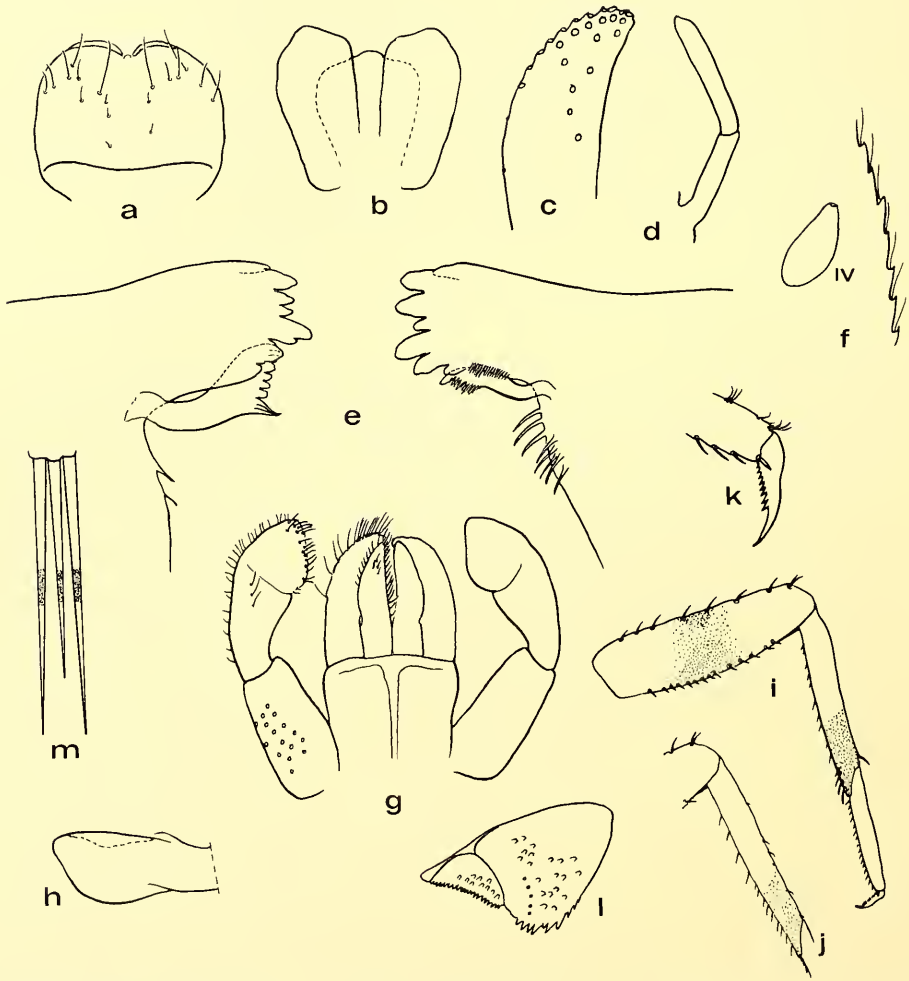

Fig. 2: Nymph of *Baetis minutus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) part of gill margin and gill IV; g) labium; h) left half of metanotum (hind wing pads absent); i) 1st leg; k) claw; l) paraproct; m) caudal filaments

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Paratype: 1 dissected nymph on slide preparation: trib. of Gombak Riv., 16 1/2 mi. N. of Kuala Lumpur on Bentong road. 9.1.1969.

The following two species, *Baetis mirabilis* sp. n. and *Baetis gombaki* sp. n. are closely related to each other. A special common character is the presence of several small tubercles at the apical margin of the third labial segment; each tubercle is marked by a bristle (Fig. 4b, f and Fig. 5g). The two species are separated mainly by a difference in the number of teeth at the inner margin of the paraprocts (Fig. 4i and 5i) and by the posterior margins of the terga of the proximal segments (Fig. 37 and 38). Both species appear to be near to the European *gracilis* group.

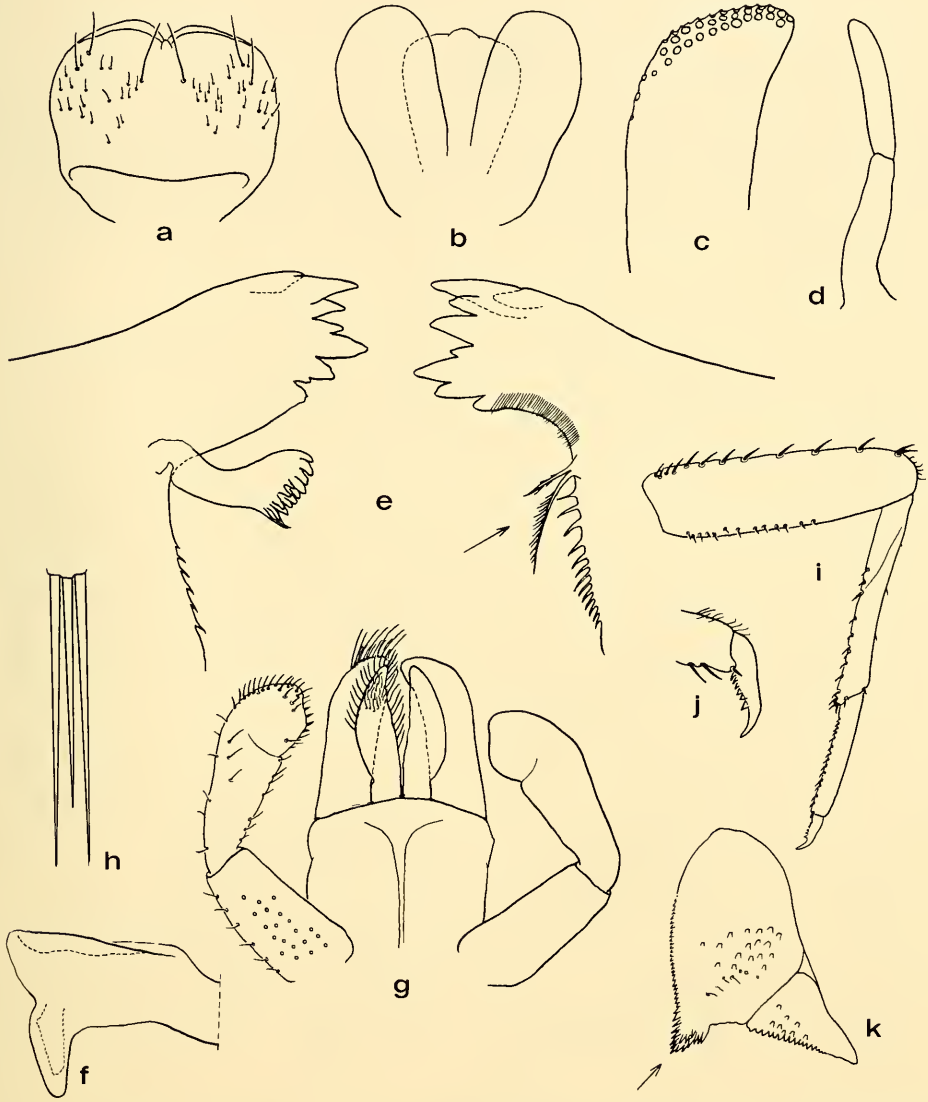

Fig. 3: Nymph of *Baetis laetificus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) left half of metatergum with hind wing pad; g) labium; h) caudal filaments; i) leg; j) claw; k) paraproct

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4. *Baetis mirabilis* sp. n. (Figs. 4, 19, 37)

Material: 11 nymphs, station II, III, V.

Body length: ca. 3,9 mm, caudal filaments broken. – Colour pattern, surface and posterior margins of terga as in Figs. 19, 37. Spines on posterior margin are sparse and very small on terga I–IV, then increasing in size. Legs light. – Hind wing pads well developed. – Gills: 7 pairs. – Labial palpus: 3rd segment with 4 or 5 small tubercles at apex, each with one bristle (Fig. 4f). – Legs: tibia of all three legs on outer margin with clavate bristles; tibia of front leg with only one such bristle, tibia of mid and hind legs with about 4–6 such bristles (Fig. 4j).

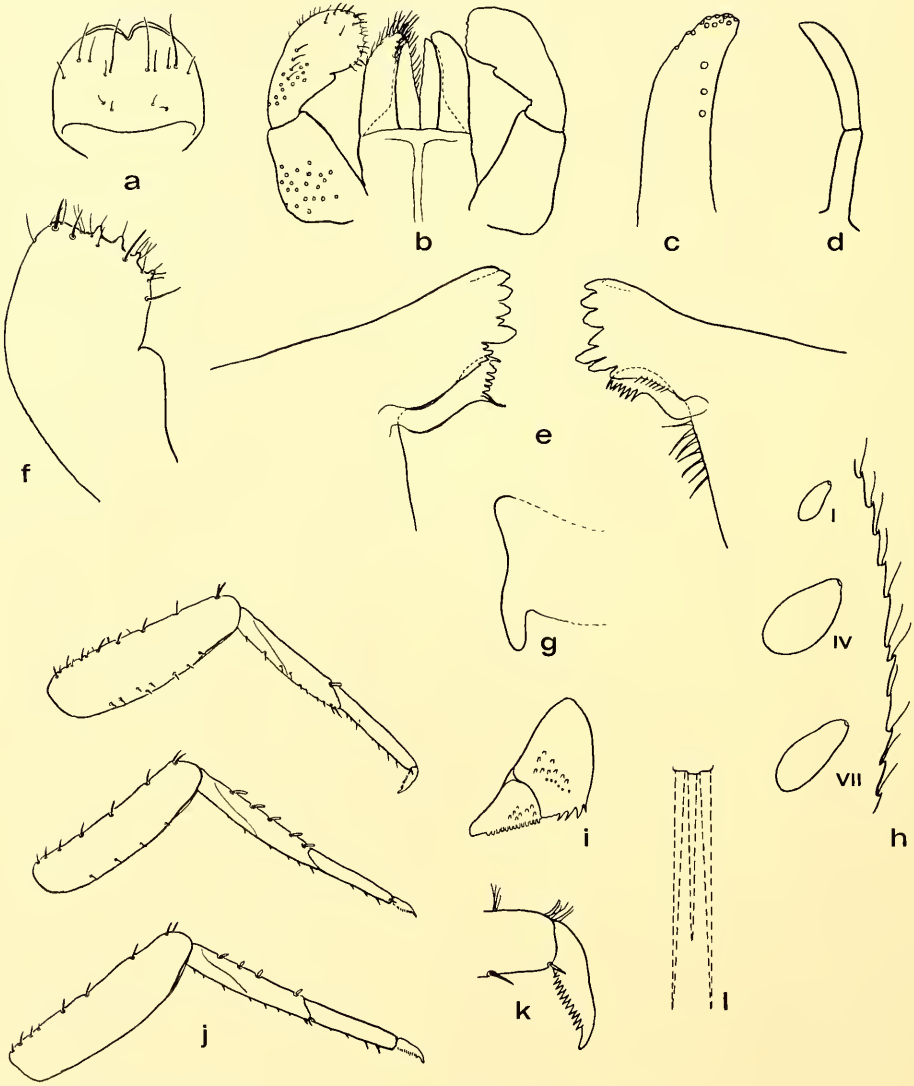

Fig. 4: Nymph of *Baetis mirabilis* sp. n.: a) labrum; b) labium; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) terminal segments of labial palpus; g) left part of metatergum with hind wing pad; h) part of gill margin with gills I, IV and VII; i) paraproct; j) legs 1, 2, 3; k) claw; l) presumed lengths of caudal filaments

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Compared to the European species groups, *Baetis mirabilis* sp. n. mostly fits within the *gracilis* group because of the mouthparts and the clavate bristles on the outer margin of the tibia (MÜLLER-LIEBENAU 1974: 34–35).

Holotype: 1 dissected nymph: Malaysia: Gombak Riv., 16½ mi. N. of Kuala Lumpur nr. Bentong road. 6.2.1969, leg. J. E. Bishop.

Paratypes: 6 slide preparations, 3 nymphs in alcohol: Gombak Riv., 4½ mi. N. of Kuala Lumpur nr. Bentong road, 6.2.1969; Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road, 6.2.1969 and 8.3.1969; Gombak Riv., University of Malaya Studies Center, 16½ mi. N. of Kuala Lumpur on Bentong road, 6.2.1969; trib. of Gombak Riv., 16½ mi. N. of Kuala Lumpur on Bentong road, 6.2.1969.

5. *Baetis gombaki* sp. n. (Figs. 5, 20, 38)

Material: 1 nymph, station III.

Body length: nearly full grown nymph ca. 4,2 mm, cerci partly broken off, ca. 2,1 mm. – Colour pattern, surface and posterior margins of terga as in Figs. 20, 38. Spines on posterior margins increasing in size from tergum I to X. Legs light. – Hind wing pads well developed. – Gills: 7 pairs. – Labial palpus: as in *B. mirabilis* sp. n., 3rd segment with 4 or 5 small tubercles at apex, each with one bristle

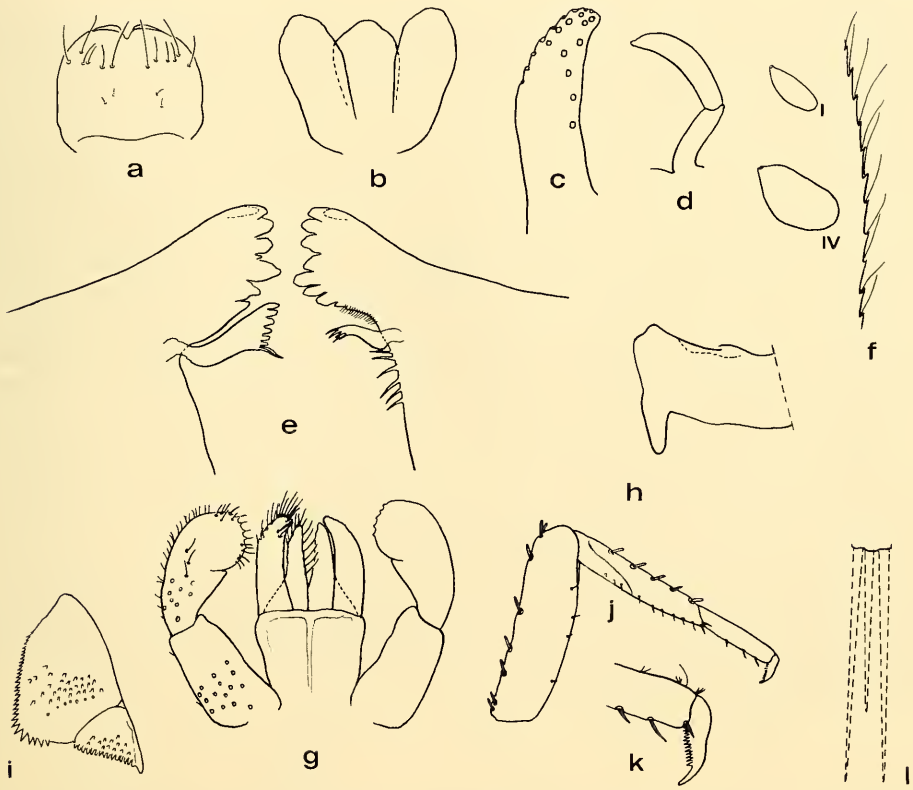

Fig. 5: Nymph of *Baetis gombaki* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa, d) maxillary palpus; e) canini area of mandibles; f) part of gill margin and gills I and IV; g) labium; h) left half of metatergum with hind wing pad; i) paraproct; j) leg; k) claw; l) presumed lengths of caudal filaments

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(Fig. 5g). – Legs: outer margin of tibia of all three legs as in *B. mirabilis* sp. n. with an increasing number of clavate bristles (Fig. 5j) from leg I to III.

Baetis gombaki sp. n. is closely related to the aforementioned *Baetis mirabilis* sp. n. Differences between both species occur in the appearance of the inner margin of the paraproct (Fig. 4i and 5i). Generally the paraprocts are a good morphological character and are not variable. As *B. mirabilis* sp. n., *B. gombaki* sp. n. also fits in the European *gracilis* group.

Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road, 8.3.1969, leg. J. E. Bishop.

No Paratypes.

The following 6 species, *Baetis diffundus* sp. n., *Baetis difficilis* sp. n., *Baetis operosus* sp. n., *Baetis multus* sp. n., *Baetis moriharai* sp. n. and *Baetis numeratus* sp. n. are closely related to one another, and also they have many morphological characteristics in common with the four species of the European *atrebatinus*-group *(B. atrebatinus, B. tricolor, B. calcaratus* and *B. balcanicus)* (Müller-Liebenau 1969, Keffermüller 1972, Müller-Liebenau & Soldán 1981). To distinguish them geographically from the European *atrebatinus* group and the North Amerian *propinquus* group (Morihara & McCafferty 1979) it appears convenient to place these 6 Malaysian species, together with two species from the Philippines (Müller-Liebenau 1982a), in one Oriental species group. The Philippine species are *Baetis molawinensis* and *B. sumigarensis.* Therefore I propose the name *molawinensis* group for the Oriental species group.

The following combination of morphological character states (with only slight deviations) is typical for the species of the *atrebatinus* complex (the combined European, North American and Oriental groups). 1. Labrum: submargin with a dense row of bristles which are clavate *(B. diffundus* sp. n. Fig. 6a), branched *(B. difficilis* sp. n. and *B. operosus* sp. n., Fig. 7a and 8a), or simple and pointed *(B. multus* sp. n., *B. moriharai* sp. n. and *B. numeratus,* Fig. 9a, 10a, 11a). In *B. multus* sp. n. and in *B. numeratus* sp. n., they are fewer in number and therefore less dense as in the other species (Fig. 9a, 11a)[2]). – 2. Antennae: distinct lobe on the outer apical margin of the basal segment (this lobe is slightly developed in *B. diffundus* sp. n., Fig. 6f, and lacking in *B. numeratus* sp. n. Fig. 11f)[2]). – 3. Maxillary palpus: distinct lateral indentation near apex (Figs. 6d, 7d, 8d, 9d). In *B. moriharai* sp. n. and in *B. numeratus* sp. n. this indentation is less clearly developed than in the other species of this group (Figs. 10d and 11d)[2]). – 4. Labium: a more or less darkly chitinised plate on the front margin of submentum (Figs. 6–11, all g). Labial palpus: large dilatation on inner apical margin of 2nd segment (Figs. 6–11, all g). – 5. Paraglossa: in most species broad in relation to its length; with three rows of densely inserted subapical bristles on ventral surface (Figs. 6–11, all c). – 6. Hypopharynx: with a "brush" of bristles at apex of median lobe (Figs. 6–11, all b). This "brush" is not as strongly developed in the European species as in the Oriental species. – 7. Tibia of all legs at inner apical margin with a longitudinal field of numerous fine bristles (Figs. 6–11, all j). – 8. The gill bases are covered by a dark prolongation on the outer hind corner of each gill-bearing segment, this prolongation increases in size from the segments I to the VII. (Figs. 21–26, 31). In the European species of the *atrebatinus* group such prolongation is indicated but less clearly developed. – The size of the hind wing pads is not characteristic in the group; they are well developed in *B. operosus* sp. n. and in *B. multus* sp. n., strongly reduced in *B. moriharai* sp. n. and in *B. numeratus* sp. n., and they are completely lacking in *B. diffundus* sp. n. and in *B. difficilis* sp. n. (Figs. 6–11, all i).

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[2]) Even if these character states are not apparent in all members of this species group, the additional morphological characters (in unique combination) are so evident that there is no doubt about the membership of any single species to the Oriental molawinensis group.

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6. *Baetis diffundus* sp. n. (Figs. 6, 21, 39)

Material: 9 nymphs, station I + U. T., II, III, IV, V.

Body length: ca. 5,1 mm, cerci ca. 3,2 mm, terminal filament slightly shorter. – Colour pattern, surface and posterior margins of terga as in Figs. 21, 39. – Labrum: submarginal bristles clavate (Fig. 6a). – Labium: 2nd segment of labial palpus with anterior margin concave (Fig. 6g). – Hind wing pads lacking. – Six pairs of abdominal gills are developed (segments II–VII).

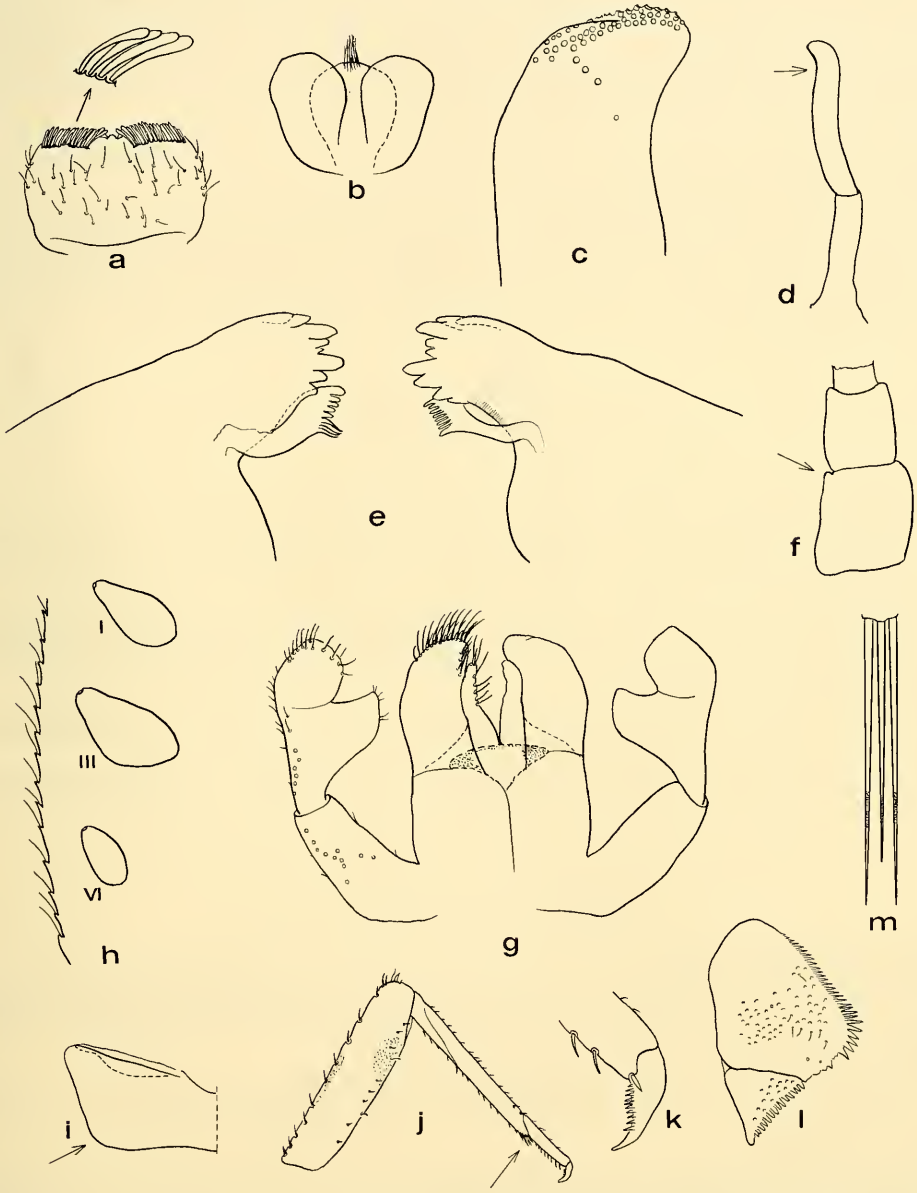

Fig. 6: Nymph of *Baetis diffundus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin and gills I, III and VI; i) left half of metatergum (no hind wing pad); j) leg; k) claw; l) paraproct; m) caudal filaments

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Baetis diffundus sp. n. is closely related to a nymph described by DEMOULIN (1968: 1–3), *Baetis* sp. from Madagascar, especially with regard to the second segment of the labial palpus with concave anterior margin. Further, it also has only 6 pairs of abdominal gills. Among other small morphological differences, the most important is the submarginal bristles on the labrum: they are clavate in *B. diffundus* sp. n. but branched in the species from Madagascar. This species has, in contrast to *B. diffundus* sp. n., hind wing pads of normal size. – Another similar species, *B. sumigarensis*, occurs in the Philippines (MÜLLER-LIEBENAU 1982a). In *B. sumigarensis* the submarginal bristles on the labrum are apically split and no lobe on outer apical margin of basal segment of antenna is developed. The scales on terga are much more densely arranged in *B. sumigarensis* than in *B. diffundus* sp. n. The most important character state common to all 3 species is the lobe on the 2nd segment of the labial palpus, which is extremely large and concave on the frontal margin (Fig. 6g) (in most species of the species complex the anterior margin is convex).

Holotype: 1 dissected nymph on slide preparation: Malaysia: Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road. 8.3.1969, leg. J. E. Bishop.

Paratypes: 4 slide preparations and 2 nymphs in alcohol: Gombak Riv., 4 1/2 mi. N. of Kuala Lumpur nr. Bentong road, 6.2.1969; Gombak Riv., 6 1/2 mi. N. of Kuala Lumpur nr. Bentong road, 8.3.1969; Gombak Riv., 9 mi. N. of Kuala Lumpur nr. Bentong road, 8.3.1969; trib. of Gombak Riv., 16 1/2 mi. N. of Kuala Lumpur on Bentong road, 14.11.1968; Gombak Riv., Univ. of Malaya Studies Center, 16 1/2 mi. N. of Kuala Lumpur on Bentong road, 6.2.1969; trib. of Gombak Riv., 21 mi. N. of Kuala Lumpur on Bentong road, 23.8.1969.

7. *Baetis difficilis* sp. n. (Figs. 7, 22, 40)

Material: 11 nymphs, station V.

Body length: ca. 5,5 mm, cerci ca. 3,1 mm, terminal filament about 1/4 shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 22, 40. Caudal filaments with a dark band near middle. – Hind wing pads lacking. – Gills: 7 pairs.

Baetis difficilis sp. n., in common with the preceding *B. diffundus* sp. n., lacks hind wing pads; it differs from *B. diffundus* sp. n. by the labial palpus, the branched submarginal bristles on the labrum and by the well developed lobe on outer apical margin of the basal segment of antenna, which is only slightly developed in *B. diffundus* sp. n.

Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., 4 1/2 mi. N. of Kuala Lumpur, nr. Bentong road. 16.10.1969, leg. J. E. Bishop.

Paratypes: 2 slide preparations and 8 nymphs in alcohol: Gombak Riv., 4 1/2 mi. N. of Kuala Lumpur nr. Bentong road 6.2.1969, 8.3.1969, 1.5.1969.

8. *Baetis operosus* sp. n. (Figs. 8, 23, 41)

Material: ca. 15 nymphs, station V.

Body length: ca. 5,7 mm, cerci ca. 3,2 mm, terminal filament about 2/5 shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 23, 41. Caudal filaments with a dark band near middle. – Hind wing pads of normal size. – Gills: 7 pairs.

B. operosus sp. n. is very similar to the preceding *B. difficilis*. The most striking difference is the absence of hind wing pads in *B. difficilis* (Fig. 7i); whereas, they are present and of normal size in *B. operosus* sp. n. (Fig. 8i).

Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., m 4 1/2 mi. N. of Kuala Lumpur. nr. Bentong road. 18.10.1969, leg. J. E. Bishop.

Paratypes: 3 slide preparations and 12 nymphs in alcohol: Gombak Riv., 4 1/2 mi. N. of Kuala Lumpur nr. Bentong road. 19.10.1968, 6.2.1969, 18.9.1969.

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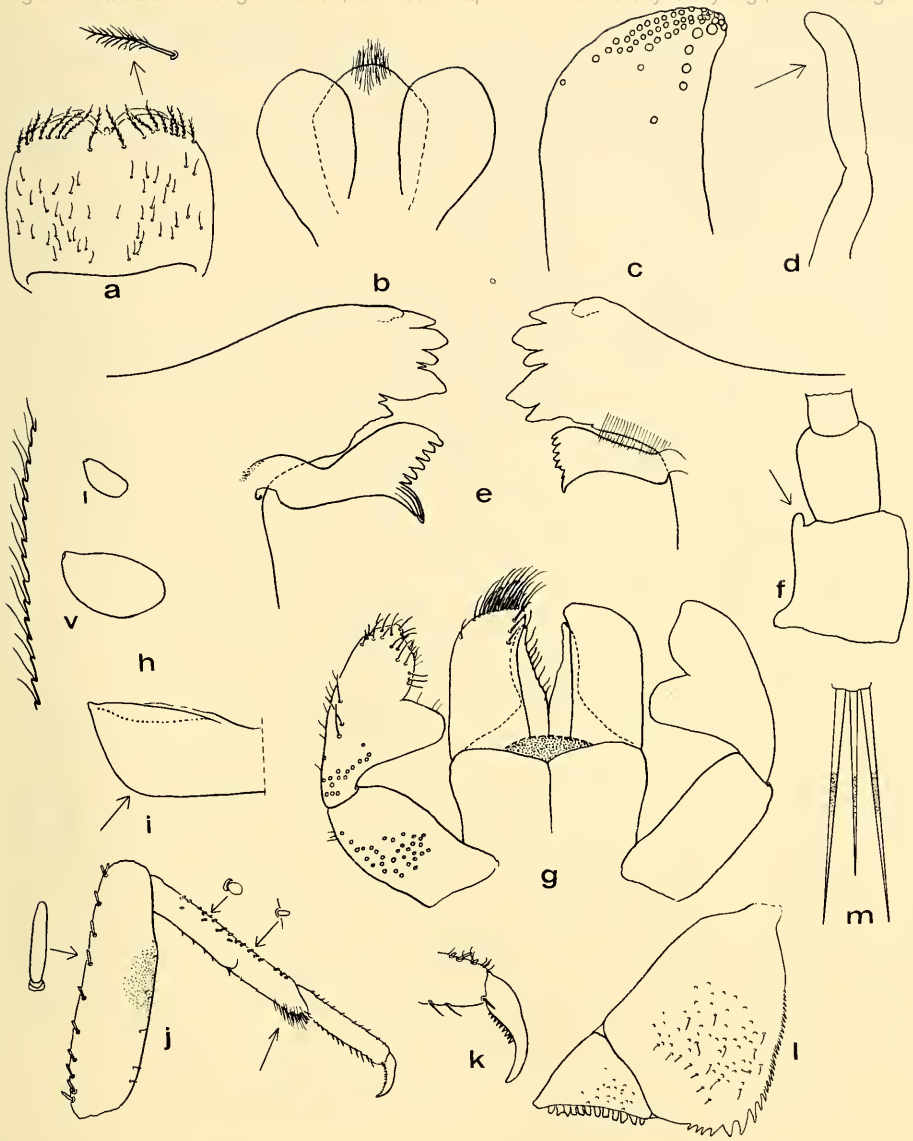

Fig. 7: Nymph of *Baetis difficilis* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin with gills I and V; i) left half of metatergum (hind wing pad absent); j) leg; k) claw; l) paraproct; m) caudal filaments

9. *Baetis multus* sp. n. (Figs. 9, 24. 42)

Material: 31 nymphs, station II, III, IV, V.

Body length: ca. 4,2 mm, cerci ca. 2,1 mm, terminal filament a little shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 24, 42. Caudal filaments with narrow dark band near apex. – Hind wing pads well developed. – Seven pairs of gills present.

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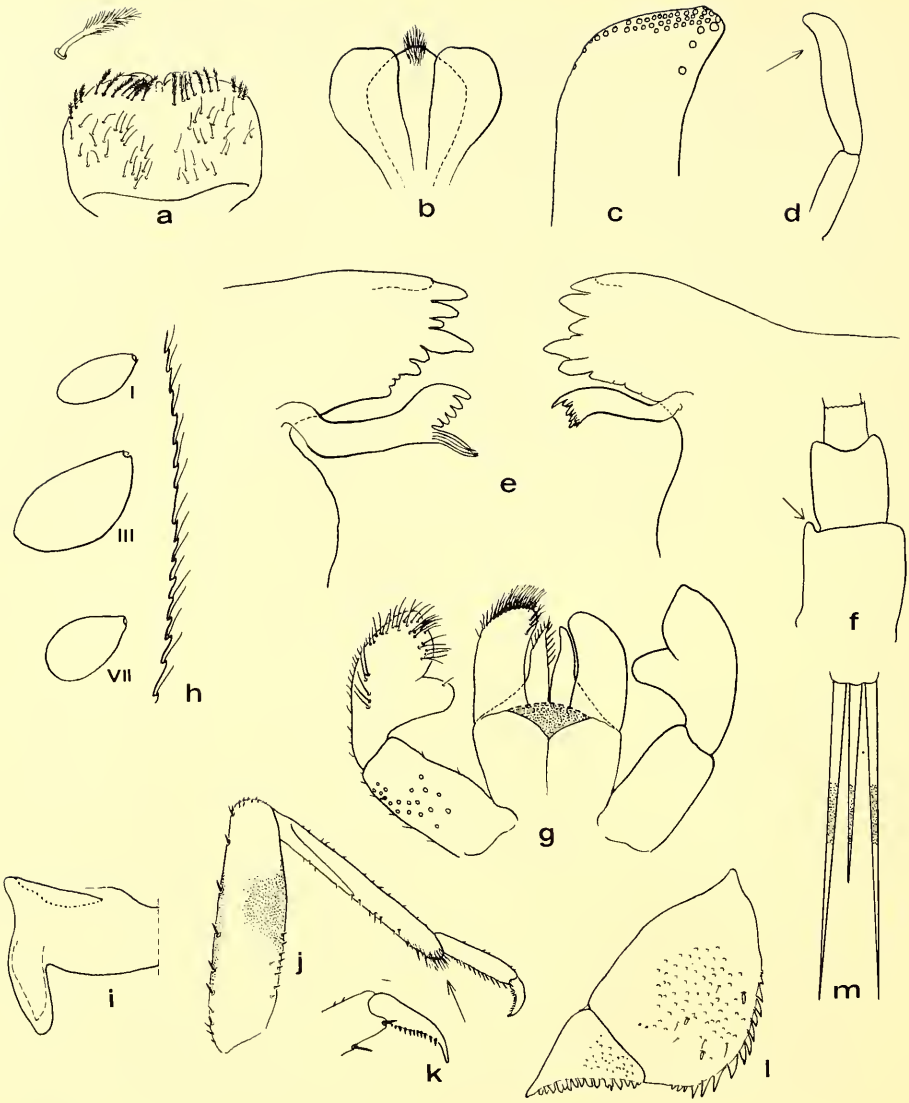

Fig. 8: Nymph of *Baetis operosus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin, gills I, III and VII; i) left half of metatergum with hind wing pad; j) leg; k) claw; l) paraprocts; m) caudal filaments

B. multus sp. n. differs from most species of this species group (except *B. numeratus* sp. n., Fig. 11), in the number of submarginal bristles on the labrum: there are only 1 + 2–3 (4) simple pointed bristles on both sides of the median line. *B. multus* sp. n. is easily distinguished from *B. numeratus* sp. n. by the well developed hind wing pads, which are reduced in *B. numeratus* sp. n. Also the colour pattern on the dorsum of abdomen is clearly different in both species (Figs. 24 and 26).

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Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., $4^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road 6.2.1969, leg. J. E. Bishop.

Paratypes: 6 slide preparations and 25 nymphs in alcohol: Gombak Riv., $4^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road 12.12.1968, 16.10.1969, 19.10.1969; Gombak Riv., $6^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road 6.2.1969, 8.3.1969; Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road, 14.1.1968, 9.1.1969; Gombak Riv., University of Malaya Studies Center, $16^1/_2$ mi. N. of Kuala Lumpur, 6.2.1969.

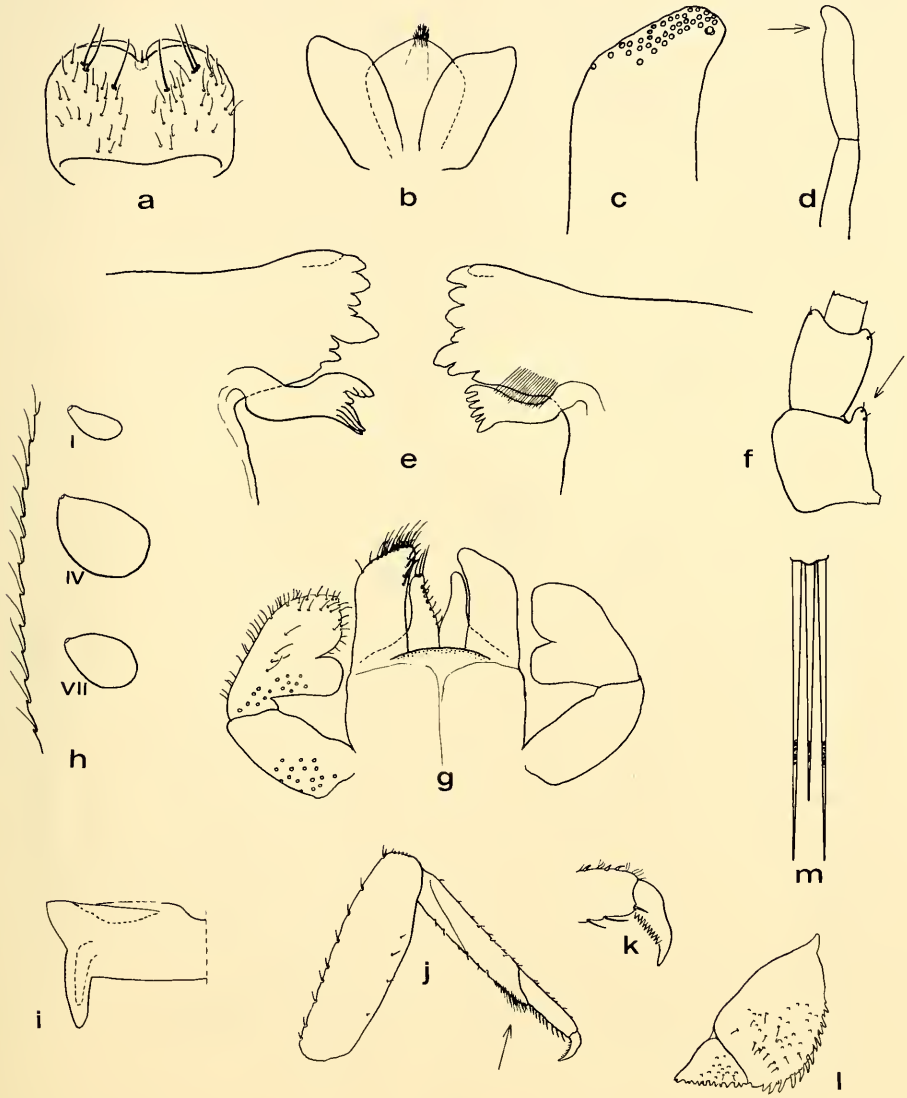

Fig. 9: Nymph of *Baetis multus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin with gills I, IV and VII; i) left half of metatergum with hind wing pad; j) leg; k) claw; l) paraproct; m) caudal filaments

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10. *Baetis moriharai* sp. n. (Figs. 10, 25, 43)

Material: 6 nymphs, station I + U. T., II, V.

Body length: ca. 4,8 mm, cerci ca. 2,2 mm, terminal filament slighthy shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 25, 43. Caudal filaments brownish at base and

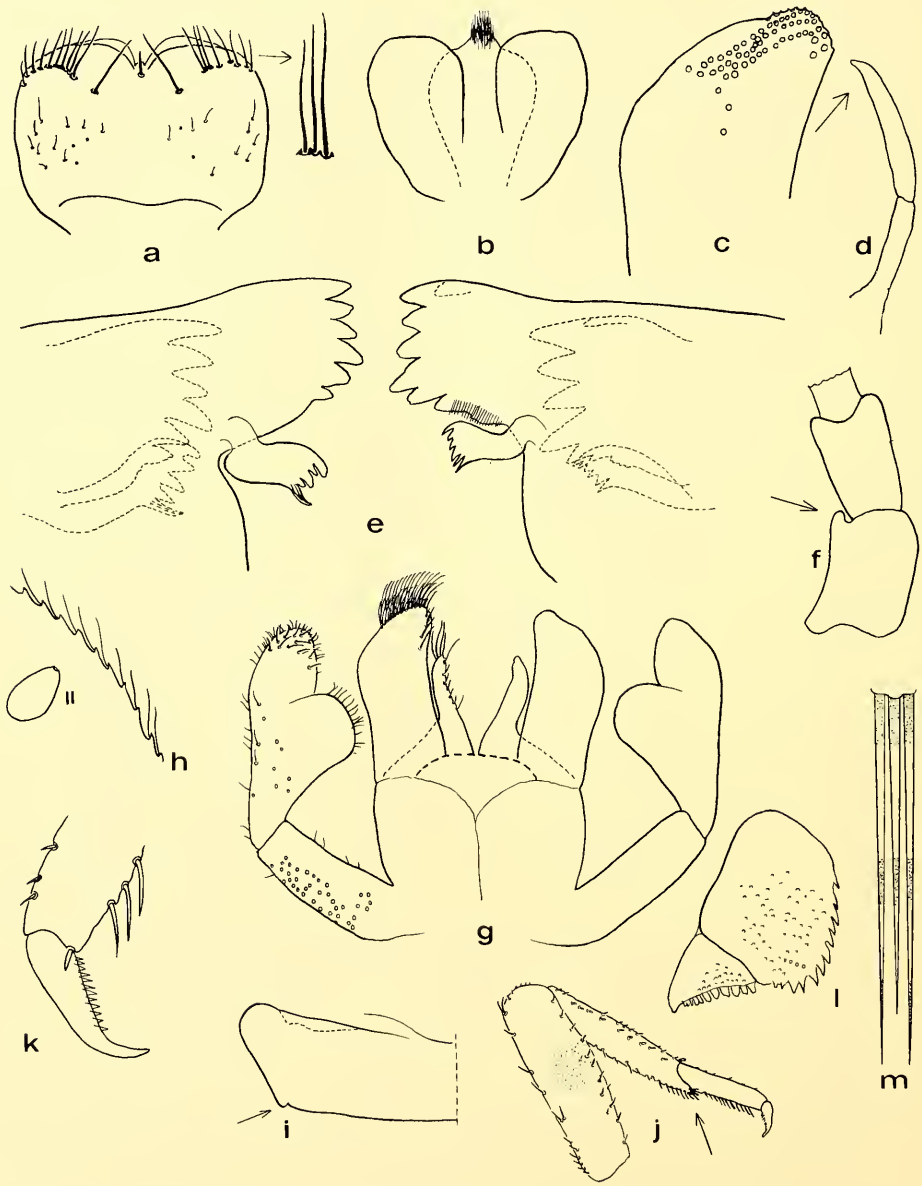

Fig. 10: Nymph of *Baetis moriharai* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin, gill II; i) left half of metatergum (minute hind wing pad indicated); j) leg; k) claw; l) paraproct; m) caudal filaments

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at apex and with a dark band near middle. Hind wing pads greatly reduced. – Legs: bristles on outer margin of tibia clavate. – Only six pairs of abdominal gills developed (II.–VII. segment). Submarginal indentation near apex of maxillary palpus smooth (Fig. 10d).

Baetis moriharai sp. n. is easily distinguished from the following most closely related *B. numeratus* sp. n. by the number of submarginal bristles on labrum, the outer apical lobe on basal segment of antennae (which is lacking in *B. numeratus* sp. n.), and the labial palpus.

Holotype: 1 dissected nymph on slide preparation. Malaysia: trib. of Gombak Riv., $16^1/_2$ mi. N. of Kuala Lumpur on Bentong road. 9.1.1969, leg. J. E. Bishop.

Paratypes: 2 dissected nymphs on slide preparation and 3 nymphs in alcohol: Gombak Riv., $4^1/_2$ mi. N. of Kuala Lumpur nr. Benton road, 19.10.1968.

Baetis moriharai sp. n. is dedicated to Dr. Dennis. K. Morihara, Pukalani, Maui, Hawaii.

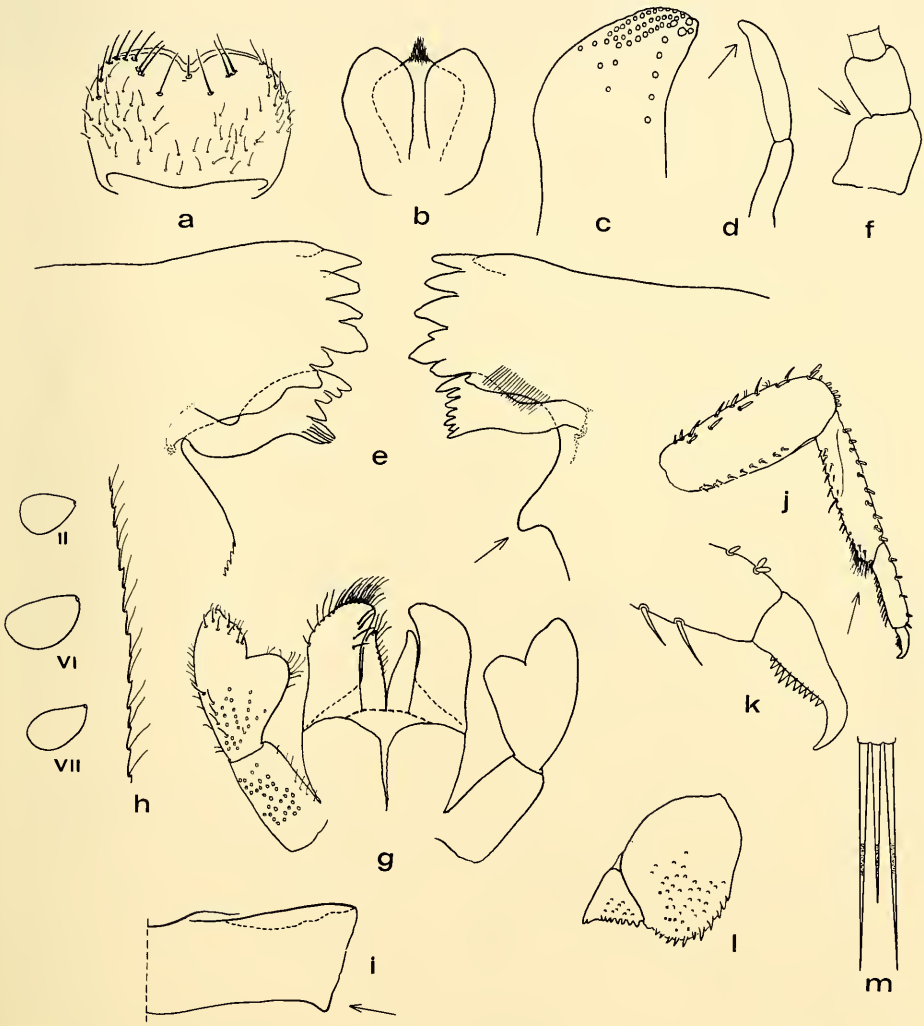

Fig. 11: Nymph of *Baetis numeratus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) basal segments of antenna; g) labium; h) part of gill margin, gills II, VI and VII; i) right half of metatergum with minute hind wing pad indicated; j) leg; k) claw; l) paraproct; m) caudal filaments

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11. *Baetis numeratus* sp. n. (Figs. 11, 26, 31, 44)

Material: 3 nymphs, station III, V.

Body length: ca. 3,5 mm, cerci ca. 2,4 mm, terminal filament slightly shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 26, 44. Some of the broad based rounded spines on posterior margin of terga are fused together at base (pointer in Fig. 44). Caudal filaments near middle with dark band. – Hind wing pads very small. – Only six pairs of gills present (segments II–VII). – Antennae without apical lobe at inner margin of basal segment. – Right mandible with projection at inner margin between prostheca and molar area (Fig. 11e). This is a diagnostic character separating this species from *Baetis moriharai* sp. n. – Maxillary palpus with smooth submarginal indentation near apex. – Legs: outer margin of tibia with clavate bristles.

Baetis moriharai sp. n. and *B. numeratus* sp. n. are the most closely related species in the Oriental *molawinensis* group; they differ in a number of common characters from the preceding four species. These include: maxillary palpus with only smooth submarginal indentation near apex; heavily reduced hind wing pads; only 6 pairs of abdominal gills; broad based and rounded spines on posterior margin of terga.

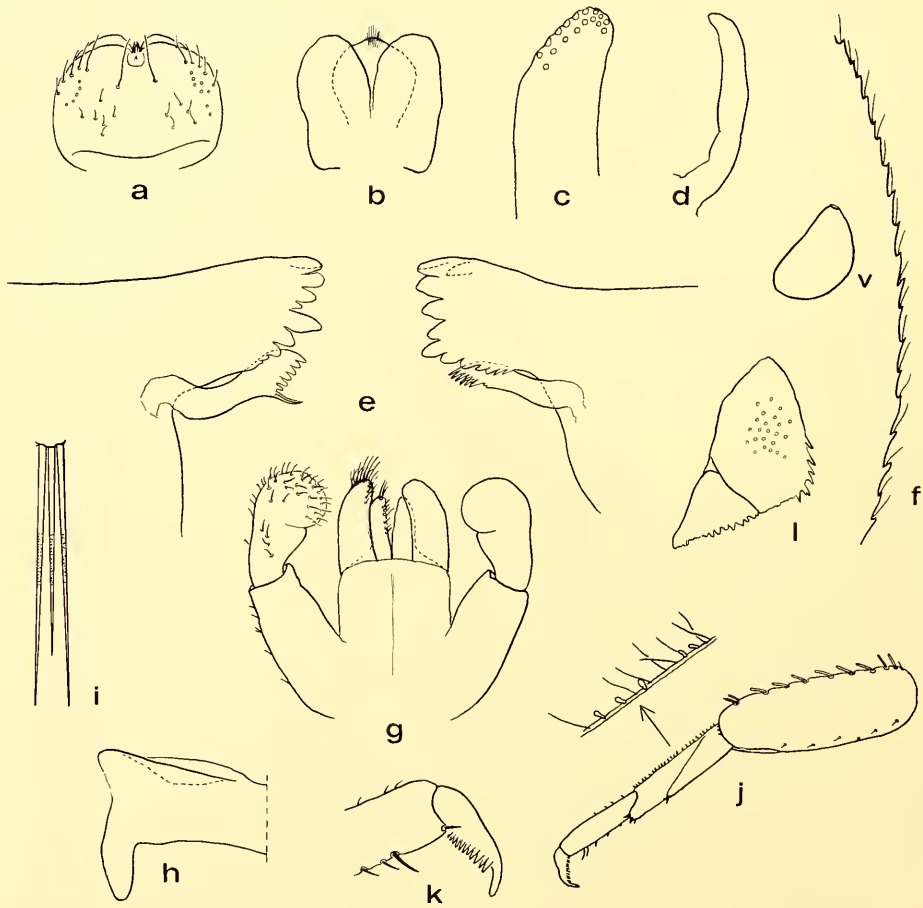

Fig. 12: Nymph of *Baetis idei* n. sp.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) part of gill margin, gill V; g) labium; h) left half of metatergum with hind wing pad; i) caudal filaments; j) leg; k) claw; l) paraproct

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Both species are easily distinguished from each other by their colour pattern (Figs. 25, 26), antennal scape (Figs. 10f and 11f). and the right mandible (Fig. 10e, Fig. 11e, pointer).

Holotype: 1 dissected nymph on slide preparation: Malaysia: Gombak Riv., $4^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road. 12.12.1968, leg. J. E. Bishop.

Paratypes: 2 slide preparations: Gombak Riv., $4^1/_2$ mi. N. of Kuala Lumpur nr. Bentong road, 19.10.1968, 12.12.1968; Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road, 14.1.1968.

12. *Baetis idei* sp. n. (Figs. 12, 27, 45)

Material: 9 nymphs, station II, III.

Body length: ca. 4,3 mm, cerci ca. 2,4 mm, terminal filament only a little shorter than cerci. – Colour pattern, surface and posterior margins of terga as in Figs. 27, 45. – Legs light; caudal filaments light with middle bristles darker. – Third segment of labial palpus shorter than wide, bulged inwards. – Hind wing pads of normal size. – Seven pairs of abdominal gills developed.

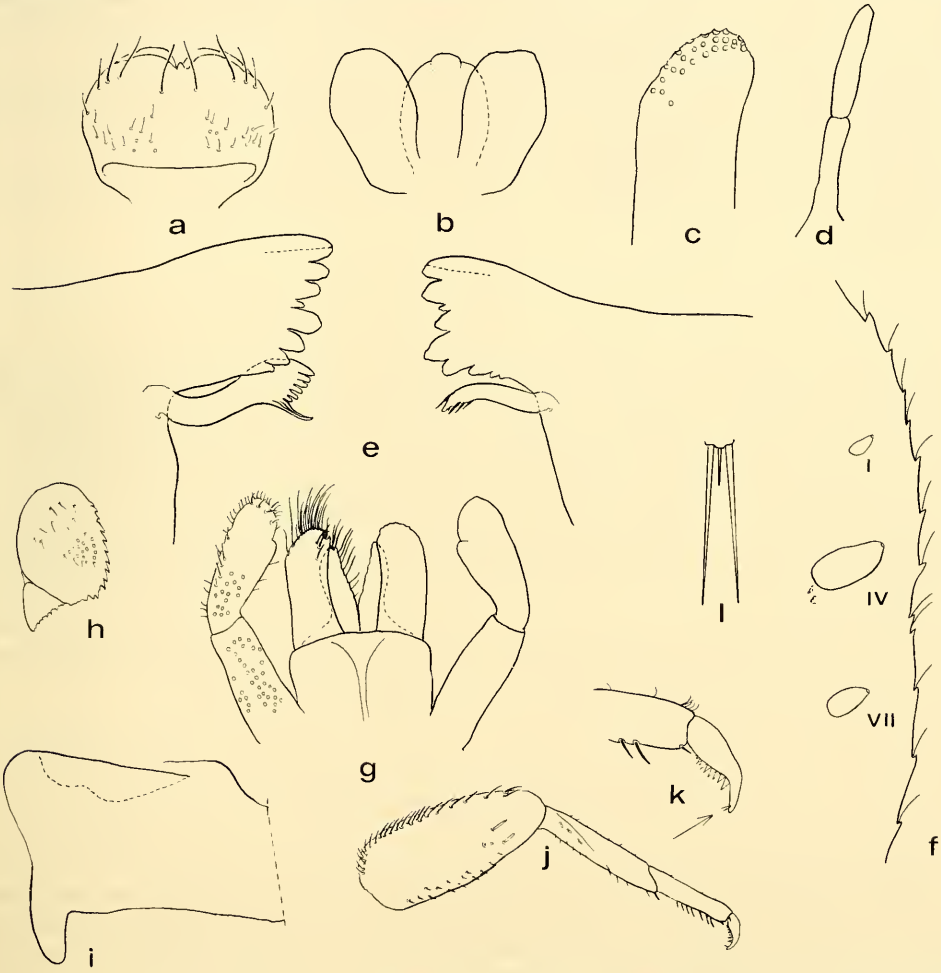

Fig. 13: Nymph of *Baetis lepidus* sp. n.: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) part of gill margin with gills I, IV and VII; g) labium; h) paraproct; i) left half of metatergum with hind wing pad; j) leg; k) claw; l) caudal filaments

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Third segment of labial palpus and the bristles on outer margin of tibia are characteristic (Fig. 12g, j). This species is not placed in any of the known European species-groups.

Holotype: 1 dissected nymph on slide preparation. Malaysia: Gombak Riv., Univ. Of Malaya Studies Center, $16^1/_2$ mi. N. of Kuala Lumpur on Bentong road. 13.1.1969, leg. J. E. Bishop.

Paratypes: 5 slide preparations and 4 nymphs in alcohol.: Gombak Riv., 9 mi. N. of Kuala Lumpur on Bentong road, 14.1.1968; Gombak Riv., University of Malaya Studies Center, $16^1/_2$ mi. N. of Kuala Lumpur on Bentong road, 6.2.1969.

Baetis idei sp. n. is dedicated to Prof. F. P. Ide, Washago, Ontario, Canada.

13. *Baetis lepidus* sp. n. (Figs. 13, 28, 46)

Material: 1 nymph, station II.

Body length: immature nymph ca. 3,1 mm, cerci ca. 2,1 mm, terminal filament reduced to about 17 segments. – Colour pattern, surface and posterior margins of terga as in Figs. 28, 46. Legs light; caudal filaments light brownish. – Hind wing pads of normal size. – Seven pairs of abdominal gills developed. – Legs: claws with 2 fine bristles near apex (Fig. 13k).

This species does not agree with any of the known European species-groups. It differs from all other species discussed by the combination of the following character states: the labial palps, claws, terminal filament, and the spines on posterior margins of terga (Fig. 46).

Holotype: dissected nymph on slide preparation: Malaysia: Trib. of Gombak Riv., $13^1/_4$ mi. N. of Kuala Lumpur on Bentong road. 30.10.1969, leg. J. E. Bishop.

No Paratypes.

Genus No. 1 (Figs. 14, 29, 47)

The mature nymph shows a number of morphological characters which are known in different combinations in other genera of the family Baetidae: Antennae: comparatively short, slightly longer than head capsule, segments more elongate towards apex. – Labium with glossa narrower than paraglossa (as in most *Baetis)*, dilation of inner apical margin of 2nd segment of palpus well developed (Fig. 14c). – Maxillary palpus long and slender with indication of three segments (Fig. 14d). Legs: inner margin of tarsus with irregular row of conspicuous bristles. – Claws: comparatively long, slender and with two rows of teeth near base. – Three caudal filaments, all of equal width at base. Although all three are broken off near base it is recognisable that the marginal bristles are of the same kind as described for the next taxon Genus No. 2 sp. 1.

Genus No. 1 resembles a number of character states from different genera, as *Baetis* Leach, *Cloeon* Leach, *Procloeon* Bengtsson, *Centroptilum* Eaton. Since only a single nymph and no coordinated imaginal material are available, it is premature to name the genus phylogenetically.

Imago ♂ and ♀ are not known.

Genus No. 1 sp. 1 (Figs. 14, 29, 47)

Material: 1♀ nymph, station II.

In addition to the above mentioned generic characters the following details might be expected to be specific: Body length: ca. 4,3 mm. – Flagellum of antenna with 21 segments. – Colour pattern as in Fig. 29. Legs light, dark band near base on femora. Bases of caudal filaments brownish. – Hind wing pads lacking. – Probably 7 pairs of gills (all gills of the single specimen are lost).

Surface and posterior margins of terga as in Fig. 47. Spines at posterior margins of terga longer on posterior 2 or 3 segments than on anterior segments.

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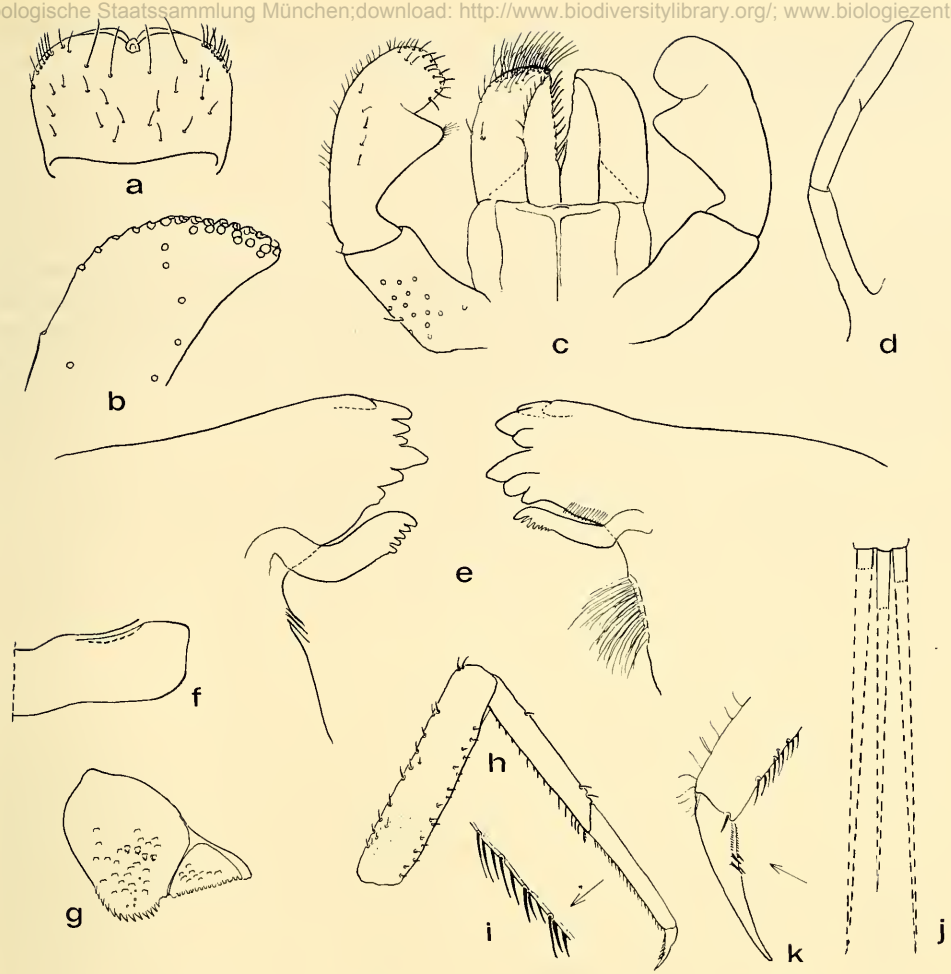

Fig. 14: Nymph of Genus No. 1 sp. 1: a) labrum; b) apex of paraglossa; c) labium; d) maxillary palpus; e) canini area of mandibles; f) right half of metatergum, hind wing pads absent; g) paraproct; h) leg; i) part of inner margin of tarsus; j) presumed length of caudal filaments; k) claw

Genus No. 2 (Figs. 15, 30, 32, 33, 48)

The main characters of this genus are known in different combinations in other genera of Baetidae. This genus is based on the following combination of morphological characters of the mature nymph (Fig. 15). Antennae: short, slightly larger than head capsule. – Labium with glossa and paraglossa of nearly same shape and size. – Maxillary palpus long, slender, twosegmented, pointed. – Legs: tibia and tarsus each with a closeset longitudinal row of extremely long, fine setae (finer than in Fig. 15j), forming a dorsal arc on the tibia and following the seam. – Gills: 7 pairs, single; gill margins smooth. – Cerci (Figs. 32, 33) comparatively short and stout, with spines on outer margin of several segments; inner margin of cerci and both sides of median terminal filament with a close-set row of long, fine bristles, which are brownish at base but hyaline and very fine towards apex (visible only with high magnification, Fig. 33). This kind of bristling on caudal filaments also occurs in the preceding Genus No. 1, further in *Cloeon, Centroptilum, Centroptella, Notobaetis, Dactylobaetis* and other genera.

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Genus No. 2 shows close relationship to *Centroptella* Braasch & Soldán 1980. But as well as in the preceding Genus No. 1 it would be premature the name Genus No. 2.

Imago ♂ and ♀ unknown.

Genus No. 2 sp. 1 (Figs. 15, 30, 32, 33, 48)

Material: 1 ♂ nymph, station II.

In addition to the above mentioned generic characters, the following details might be expected to be specific: Body length: (immature) ♂ nymph ca. 4,1 mm; Cerci ca. 1,9 mm; terminal filament slightly shorter than cerci (Fig. 32). – Colour pattern as in Fig. 30; legs brownish; tarsi distally darker. Caudal filaments darker at middle (Figs. 15h). – Flagellum of antenna with 19 elongate segments. – Maxillary palpus: second segment more than three times as long as basal segment (Fig. 15d). – Labium: dilation

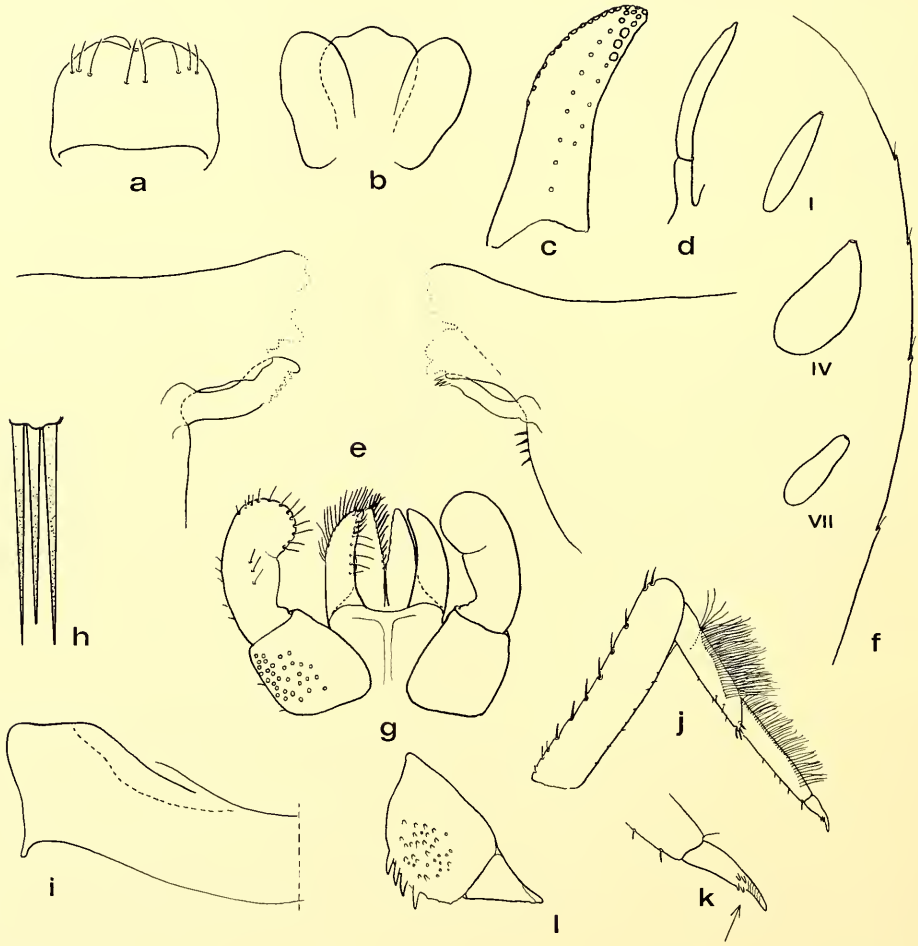

Fig. 15: Nymph of Genus No. 2 sp. 1: a) labrum; b) hypopharynx; c) apex of paraglossa; d) maxillary palpus; e) canini area of mandibles; f) part of gill margin, gills I, IV and VII; g) labium; h) caudal filaments; i) left half of metatergum (small hind wing pad indicated); j) leg; k) claw; l) paraproct

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on inner apical margin of 2nd segment of palpus only slightly developed, inner margin of 3rd segment rounded (Fig. 15g). – Mandibles: (Fig. 15e), original shape of canini unknown, probably two separated groups of canini on right mandible. – Hind wing pads reduced (Fig. 15i). – Seven pairs of gills developed, with smooth margins. Gills of segments I. and VII. narrow and elongate, the gill of segment I. extremely narrow (Figs. 15, 30). – Claw with two similar rows of denticles. – Surface and posterior margins of terga as in Fig. 48. Surface with quadrangular scale bases; some scales pointed and more elongate than in Fig. 48.

In 1980, Braasch & Soldán described the genus and species *Centroptella longisetosa* from China. The most evident morphological characters of this genus is the right mandible with the incisors deeply cleft and the right protheca 2- or more branched. Additional morphological characters (antenna, labrum, paraproct, bristle formation on tibia and tarsus of all legs, scales and scale bases on terga) show close relationship of the above described Genus No. 2 sp. 1 to *Centroptella,* also in certain respect to *Notobaetis* Morihara & Edmunds, and more remote relationship to *Centroptilum* Eaton. The only character that does not fit in this character combination is the prostheca of the right mandible, which is not branched in Genus No. 2 sp. 1. Nevertheless Genus No. 2 from Malaysia appears to be very closely related, if not synonymous to *Centroptella* Braasch & Soldán. This need not be a contradiction because we know that in the genus *Baetis* most nymphs have a "normal" prostheca. However two species have different prosthecae on right mandible: *Baetis muticus* and *B. navasi;* both are contained in one species group within the genus *Baetis.* – Additional species of *Centroptella* from Sri Lanka are described and discussed by Müller-Liebenau, 1983.

Discussion

In the baetid material collected by Dr. J. E. Bishop in 1969/1971 in the Malaysian River Gombak near Kuala Lumpur, 18 species of 6 genera of the family Baetidae are contained. Three of them were discribed in advance (p. 253), the remainder is described in this paper.

Detailed descriptions of the collecting sites in upper tributaries (U. T.) and of the Stations I–V in the Gombak River are given by Bishop (1973: 20–26). The altitude of the collecting sites is as follows: upper tributaries up to 1200 m above sea level, Station I is situated at 233,2 m, Station II at 220 m, Station III at 70,1 m, Station IV at 50,3 m and Station V at 35,6 m above sea level. The water temperatures ranged from about 20,0–26,5° C at Station I to 22,5–32,5° C at Station V.

The collecting sites show different aspects from the upper tributaries to Station I–V although at all stations there were riffle pools, boulders of different sizes, gravels of variable dimensions, rapid-waters and slow-flowing parts as well as riparian vegetation and floating leaf drifts which often are preferred habitats for baetid nymphs. Therefore there are suitable habitats for baetid nymphs at all stations.

With regard to the distribution of the baetid nymphs in the River, Bishop (1973: 212) mentions:

"At all stations they were a major component of the insect fauna, becoming a dominant at Stations IV and V where food was very abundant and the number of stenothermal predators reduced. From the numerical data, little real difference in erosional and depositional densities was obvious, but this resulted both from the heterogenous nature of the bottoms which always overlapped in physical properties and the fact that small baetids were commonly found in the interstitial spaces of the gravels, presumably feeding on the microflora growing there as described by Brown (1961) and Minckley (1963). A definite succession of species was evident (Fig. 40) but without complete associated adult and nymphal records, discussion of this is premature."

The result of a preliminary examination of the baetid nymphs of the River Gombak has been published in the monograph dealing with the limnology of the investigated River (Bishof 1973). In that publication Bishop (p. 213, Fig. 40) gives the general longitudinal distribution of the Baetidae. A recent detailed examination of the same material allows now the completion of Bishop's Figure 40 as shown in Table 1. The "unknown *Baetis*-type (cf. *Baetopus)*" proved to be a new genus and species: *Rapto-*

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No. of specimens	Species	Station I + U.T.	II	III	IV	V
2	Raptobaetopus orientalis	———				
91	Platybaetis bishopi	———	———		———	
82	Pseudocloeon verum	———	———	———	———	———
	Baetis					
20	illiesi sp.n. (= sp.C)	———	———			
9	diffundus sp.n. (= sp.E)	———	———	———	———	———
2	laetificus sp.n. (= sp.F)	———	———			
6	moriharai sp.n. (= sp.X)	———	———			———
31	multus sp.n. (= sp.B)		———	———	———	———
9	idei sp.n. (= sp.A)		———	———		
11	mirabilis sp.n. (= sp.H)		———	———		———
1	lepidus sp.n. (= sp.D)		———			
1	gombaki sp.n. (= sp.P)			———		
3	numeratus sp.n. (= sp.O)			———		———
7	minutus sp.n. (= sp.M)				———	
15	operosus sp.n. (= sp.Km)					———
11	difficilis sp.n. (= sp.Ko)					———
1	Genus No.1 sp.1		———			
1	Genus No.2 sp.1		———			

Table 1: Longitudinal distribution of the Baetidae in the River Gombak. The letters in parenthesis are the author's temporary specific designations used by BISHOP (1973, Fig. 40, p. 213), and the two later discovered species, "*Baetis* sp. O" and "*Baetis* sp. P."

baetopus orientalis (MÜLLER-LIEBENAU (1978a, 1978b, 1980a). – "*Pseudocloeon* sp. C" and "*Pseudocloeon* sp. B" are synonymous and described as *Platybaetis bishopi* (MÜLLER-LIEBENAU 1980c). – "*Pseudocloeon* type G" is a new species, *Pseudocloeon verum* (MÜLLER-LIEBENAU 1982b). – Two additional *Baetis* species were discovered in the material, viz. *B. numeratus* sp. n. (= sp. O) and *B. gombaki* sp. n. (= sp. P.). – The nymphs of the preliminary *Baetis* sp. J and *Baetis* sp. L do not belong to the genus *Baetis* but appear to be two new genera of the family: Genus No. 1 sp. 1 and Genus No. 2 sp. 1 (pp. 270, 272).

The number of nymphs collected for each species varies greatly from 4 species represented by 1 nymph each up to 82 nymphs of *Pseudocloeon verum* and 91 of *Platybaetis bishopi*. At present it would not be very accurate to make definitive conclusions regarding the species-distribution from the source and upper tributaries of River Gombak towards the mouth near Kuala Lumpur. A final aspect of the longitudinal distribution of species in the river course can not be completed until more material is studied.

Nearly all baetid nymphs were collected in the bank area and in leaf drift in upper tributaries and at Stations I–V; only a few specimens were collected in the erosional area of the River Gombak, but then nymphs of the same species also occurred in the bank area and in leaf drift.

Species composition

It is remarkable that of the thirten Malaysian *Baetis* species treated in this paper six belonge to the newly proposed *molawinensis* group (s. p. 261–269): *B. diffundus* sp. n., *B. difficilis* sp. n., *B. operosus* sp. n., *B. multus* sp. n., *B. moriharai* sp. n. and *B. numeratus* sp. n. As mentioned before not enough material is available to justify a definitive conclusion regarding the vertical distribution in the river. But

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it is obvious that these six closely related species, at places where they occur together, probably inhabit different microhabitats, and this phenomenon appears to be a case of adaptive radiation. – Further it is remarkable that four more species, closely related to each other occur in the comparatively limited area in the Gombak River. These species are *B. minutus* sp. n., *B. laetificus* sp. n., *B. mirabilis* sp. n. and *B. gombaki* sp. n., which are all morphologically similar to the European species group complex *niger-muticus-gracilis* (Müller-Liebenau 1974: 35). – One species, *B. illiesi* sp. n., is morphologically similar to the European *rhodani* group. *B. rhodani* is one of the most common and widely distributed *Baetis* species in European running waters. In the River Gombak area 20 specimens of *B. illiesi* sp. n. were collected at 4 different collecting sites in the upper tributaries and at Stations I and II. – The remaining two species, *B. idei* sp. n. and *B. lepidus* sp. n., are not correlated to any European species group. The 9 nymphs of *B. idei* sp. n. occur at Stations II and III, whereas, the single nymph of *B. lepidus* sp. n. was collected at Station II.

The microhabitats of the single specimens of both newly described genera, Genus No. 1 sp. 1 and Genus No. 2 sp. 1, are unknown. Both nymphs were collected at Station II. Judging from their morphology these species appear to prefer places with slow or with no current at all. Such niches certainly are available at Station II, as the current velocity there was from almost zero in the larger pools to 250 cm/sec in short rushing sections between boulders (Bishop 1973).

Key

In the following key only the nymphs of the species of the genus *Baetis* described in this paper are considered. The nymphs of Genus No. 1 sp. 1 and Genus No. 2 sp. 1 are easily distingushed from all *Baetis* species by their claws having two rows of denticles.

Character states similar to the European *rhodani* group:

1 stout broad blunt bristles on surfaces of scape and pedicel of antenna, paraproct, terga and posterior margin of terga (Fig. 1 and 34), pp. 255, 282 . . . . . *illiesi* sp. n.
– no such bristles occurring on respective surfaces or posterior margins of terga 2

2 terminal segment of labial palp apically bulging inward or straight, when straight with 4 or 5 small subapical tubercles, each with a bristle (Fig. 4b and f, 5g); inner apical lobe on 2. segment of labial palp only slightly developed; scale bases on terga rectangular, posterior margin of terga with pointed spines 3
– 2. segment of labial palp either comparatively large (6 species similar to the Oriental *molawinensis* group, p. 276) or of "normal" size 6

Character states similar to the European *muticus-niger-gracilis*-complex:

3 right prostheca branched into two, feathered, bristle-like structures; hind wing pads of normal size; paraproct with apical tongue-like prolongation on inner margin (Fig. 3k); gills probably on abdominal segments 2–7 only (*muticus* group, p. 257) . . . . . *laetificus* sp. n.
– right prostheca not branched, gills on abdominal segments 1–7 4

4 hind wing pads absent; outer margin of tibiae of 1st leg mostly only with 1 bristle (Fig. 2i) and with about 3 to 6 pointed bristles on legs 2 and 3; terminal segment of labial palp without tubercles (*niger* group, p. 257) . . . . . *minutus* sp. n.
– hind wing pads present, outer margin of tibia 2 and 3 with clavate bristles; terminal segment of labial palp with 4 or 5 small tubercles, 1 bristle arising from each (Figs. 4b and f, 5g) (*niger* group, p. 257) 5

5 inner margin of paraprocts with 4 to 5 spines near apex (Fig. 4i) (*gracilis* group, p. 258) . . *mirabilis* sp. n.
– inner margin of paraprocts with more than 5 denticles (Fig. 5i) (*gracilis* group, p. 259) . . *gombaki* sp. n.

6 labium with small glossa compared with broad paraglossa; 2nd segment of labial palp largely developed; maxillary palpus with inner subapical indentation (only slightly developed in *B. moriharai* sp. n. and *B. numeratus* sp. n.); basal segment of antennae with an apical lobe on outer margin (not in *B. numeratus* sp. n.) (Figs. 6–11) 7

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– glossa and paraglossa of normal proportions; 2nd segment of labial palpus rather small; maxillary palpus without submarginal indentation; antennae without apical lobe on basal segment Figs. 12–13 12

Charakter states similar to Oriental *molawinensis* group:

7 hind wing pads absent (Fig. 6i and 7i) 8
– hind wing pads of ,,normal" size (Fig. 8i and 9i) or very reduced (Fig. 10i and 11i) 9

8 labrum with a close-set row of about 15–20 clavate bristles; apical margin of 2nd segment of labial palpus slightly curved, pointed outwardly; outer apical lobe on basal segment of antennae only slightly developed (Fig. 6f), 6 pairs of abdominal gills, spines on posterior margins of terga pointed (Fig. 39) . . . . . *diffundus* sp. n.
– labrum with 1+6–7 branched bristles; 2nd segment of labial palp rounded at apex; outer apical lobe on basal segment of antennae well developed (Fig. 7f) 7 pairs of gills, spines on posterior margin of terga pointed (Fig. 40) . . . . . *difficilis* sp. n.

9 hind wing pads of "normal" size (Fig. 8i and 9i) 10
– hind wing pads highly reduced (Fig. 10i and 11i) 11

10 labrum with submarginal row of about 10 bristles (Fig. 8); 7 pairs of gills, spines on posterior margins of terga pointed (Fig. 41) . . . . . *operosus* sp. n.
– labrum with 1+2 or 3 submarginal simple, pointed bristles; 7 pairs of gills, spines on posterior margins of terga pointed (Fig. 42) . . . . . *multus* sp. n.

11 labrum with 1+ about 8 submarginal simple, pointed bristles; apical lobe on outer margin of basal segment of antennae well developed (Fig. 10f), 6 pairs of abdominal gills, spines on posterior margins of terga broad based, rounded (Fig. 43) . . . . . *moriharai* sp. n.
– labrum submarginal with 1+2 to 4 pointed bristles; no lobe on outer margin of basal segment of antennae; (Fig. 11f); 6 pairs of abdominal gills, spines on posterior margins of terga broad based, rounded, some of them fused together at base (Fig. 44) . . . . . *numeratus* sp. n.

Not included with any known species group:

12 3rd segment of labial palpus bulging outwards, outer margin of tibia with short clavate bristles, scale bases on terga numerous and slightly curved, posterior margins of terga with apically rounded spines, terminal filament only slightly shorter than cerci (Figs. 12 and 45) . . . . . *idei* sp. n.
– 3rd segment of labial palpus tapering apically, outer margin of tibia with pointed bristles; posterior margin of terga with broad based, short, rounded spines with clearly separated tip (Fig. 46); terminal filament reduced to a small number of segments (Fig. 13) . . . . . *lepidus* sp. n.

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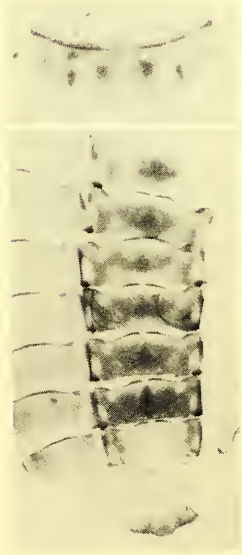

Fig. 16–20: Colour pattern of pronotum (at higher magnification) and abdomen

Fig. 16: Nymph of *Baetis illiesi* sp. n. – Fig. 17: Nymph of *Baetis minutus* sp. n. – Fig. 18: Nymph of *Baetis laetificus* sp. n. – Fig. 19: Nymph of *Baetis mirabilis* sp. n. – Fig. 20: Nymph of *Baetis gombaki* sp. n.

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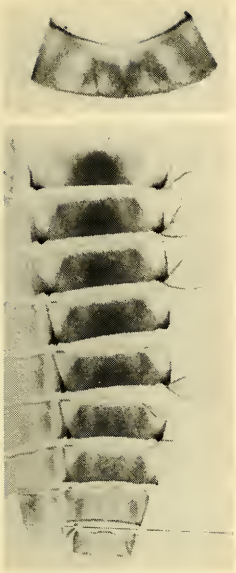

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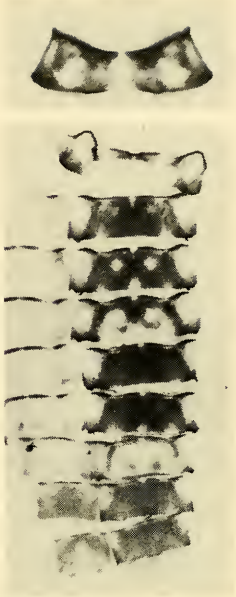

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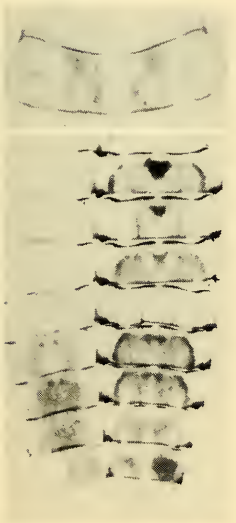

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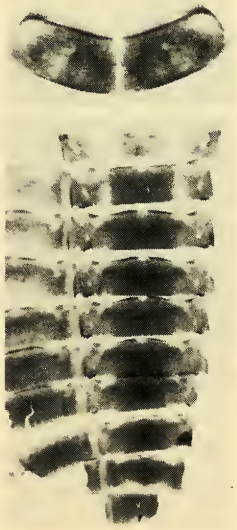

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Fig. 21–26: Colour pattern of pronotum (at higher magnification) and abdomen

Fig. 21: Nymph of *Baetis diffundus* sp. n. – Fig. 22: Nymph of *Baetis difficilis* sp. n. – Fig. 23: Nymph of *Baetis operosus* sp. n. – Fig. 24: Nymph of *Baetis multus* sp. n. – Fig. 25: Nymph of *Baetis moriharai* sp. n. – Fig. 26: Nymph of *Baetis numeratus* sp. n.

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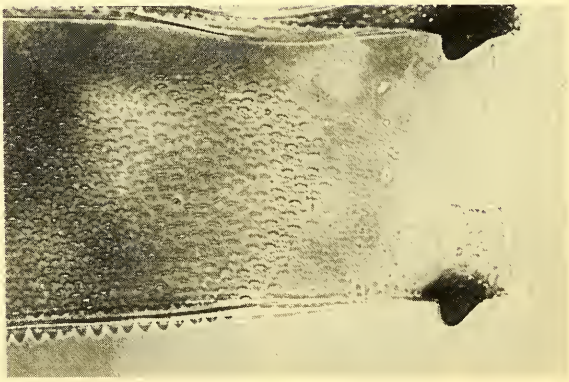

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Fig. 27–30: Colour pattern of pronotum (at higher magnification) and abdomen.
Fig. 27: Nymph of *Baetis idei* sp. n. – Fig. 28: Nymph of *Baetis lepidus* sp. n. – Fig. 29: Nymph of Genus No. 1 sp. 1 – Fig. 30: Nymph of Genus No. 2 sp. 1.
Fig. 31: Nymph of *Baetis numeratus* sp. n.: prolongation on outer hind corner of two middle segments, covering gill bases.

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Fig. 32: Nymph of Genus No. 2 sp. 1: caudal filaments
Fig. 33: Nymph of Genus No. 2 sp. 1: tip of terminal filament and right cercus at higher magnification as in showing bristles with dark bases and with hyaline ending

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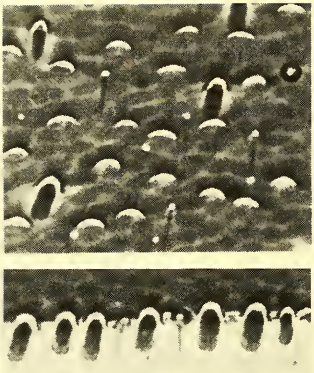

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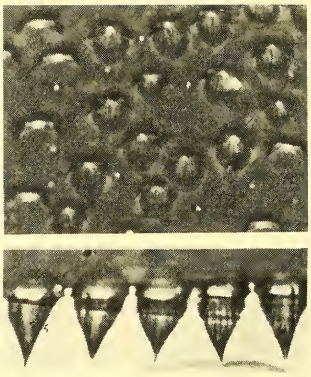

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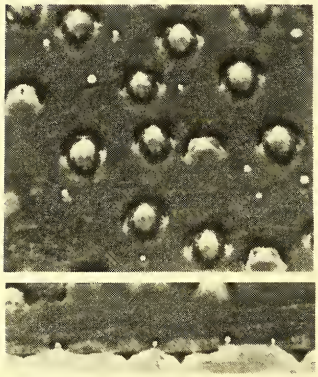

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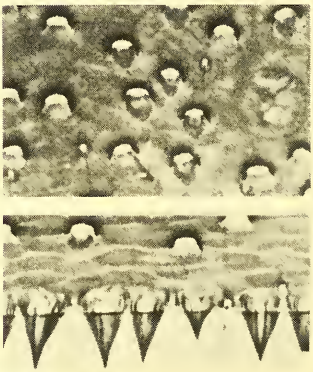

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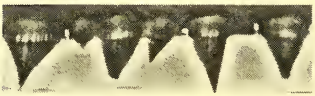

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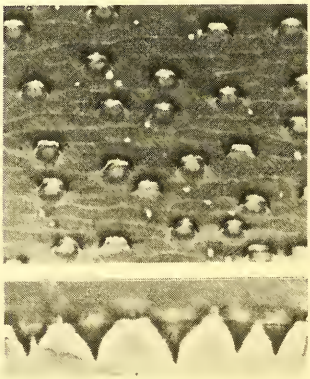

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Fig. 34–36: Surface and posterior margin of nymphal tergum

Fig. 34: *Baetis illiesi* sp. n. – Fig. 35: *Baetis minutus* sp. n. Fig. 36: *Baetis laetificus* sp. n. segment II.

Fig. 36a: posterior margin of nymphal tergum segment IX

Fig. 37–38: Surface and posterior margin of nymphal tergum

Fig. 37: *Baetis mirabilis* sp. n. Fig. 38: *Baetis gombaki* sp. n.

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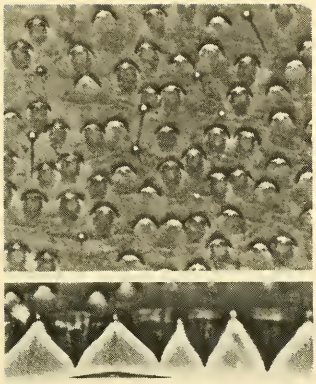

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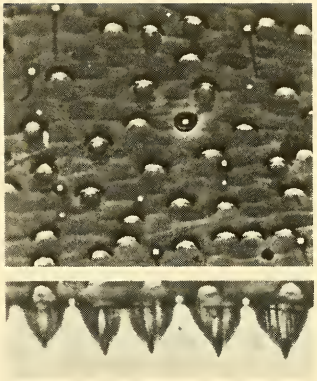

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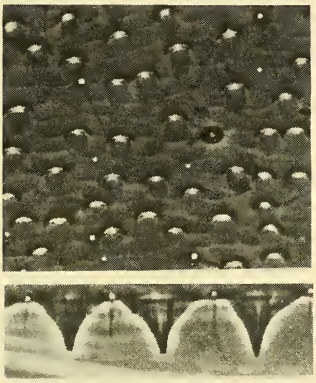

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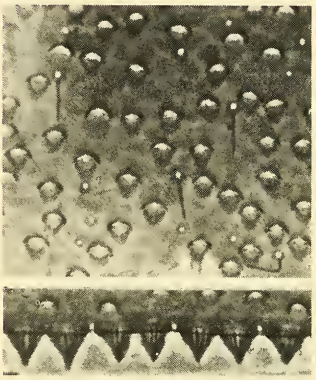

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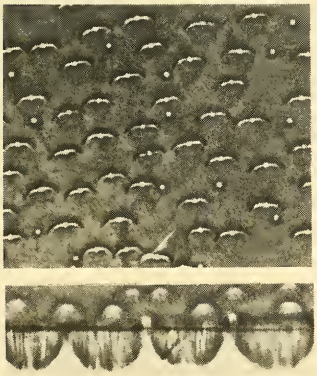

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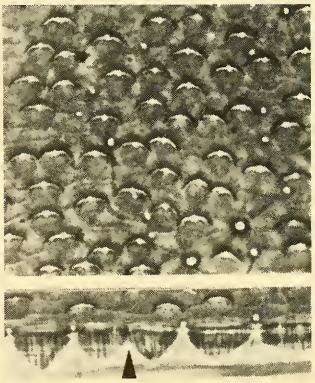

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Fig. 39–44: Surface and posterior margin of nymphal tergum

Fig. 39: *Baetis diffundus* sp. n. – Fig. 40: *Baetis difficilis* sp. n. – Fig. 41: *Baetis operosus* sp. n. – Fig. 42: *Baetis multus* sp. n. – Fig. 43: *Baetis moriharai* sp. n. – Fig. 44: *Baetis numeratus* sp. n.

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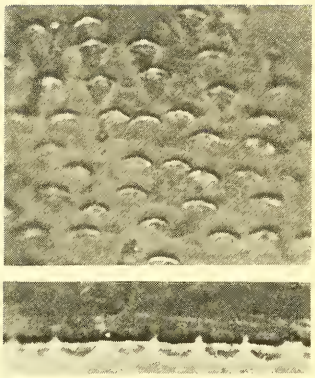

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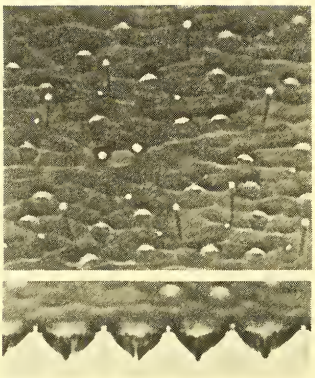

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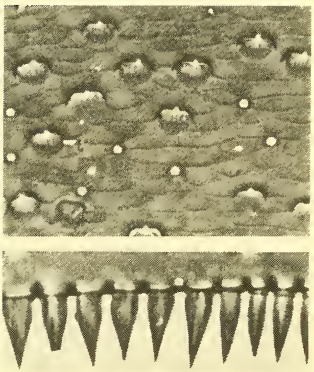

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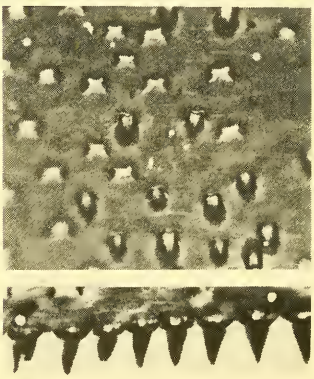

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Fig. 45–48: Surface and posterior margin of nymphal tergum
Fig. 45: *Baetis idei* sp. n. – Fig. 46: *Baetis lepidus* sp. n. Fig. 47: Genus No. 1 sp. 1. – Fig. 48: Genus No. 2 sp. 1.

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