

A Revision of the Genus *Baetis* in Taiwan (Ephemeroptera, Baetidae)

臺灣的四節蜉屬(蜉蝣目，四節蜉科)

Shih-Chang Kang, Hsien-Cheng Chang, Chung-Tu Yang

康世昌 張先正 楊仲圖

JOURNAL OF TAIWAN MUSEUM 47(2):9-44 DECEMBER 1994

臺灣省立博物館半年刊 第四十七卷第二期 9~44

中華民國八十三年

## A Revision of the Genus *Baetis* in Taiwan (Ephemeroptera, Baetidae)

Shih-Chang Kang<sup>1</sup>, Hsien-Cheng Chang<sup>2</sup> and Chung-Tu Yang<sup>1</sup>

Accepted August 12, 1994

### 摘 要

康世昌、張先正、楊仲圖 臺灣的四節蜉屬（蜉蝣目，四節蜉科） 臺灣省立博物館半年刊 47(2): 9-44

本文建立五個新亞屬以分類分布於台灣的四節蜉屬 13 種，其中包含 9 新種，分別為：*Margobaetis* 新亞屬，包含 *B. taiwanensis* Müller-Liebenau、*B. mundus* 新種、*B. gracilentus* 新種、*B. terminus* 新種及 *B. facetus* 新種；*Tatubaetis* 新亞屬，僅含 *B. tatuensis* Müller-Liebenau；*Tenuibaetis* 新亞屬，包含 *B. pseudofrequentus* Müller-Liebenau、*B. inornatus* 新種及 *B. arduus* 新種；*Mullerbaetis* 新亞屬，包含 *B. molawinensis* Müller-Liebenau 新記錄及 *B. morus* 新種；*Acerbaetis* 新亞屬，包含 *B. clivosus* 新種及 *B. yehi* 新種。所有的種類及亞屬的描述均據稚蟲的特徵。其中，*B. taiwanensis* 及 *B. mundus* 兩種的卵經用掃描式電子顯微鏡觀察與描述。文中附亞屬及種的檢索表。

關鍵詞：蜉蝣目，四節蜉科，四節蜉屬，稚蟲，卵，分類，台灣，新亞屬，新種。

### Abstract

Five new subgenera have been erected for thirteen species including 9 new species of the genus *Baetis* from Taiwan, i.e., *Margobaetis* n. subgen. including *B. taiwanensis* Müller-Liebenau, *B. mundus* n. sp., *B. gracilentus* n. sp., *B. terminus* n. sp. and *B. facetus* n. sp.; *Tatubaetis* n. subgen. including only *B. tatuensis* Müller-Liebenau; *Tenuibaetis* n. subgen. including *B. pseudofrequentus* Müller-Liebenau, *B. inornatus* n. sp. and *B. arduus* n. sp.; *Mullerbaetis* n. subgen. including *B. molawinensis* Müller-Liebenau new record and *B. morus* n. sp.; *Acerbaetis* n. subgen. including *B. clivosus* n. sp. and *B. yehi* n. sp. All species and subgenera have been described based on nymphal stage. In addition, the eggs of *B. taiwanensis* and *B. mundus* were observed via scanning electron microscopy. Key to the subgenera and species are offered.

**Key words:** Ephemeroptera, Baetidae, *Baetis*, nymph, egg, classification, Taiwan, new subgenus, new species.

<sup>1</sup>Department of Entomology, National Chung Hsing University, Taichung 402, Taiwan, Republic of China.

<sup>2</sup>Department of Plant Pathology, National Taiwan University, Taipei, Taiwan, Republic of China.

## Intruduction

The genus *Baetis* Leach, 1815 is the largest genus of Ephemeroptera. We herein describe thirteen species of *Baetis*, over one-fifth of total species of Ephemeroptera of Taiwan.

The most recent studies of the genus *Baetis* of Taiwan and her neighboring area – Philippines, Malaysia and Sri Lank, were done by Müller-Liebenau (1981; 1982; 1984a 1984b; 1985; Müller-Liebenau and Hubber, 1985). She (1985) had described three species of *Baetis* from Taiwan. In the present work, an additional ten species from Taiwan will be described.

We understand that this genus contains too many species but that are poor in subdivision. In previous studies, most European species were grouped into as species group (Müller-Liebenau, 1973; Sartori and Thomas, 1991). Generally, those species groups lack clear definition and we found many species could be assigned to none of those species groups. Hence a new scheme of subdivision is necessary. In the present work, we create five new subgenera, i.e., *Margobaetis* n. subgen., *Tatubaetis* n. subgen., *Tenuibaetis* n. subgen., *Mullerbaetia* n. subgen. and *Acerbaetis* n. subgen., and attempt to group not only Taiwanese species but also the species the neighboring areas.

All types and examined specimens in this work were nymphs. The descriptive method of mandibular incisor is after Morihara and McCafferty (1979).

In addition, the chorionic structure of *B. taiwanensis* and *B. mundus* n. sp. were examined using scanning electron microscopy. Egg materials were acquired from mature female nymphs (with black wing pads).

The following new taxa with discordant authorial names have been based on contribution of each author. The final revision was finished by the first author.

Abbreviations used in the collection localities, collectors and deposition of types are: Taiwan (TW), Taipei Hsien (TPH), Ilan Hsien (ILH), Hualien Hsien (HLH), Taitung Hsien (TTH), Pingtung Hsien (PTH), Kaohsiung Hsien (KSH), Chiai Hsien (CIH), Yunlin Hsien (YLH),

Nantou Hsien (NTH), Taichung Hsien (TCH), Hsinchu Hsien (HCH), Taoyuan Hsien (TYH), Shih-Chang Kang (SCK), Hsien-Cheng Chang (HCC), Wen-Bin Yeh (WBY), Department of Entomology, National Chung-Hsing University, Taichung, Taiwan (NCHU) and National Museum of Natural Science, Taichung, Taiwan (NMNS).

## Genus *Baetis* Leach

The generic characters outlined by Edmunds et al. (1976) are modified as follows:

### Nymph:

Body length: 3–12 mm, head relatively short and high; antennae inserted at about midpoint on height of head. Labrum with a narrow but distinct median cleft and a row of branched setae on anterior margin. Labial palpi 3-segmented; second segment usually enlarged apically on the mesial surface. Prosthema of left mandible toothed, apical denticles blunt, basal denticles acute, long (Fig. 1E); Claw with one row of denticles on mesial margin. Hind wing pad present or absent. Gills present on abdominal segments I–VII or II–VII, single lamella, margins serrate, with a few fine setae. In most species, three caudal filaments; in a few species only two caudal filaments with vestigial terminal filament, terminal filament always shorter than cerci; long setae present on both sides of terminal filament and on mesial side of cerci (Fig. 12).

### Key to the Subgenera and Species of the Genus *Baetis* from Taiwan (for nymph only)

1. The prosthema of right mandible toothed (Figs. 1E, 7E, 10L); posterior margin of paraproct curved evenly, dentate (Figs. 1G, 10H, 11I, 16L) ..... 2
- The prosthema of right mandible reduced to two fine spicate setae (Figs. 17F, 18F); posterior margin of paraproct with a acute extension (Figs. 17G, 18I) ..... *Acerbaetis* n. subgen ..... 12

2. Margins of gills surround with dark band (Figs. 1K; 8K) . . . . .  
*Margobaetis* n. subgen . . . . . 5
- Margins of gills without dark band . . . 3
3. Labrum with a row of close-set setae near anterior margin (Figs. 15A, 16A); mesial margin of second segment of labial palpus with a large lobe almost as large as segment III (Figs. 15E, 16E); anteromesial corner of femur without tufted setae . . . . .  
*Mullerbaetis* n. subgen . . . . . 9
- Labrum with a few long acute setae near anterior margin (Figs. 1A; 14A); mesial margin of second segment of labial palpus without or only with a small lobe (Figs. 1C, 6C; 10C; 14C); anteromesial corner of femur with a tuft of fine setae (Fig. 10G) . . . . . 4
4. Labial palpus slender, segment II over 2x as long as segment III (Figs. 11D, 13D, 14D); paraproct with notched scales medially (Figs. 11I, 14K, 13J) . . . . .  
*Tenuibaetis* n. subgen . . . . . 10
- Labial palpus stout, segment II only slightly longer than segment III (Fig. 10C); paraproct without notched scale (Fig. 10H) . . . . .  
*Tatubaetis* n. subgen . . . . .  
. . . . . *B. (Ta.) tatuensis* Müller-Liebenau
5. Hind wing pads absent (Fig. 9G); mesonotum with a large pale marking anteromedially (Fig. 9F) . . . . . *B. (Ma.) facetus* n. sp.
- Hind wing pads present (Figs. 1F, 6F); mesonotum not same as above . . . . . 6
6. Abdominal terga IX and X pale distinctly (Fig. 1J) . . . . . 7  
Abdominal terga not same as above . . . 8
7. Abdominal terga I–VIII uniformly dark brown (Fig. 19); segment II of labial palpi with over 10 pores (Fig. 1C); posterior spines present on abdominal terga III–X . . . . . *B. (Ma.) mundus* n. sp.
- Abdominal terga I–VIII each with a V-shaped marking anteromedially (Fig. 20); segment II of labial palpi without or with less than 5 pores (Fig. 6C); posterior spines present on abdominal terga V–X . . . . .  
. . . . . *B. (Ma.) taiwanensis* Müller-Liebenau
8. The most jutting of mandibular incisors on the medial denticle (Fig. 7F); gills slender, lanceolate (Fig. 7L); terminal fila-

ment ca. 0.43x as long as cerci . . . . .

- . . . . . *B. (Ma.) gracilentus* n. sp.
- The most jutting of mandibular incisors on the apical denticle (Fig. 8E); gills long oval (Fig. 8K); terminal filament ca. 0.65x as long as cerci . . . . .  
. . . . . *B. (Ma.) terminus* n. sp.
9. Hind wing pads absent (Fig. 15I); gills 6 pairs; posterior margin of paraproct slightly jutting (Fig. 15J) . . . . .  
. . . . . *B. (Mu.) molawinensis* Müller-Liebenau
  - Hind wing pads present (Fig. 16I); gills 7 pairs; posterior margin of paraproct curved evenly (Fig. 16L) . . . . . *B. (Mu.) morus* n. sp.
  10. Posterior spines of terga acute (Fig. 11K); metanotum with a pale marking postero-medially (Fig. 11H) . . . . .  
*B. (Te.) pseudofrequentus* Müller-Liebenau
  - Posterior spines of terga blunt (Figs. 13I, 14L); metanotum uniformly brown . . . . . 11
  11. Labrum with a V-shaped marking (Fig. 13A); tergum I with a few posterior spines; terga uniformly brown, without distinct marking . . . . . *B. (Te.) inornatus* n. sp.
  - Labrum without V-shaped marking; tergum I without posterior spine; terga pale, with distinct markings as Fig. 27 . . . . .  
. . . . . *B. (Te.) arduus* n. sp.
  12. Gills 7 pairs; anterior margins of femora with acute setae (Fig. 17H); posterior spines present on terga II–X . . . . .  
. . . . . *B. (A.) clivus* n. sp.
  - Gills 6 pairs; anterior margins of femora without setae (Fig. 18H); posterior spines only present on terga IX and X . . . . .  
. . . . . *B. (A.) yehi* n. sp.

#### Subgenus *Margobaetis* Kang and Yang, n. subgen.

#### Type species:

*Baetis (Margobaetis) mundus* Chang and Yang, n. sp. (here designated).

#### Description:

**Mature nymph.** – Prostheca on the right mandible toothed, toothbrush like (Figs. 1E, 6E, 7E, 8E, 9E). Ridge between molar and

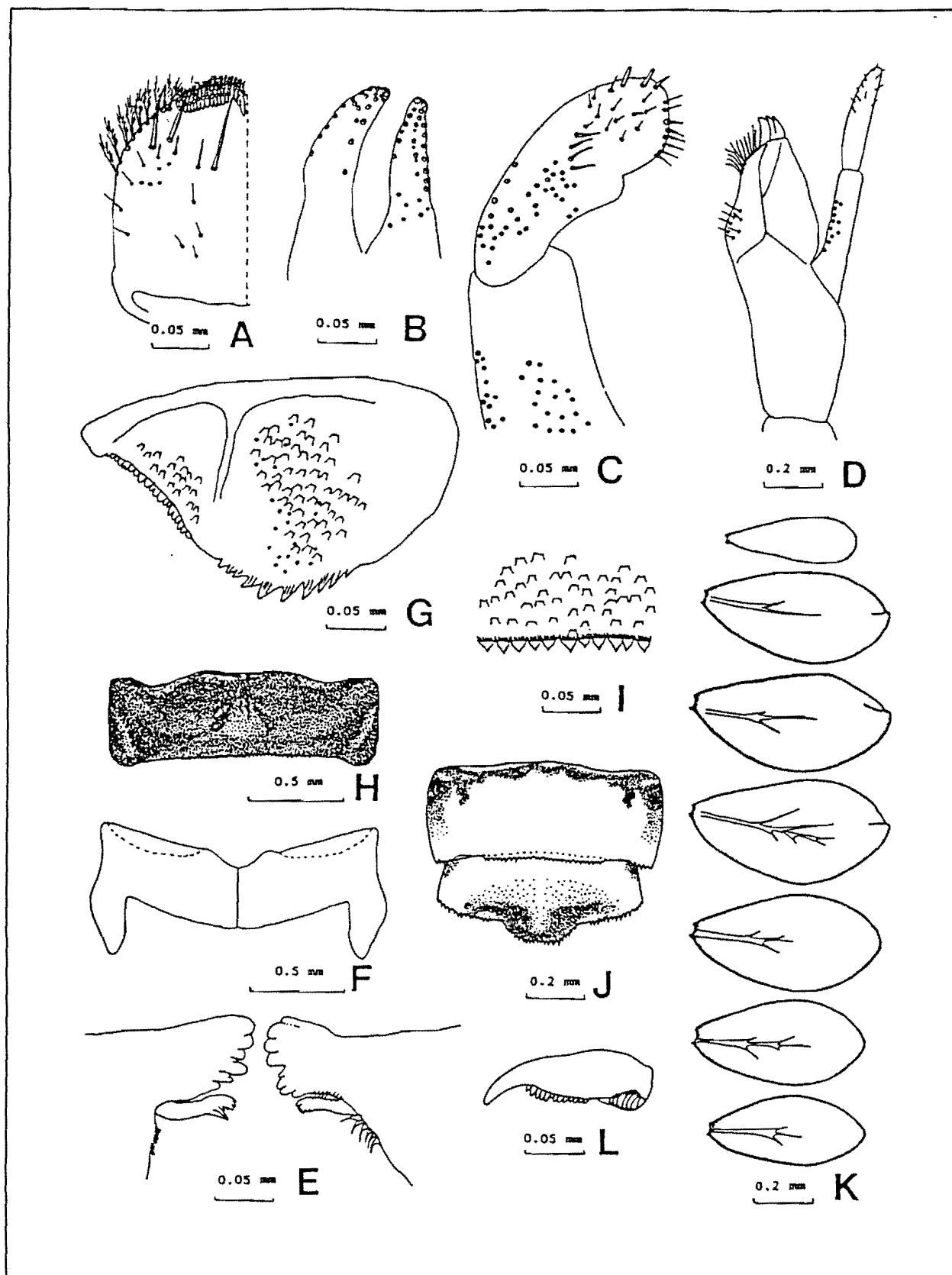


Fig. 1. Nymph of *Baetis mundus* n. sp. A. labrum (left half), dorsal; B. glossa and paraglossa, ventral; C. labial palpus, dorsal; D. maxilla, ventral; E. mandibular incisors and prosthecae, dorsal; F. metanotum with hind wing pads, dorsal; G. paraproct; H. tergum VI, dorsal; I. surface and posteromedial margin of tergum VI, dorsal; J. terga IX and X, dorsal; K. gills I-VII; L. hind claw.

incisor of mandible with setae (Figs. 1E, 7F); incisor of right mandible fringe with a row of long fine setae near mesial margin (Figs. 1E, 6E). Palpus of maxilla 2-segmented (Figs. 1D, 6D). Labial palpus 3-segmented, articulation between segment II and III obscure; segment II about 2x as long as segment III, anteromesial corner of segment II somewhat jutting (Figs. 1C, 6C, 7E); paraglossa and glossa subequal in size (Figs. 1B; 6B; 7B; 8B; 9B). Terga, sterna, dorsum of legs scatter with trapezoidal-based scales (Figs. 1G, I; 6G, I, J; 7H, I, K; 8I, J; 9I, K). Paraproct with trapezoidal-based scales (Figs. 1G, 6G). Gills 7 pairs, each gill with a dark band surrounding the margin (Figs. 1K, 8K); margins of gills serrated and with fine setae.

**Etymology.** – Masculine gender, margo (boundary or border), in reference to the gill with a dark band surrounding the margins.

**Species included.** – Besides the type species *Baetis mundus* n. sp., 4 species from Taiwan should be included in the subgenus *Margobaetis*, i.e., *B. taiwanensis* Müller-Liebenau, 1985, *B. gracilentus* n. sp., *B. terminus* n. sp., and *B. facetus* n. sp.

#### Remarks:

Nymphs of this subgenus *Margobaetis* can be recognized from the following combination characters: (1) prostheca of right mandible toothbrush like; (2) glossa and paraglossa subequal in size; (3) terga, sterna and dorsum of legs with trapezoidal-based scales; (4) each gill with a dark band surrounding the margins.

*Baetis (Margobaetis) mundus* Chang  
and Yang n. sp.  
(Figs. 1, 2, 3, 19)

**Mature nymphs:** (Figs. 1, 19)

**Body length:** male 4.2 – 5.9 mm; female 4.5 – 7.3 mm.

**Head:** **Antennae:** length ca. 3.2x width of head; neither of scape and pedicel with setae. **Labrum** (Fig. 1A): ca. 0.8x as long as wide, with a V-shaped notch anteromedially; dorsum with several long acute setae near anterior

margin. **Mandibles** (Fig. 1E): left incisor with 3+1+3 denticles; right incisor with 3(1)+4 denticles; prostheca of right mandible manifold; edges between molar and prostheca with several fine setae. **Maxillae** (Fig. 1D): maxillary palpus ca. 1.2x as long as galea-lancinia, 2-segmented, segment II ca. 1.4x as long as segment I. **Labium:** labial palpus (Fig. 1C) 3-segmented, the articulation between segments II and III obscure; segment I expanded, wider than segment I and II; paraglossa and glossa with long acute setae at apices (Fig. 1B).

**Thorax:** hind wing pads distinct (Fig. 1F); nota dark brown, mesonotum with a pale marking posteromedially. **Legs:** femora brown, pale distally, with 1 pale, oblong marking on basal half; dorsum of tibiae and tarsi with trapezoidal-based scales densely; lateral margin of each tibia with 1–6 clavate setae; claw convex on mesial margin (Fig. 1L); hind claw ca. 0.4x as long as hind tarsus.

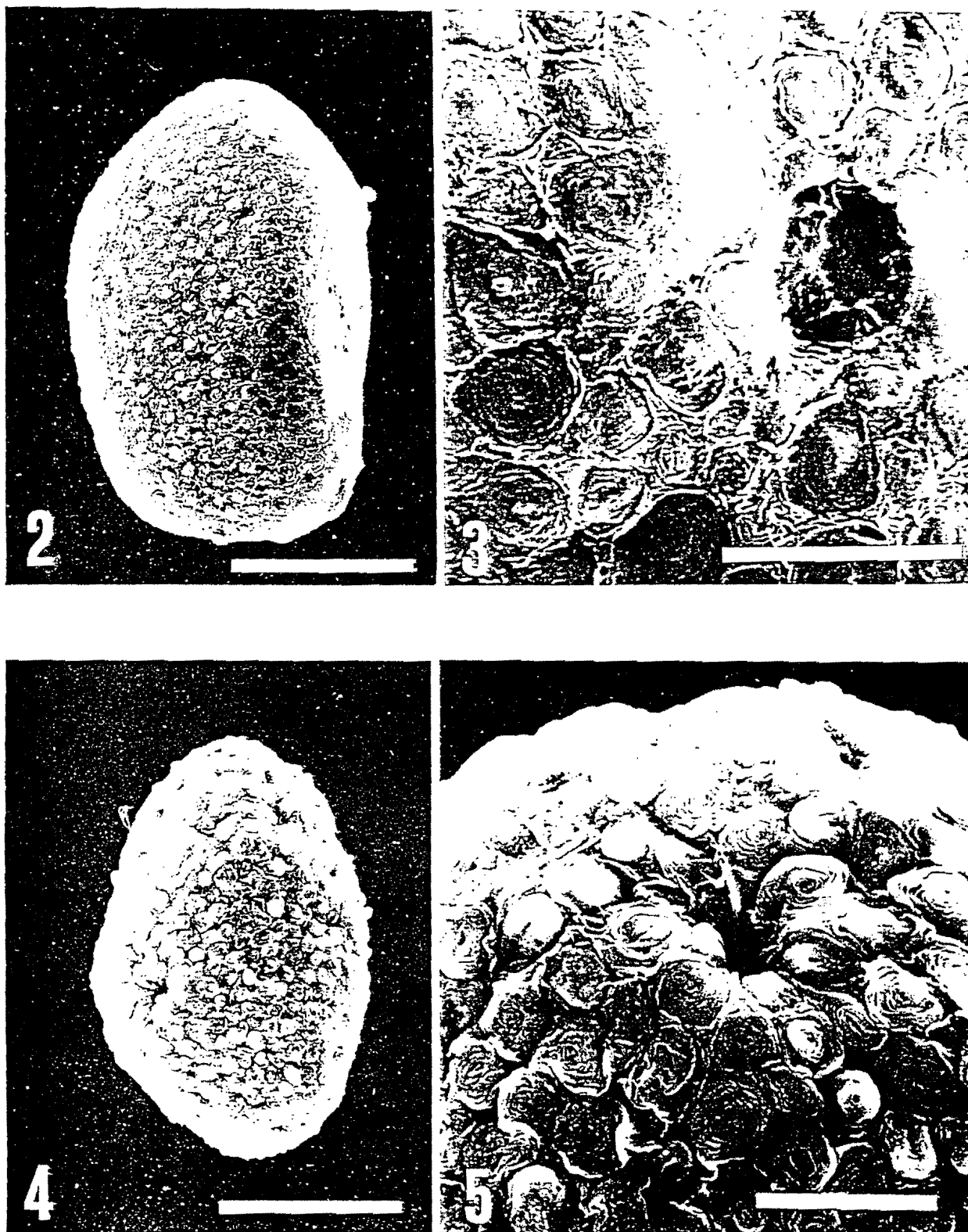
**Abdomen:** **Terga:** color pattern as Figs. 1H and 19, uniformly dark brown, terga IX and X pale distinctly. Each tergum with trapezoidal-based scales densely, posterior spines blunt triangular (Fig. 1I), present on terga III–X and sterna VII–IX, terga III, IV and sterna VII, VIII somewhat obscure. **Paraproct** (Fig. 1G): subtriangular, surface with trapezoidal-based scales and pores; posteromedial margin with irregular, acute denticles. **Gills** (Fig. 1K): present on abdominal segments I–VII, long oval; each gill with a dark band surrounding the margin; tracheae distinct or obscure. **Caudal filaments:** uniformly brown, lightish medially, darkish on distal half; terminal filament ca. 0.62x as long as cerci; basal 3/5 of cerci fringe with long fine setae.

**Eggs:** (Figs. 2, 3)

Oval, length ca. 100  $\mu$ m, width ca. 70  $\mu$ m; surface of semiglobe cloggy, full with rotiform structures. In the gap of rotiform structures with threads. The remains of semiglobe more smooth, with fine reticular ridges.

**Type material:**

**Holotype:** mature female nymph (in alcohol), Kuanwu, Wufeng, HCH, TW, (795 m), 24 Oct. 1991, SCK and HCC. In NCHU.



Figs. 2-5. Eggs. 2-3, *Baetis mundus* n. sp. (2, general view; 3, detail); 4-5, *B. taiwanensis* Müller-Liebenau. (4, general view; 5, detail) [scales: 2 and 4 = 40  $\mu$ m; 3 and 5 = 10  $\mu$ m]

**Paratypes** (mature nymph): 6♂♂, 8♀♀, same data as for holotype. 3♂♂, 5♀♀ in NCHU; 3♂♂, 3♀♀ in NMNS.

**Other mature nymphal specimens examined:**

6♀♀, Niaotsui, Chienshih, HCH, TW, (795 m), 11 Jul. 1992, SCK; 3♂♂, 2♀♀, Chianrenngu, Maolin, KSH, TW, (205 m), 27 Jul. 1993, SCK; 7♂♂, 4♀♀, Mirnchyr, Tatung, ILH, TW, (1,090 m), 9 Sept. 1993, SCK; 3♂♂, 4♀♀, Shitsun, Fuhsing, TYH, TW, (1,065 m), 9 Sept. 1993, SCK; 4♀♀, Fushan, Yuanshan, ILH, TW, (570 m), 15 Sept. 1993, SCK; 1♀, Fushan, Yuanshan, ILH, TW, (530 m), 15 Sept. 1993, SCK; 7♂♂, 13♀♀, Harpen, Wulai, TPH, TW, (570 m), 16 Sept. 1993, SCK; 1♂, 4♀♀, Jingyang, Nanao, ILH, TW, (220 m), 17 Sept. 1993, SCK; 1♀, Fenglin, HLH, TW, (140 m), 18 Sept. 1993, SCK; 3♂♂, 4♀♀, Tzuyurnchiao, Hsiulin, HLH, TW, (1,300 m), 19 Sept. 1993, SCK.

**Distribution:**

Taiwan.

**Etymology:**

Mundus, L., masculine, meaning clean or neat.

**Remarks:**

This new species resembles *Baetis taiwanensis* Müller-Liebenau but can be differentiated in nymphs by the following characters: (1) terga I–VIII uniformly dark brown; (2) dorsum of labial palpus with numerous pores, segment II with more than 10 pores (compare between Figs. 1C and 6C); (3) posterior spines present on terga III–X, on terga V–X in *taiwanensis*; (4) body size larger than in *taiwanensis*; (5) trapezoidal-based scales of paraproct denser than in *taiwanensis*.

*Baetis (Margobaetis) taiwanensis* Müller-Liebenau  
(Figs. 4, 5, 6, 20)

*Baetis taiwanensis* Müller-Liebenau, 1985: 94.

**Mature nymphs:** (Figs. 6, 20)

Body length: male 3.7–4.4 mm; female 4.5–5.0 mm.

**Head:** Antennae: length ca. 2.8× width of head; scape and pedicel with fine setae sparsely. **Labrum** (Fig. 6A): ca. 0.66× as long as wide; dorsum with several long acute setae near anterior margin. **Mandibles** (Fig. 6E): left incisor with 3+1+3 denticles; right incisor with 3(1)+4 denticles; prostheca of right mandible maniform; edge between molar and prostheca of right mandible with a few setae. **Maxillae** (Fig. 6D): maxillary palpus slightly longer than galea-lancinia, 2-segmented, segment II ca. 1.4× as long as segment I. **Labium:** labial palpus (Fig. 6C) 3-segmented, the articulation between segments II and III obscure; paraglossa with a row of long acute setae along lateral and mesial margins but 3 rows at apex; paraglossa 1.37× as wide as glossa (Fig. 6B).

**Thorax:** hind wing pads distinct (Fig. 6F); nota light brown or red brown. **Legs:** femora with 2 pale, oblong markings, 1 distal and 1 basal, the basal one larger than the distal one; lateral margins of middle and hind tibiae with 5–7 clavate setae (Fig. 6G); hind claw ca. 0.35× as long as hind tarsus.

**Abdomen:** **Terga:** light brown or red brown, color pattern as Figs. 6H and 20. Each tergum with trapezoidal-based scales sparsely. Posterior spines blunt triangular (Fig. 6I), present on terga V–X, on tergum V obscure. **Paraproct** (Fig. 6J): subtriangular, surface with trapezoidal-based scales and pores; postero-medial margin with 4–6 irregular, acute denticles. **Gills** (Fig. 6K): present on abdominal segments I–VII, long oval; each gill with a dark band surrounding the margin; tracheae obscure. **Caudal filaments:** terminal filament 0.60× as long as cerci; basal 2/3 of cerci fringe with long fine setae; cerci with an obscure band medially and a distinct band distally.

**Eggs:** (Figs. 4, 5)

Oval, length ca. 90 μm, width ca. 60 μm; surface of whole egg cloggy, full with rotiform structures, like cross section of cabbage. In the gap of rotiform structures with irregular threads.

**Mature nymphal specimens examined:**

1♂, 4♀♀, Yehyu, Lanhyu, TTH, TW, (20



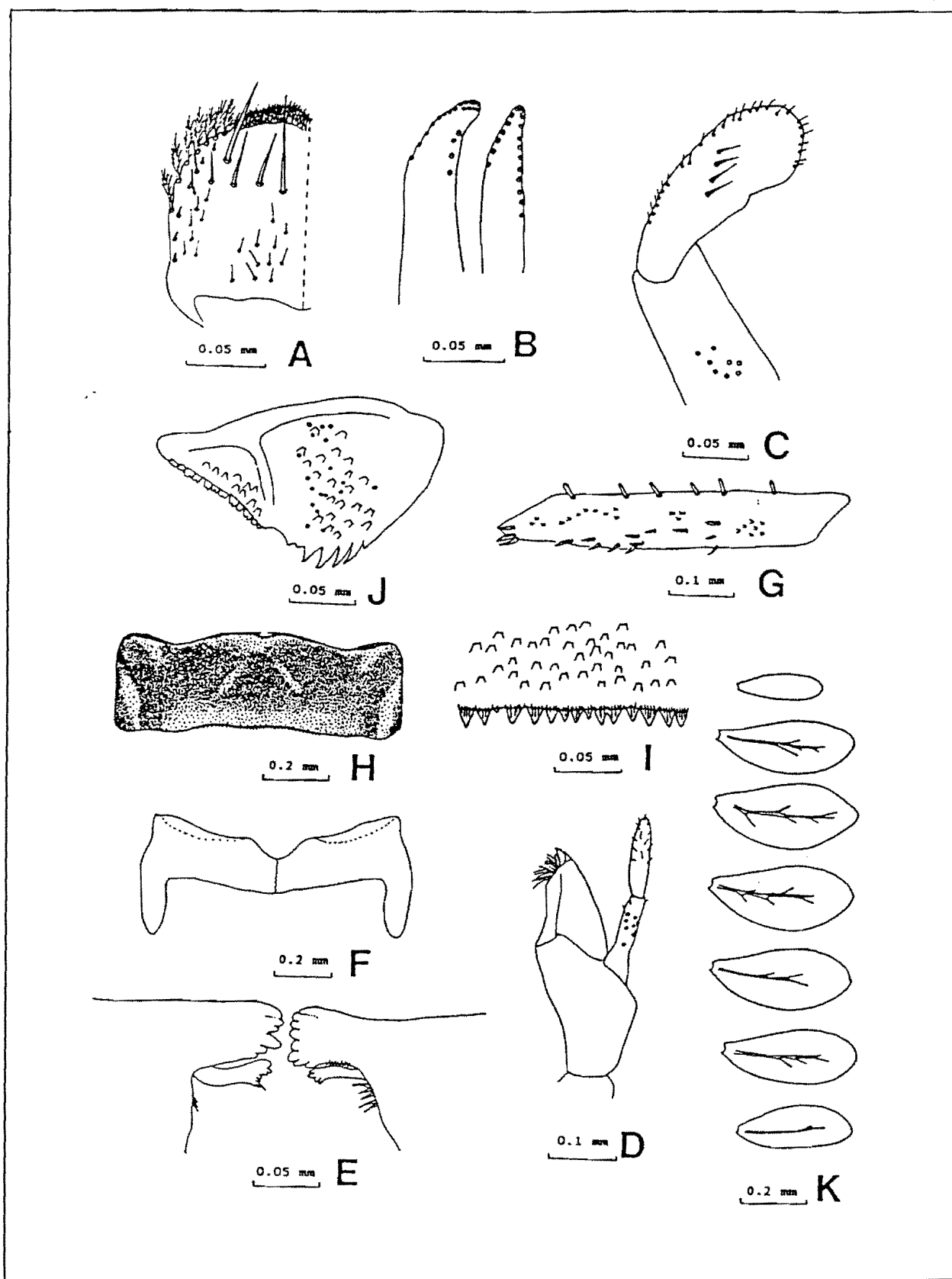


Fig. 6. Nymph of *Baetis taiwanensis* Muller-Liebenau. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, labial palpus, dorsal; D, maxilla, ventral; E, mandibular incisors and prosthecae, dorsal; F, metanotum with hind wing pads, dorsal; G, tibia, dorsal; H, tergum VI, dorsal; I, surface and postero-medial margin of tergum VI, dorsal; J, paraproct; K, gills I-VII.

m), 3 Apr. 1991, HCC; 4♂♂, 7♀♀, Chilan, Ta-tung, ILH, TW, (200 m), 30 May 1991, SCK & HCC; 3♂♂, 3♀♀, Yehyu, Lanhsu, TTH, TW, (30 m), 29 Jul. 1991, HCC; 38♂♂, 54♀♀, Lanhsu, TTH, TW, (30 m), 29 Jul. 1991, HCC; 2♂♂, 2♀♀, Tsaotun, Kuohsing, NTH, TW, (190 m), 20 Aug. 1991, HCC; 7♂♂, 12♀♀, Janghur, Kukeng, YLH, TW, (295 m), 26 Jul. 1993, SCK; 2♂♂, 8♀♀, Tuungtour, Chushan, NTH, TW, (255 m), 26 Jul. 1993, SCK; 12♂♂, 16♀♀, Tuungtour, Chushan, NTH, TW, (120 m), 27 Jul. 1993, SCK; 4♀♀, Chairdierruu, Liukuei, KSH, TW, (340 m), 27 Jul. 1993, SCK; 1♂, 7♀♀, Shanherchiaur, Liukuei, KSH, TW, (250 m), 27 Jul. 1993, SCK; 1♀, Tona Spring, Maolin, KSH, TW, (340 m), 27 Jul. 1993, SCK; 5♀♀, Fushan, Yuanshan, ILH, TW, (480 m), 15 Sept. 1993, SCK; 5♂♂, 5♀♀, Charngchunchiao, Hsiulin, HLH, TW, (70 m), 19 Sept. 1993, SCK; 1♀, Tienhsiang, Hsiulin, HLH, TW, (450 m), 19 Sept. 1993, SCK.

#### Distribution:

Taiwan.

#### Remarks:

The chorionic structure resembles that of *Baetis mundus* n. sp. but the rotiform structures much sharper and distributed over entire surface.

*Baetis* (Margobaetis) *gracilentus* Chang  
& Yang n. sp.  
(Figs. 7, 21)

#### Mature nymphs: (Fig. 7)

Body length: male 4.6–4.8 mm; female 4.9–5.2 mm.

**Head:** Antennae (Fig. 7C): length ca. 3x width of head; scape and pedicel with short fine setae sparsely. **Labrum** (Fig. 7A): ca. 0.66x as long as wide; dorsum with several long acute setae near anterior margin. **Mandibles** (Fig. 7F): left incisor with 3+4 denticles, medial denticles more jutting than laterals; right incisor with 3(1)+1+3 denticles; prosthema of right mandible like toothbrush; edge between molar and prosthema with a row of setae. **Maxillae** (Fig. 7D): maxillary palpus ca. 1.5x as long as galealancina, 3-segmented, the articulation between

segments II and III obscure. **Labium:** labial palpus 3-segmented, the articulation between segments II and III obscure; segment III expanded, round; anteromesial corner slightly jutting (Fig. 7E); paraglossa with 3 rows of long acute setae at the apex (Fig. 7B).

**Thorax:** hind wing pads distinct (Fig. 7G); nota light brown, somewhat reddish. **Legs:** femora slender, with undulate wrinkles medially and pores; femora, tibiae and tarsi with trapezoidal-based scales densely (Fig. 7H); coniform spicate setae present on fore leg and absent on middle and hind leg; hind claw ca. 0.29x as long as hind tarsus.

**Abdomen:** **Terga:** light brown somewhat reddish, color pattern as Figs. 7J and 21. Posterior spines acutely triangular, present on terga II–X and sterna IV–IX medially, obscure on sternum IV. Each tergum with trapezoidal-based scales and pores (Fig. 7K). **Paraproct** (Fig. 7I): triangular, surface with trapezoidal-based scales and pores; posteromedial margin with irregular, acute denticles. **Gills** (Fig. 7L): present on abdominal segments I–VII, slender, leaf-like; tracheae distinct; gill I much smaller than other gills. **Caudal filaments:** cerci fade distally, basal 1/3 of cerci fringe with long fine setae; cerci very long, distal segments of cerci extended in length, slender, over 2x of basal segments; terminal filament 0.43x as long as cerci.

#### Type material:

**Holotype:** mature female nymph (in alcohol), Hwesunlinchun, Lenai, NTH, TW, (870 m), 20 Aug. 1991, HCC. In NCHU. **Paratypes** (mature nymph): 5♂♂, 10♀♀ same data as for holotype. 3♂♂, 7♀♀ in NCHU; 2♂♂, 3♀♀ in NMNS.

#### Other mature nymphal specimens examined:

5♂♂, 8♀♀, same data as for holotype. 1♂, 2♀♀, Taian-Wenchuan, Taian, MLH, TW, (550 m), 31 Oct. 1990, SCK; 1♂, 1♀, Hungtou, Lanhyu, TTH, TW, (25 m), 3 Apr. 1991, HCC; 1♂, Chiayan, Hoping, TCH, TW, (1,520 m), 28 May 1991, SCK and HCC; 1♀, Tapa, Wufeng, HCH, TW, (1,775 m), 23 Oct. 1991, SCK and HCC; 1♂, Mirnchyr, Tatung, ILH, TW, (1,090 m), 9 Sept. 1993, SCK; 1♀, Shitsun, Fuhsing, TYH, TW, (1,065 m), 9 Sept.

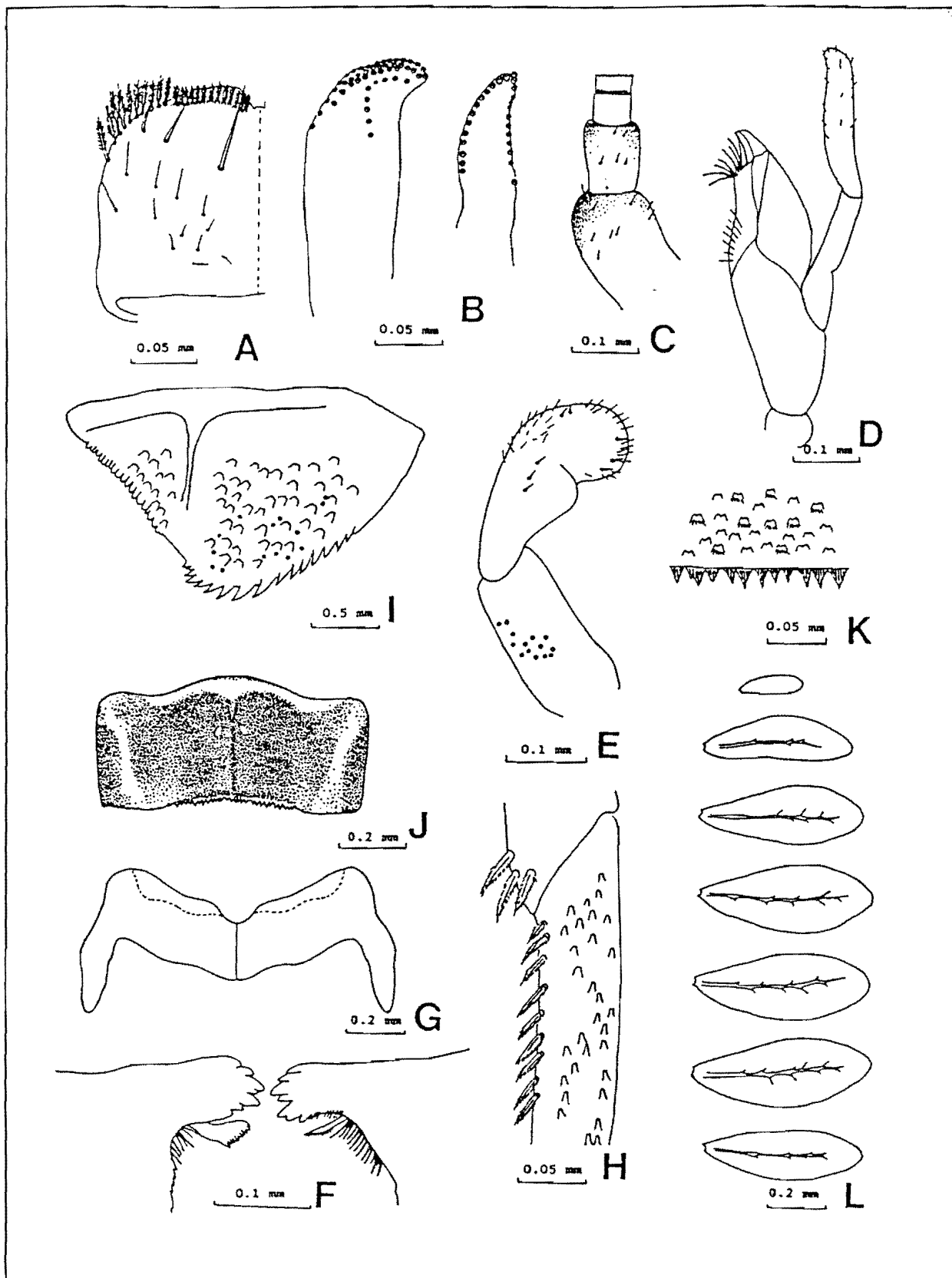


Fig. 7. Nymph of *Baetis gracilentus* n. sp. A, labrum, dorsal; B, glossa and paraglossa, ventral; C, antennal scape and pedicel, dorsal; D, maxilla; E, labial palpus, dorsal; F, mandibular incisors and prosthecae, dorsal; G, metanotum with hind wing pads, dorsal; H, hind tibia, dorsal; I, paraproct; J, tergum VI, dorsal; K, surface and posteromedial margin of tergum VI, dorsal; L, gills I-VII.

19  
TP  
49  
15

Dis

Ety

Re:

tail  
ent  
(1)  
tha  
1/2  
fila  
me  
ove

Ma

4.6

hes  
wit  
as  
set  
lef  
mo  
3(  
ma  
an  
Ma  
as  
cul  
La  
the  
ob  
lor  
ma

no

1993, SCK; 1♀, Parnshankeng, Shuangchi, TPH, TW, (145 m), 10 Sept. 1993, SCK; 6♂♂, 4♀♀, Fushan, Yuanshan, ILH, TW, (570 m), 15 Sept. 1993, SCK.

**Distribution:**

Taiwan.

**Etymology:**

Gracilentus, L., masculine, meaning slender.

**Remarks:**

This new species is closely related to *Baetis taiwanensis* Müller-Liebenau but can be differentiated in nymphs by the following characters: (1) gills slender, lanceolate; (2) femora slender than in *taiwanensis*; (3) cerci only on basal 1/3 fringe with long fine setae; (4) terminal filament 0.43× as long as cerci; (5) distal segments of cerci extended in length, slender, over 2× of basal segments.

*Baetis (Margobaetis) terminus* Chang

& Yang n. sp.

(Figs. 8, 22)

**Mature nymphs:** (Fig. 8)

Body length: male 4.0–5.4 mm; female 4.6–6.0 mm.

**Head:** Antennae: length ca. 3.6× width of head; surface of scape and pedicel smooth, without setae. **Labrum** (Fig. 8A): ca. 0.83× as long as wide; dorsum with several long acute setae near anterior margin. **Mandibles** (Fig. 8E): left incisor with 3+1+3 denticles, the lateral more jutting than others; right incisor with 3(1)+1+3 denticles; prostheca of right mandible like toothbrush; edge between molar and prostheca with a row of close-set setae. **Maxillae** (Fig. 8D): maxillary palpus ca. 1.5× as long as galea-lancina, 3-segmented, the articulation between segment II and III obscure. **Labium:** labial palpus slender, 3-segmented, the articulation between segments II and III obscure (Fig. 8C): paraglossa with a row of long acute setae along the lateral and mesial margins (Fig. 8B).

**Thorax:** hind wing pads distinct (Fig. 8F); nota light brown. **Legs:** dorsum of femora,

tibiae and tarsi with trapezoidal-based scales densely; fore tibia with coniform spicate setae but absent in middle and hind tibiae; hind claw ca. 0.32× as long as hind tarsus.

**Abdomen:** Terga: light brown, color pattern as Figs. 8H and 22. Posterior spines triangular (Fig. 8I), present on terga III–X and sterna VI–IX, obscure on tergum III and sternum IV; each tergum with trapezoidal-based scales (Fig. 8I). **Paraproct** (Fig. 8J): subtriangular, surface with trapezoidal-based scales and pores; posteromedial margin with irregular, acute denticles. **Gills** (Fig. 8K): present on abdominal segments I–VII, leaf-like; each gill with a dark band surrounding the margin; tracheae distinct. **Caudal filaments:** uniformly brown, lightish medially; terminal filament 0.65× as long as cerci; basal 3/5 of cerci fringe with long fine setae; distal segments of cerci extend in length, slender, over 2× as long as basal segments.

**Type material:**

**Holotype:** mature male nymph (in alcohol), Piluchi, Lenai, NTH, TW, (2,300 m), 1 Dec. 1990, WBY. In NCHU. **Paratypes** (mature nymph): 4♂♂, 6♀♀, same data as for holotype; 4♂♂, 3♀♀, Alishan, CIH, TW, (2,195 m), 8 Feb. 1991, HCC. 5♂♂, 6♀♀ in NCHU; 3♂♂, 3♀♀ in NMNS.

**Other mature nymphal specimens examined:**

8♂♂, 7♀♀, same data as for holotype. 9♂♂, 13♀♀, Alishan, CIH, TW, (2,195 m), 8 Feb. 1991, HCC; 8♂♂, 8♀♀, Hungtou, Lanhyu, TTH, TW, (25 m), 3 Aprl 1991, HCC; 23♂♂, 45♀♀, Chia-yan, Hoping, TCH, TW, (1,520 m), 28 May 1991, SCK and HCC; 3♂♂, 2♀♀, Hwesunlinchun, Lenai, NTH, TW, (870 m), 20 Aug. 1991, HCC; 17♂♂, 22♀♀, Tapa, Wufeng, HCH, TW, (1,775 m), 23 Oct. 1991, SCK and HCC; 6♂♂, 8♀♀, Wufeng, HCH, TW, (1,970 m), 24 Oct. 1991, SCK and HCC; 2♂♂, 2♀♀, Laichi, Alishan, CIH, TW, (1,035 m), 19 Nov. 1991, SCK; 2♂♂, 5♀♀, Mirnchyr, Tatung, ILH, TW, (1,090 m), 9 Sept. 1993, SCK; 5♂♂, 6♀♀, Shitsun, Fuhsing, TYH, TW, (1,065 m), 9 Sept. 1993, SCK.

**Distribution:**

Taiwan.

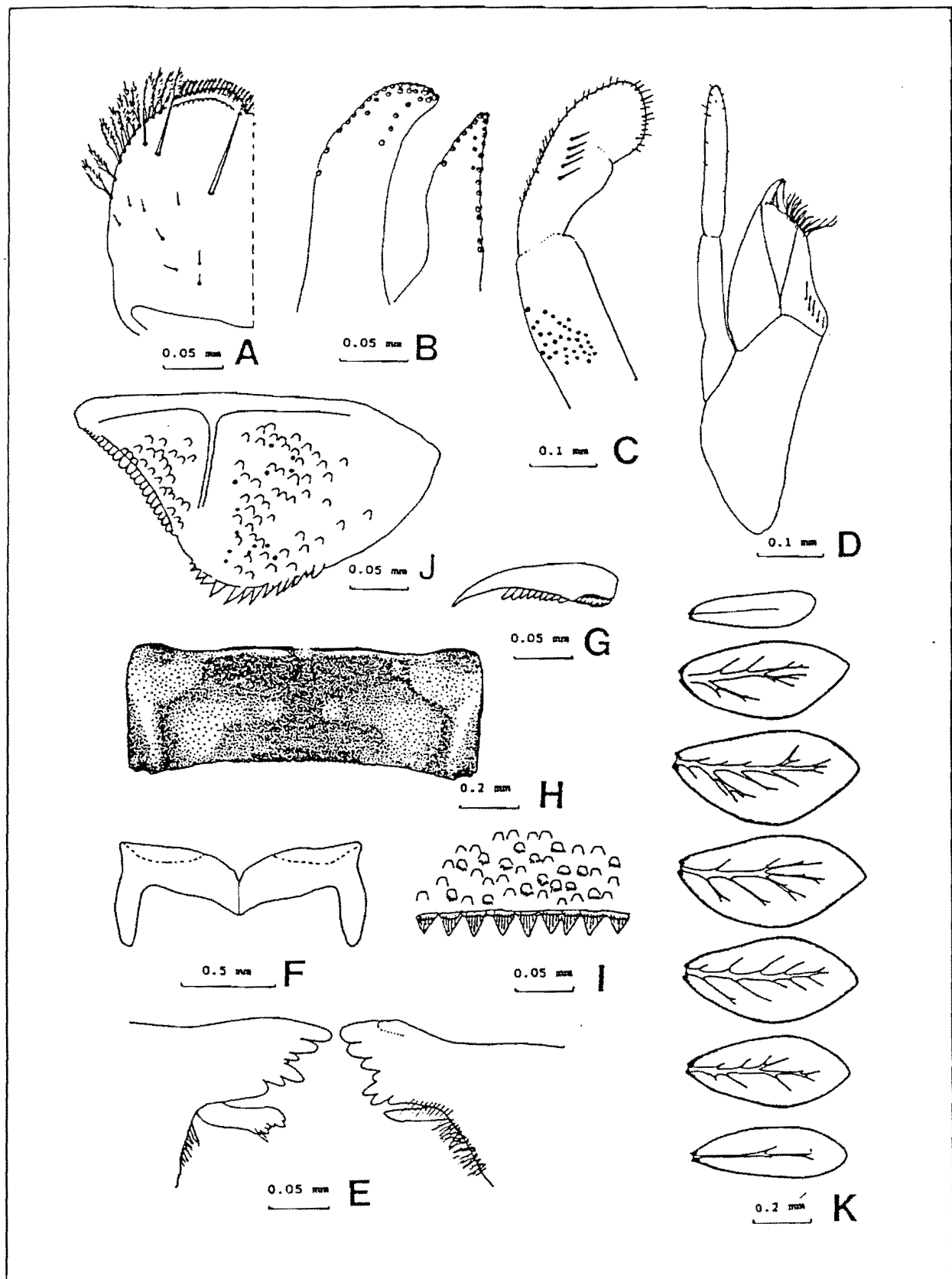


Fig. 8. Nymph of *Baetis terminus* n. sp. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, labial palpus, dorsal; D, maxilla, ventral; E, mandibular incisors and prosthecae, dorsal; F, metanotum with hind wing pads, dorsal; G, hind claw; H, tergum VI, dorsal; I, surface and posteromedial margin of tergum VI, dorsal; J, paraproct; K, gills I-VII.

Ety

end.

Ren

grac.  
nym  
wide  
of i  
den  
with  
0.65

Mat

4.4

head  
setae  
wide  
on  
incis  
with  
man  
pros  
max  
lanc  
Lab  
the  
obse  
conc  
long  
mes

nota  
with  
dist  
later  
tibia  
scale  
tarsi

dish

### **Etymology:**

Terminus. L., masculine, meaning limit or end.

### **Remarks:**

This new species is closely related to *Baetis gracilentus* n. sp. but can be differentiated in nymphs by the following characters: (1) gills wider than in *gracilentus*; (2) apical denticle of incisor more jutting than basal and middle denticles (Fig. 8E); (3) basal 3/5 of cerci fringe with long fine setae; (4) terminal filament ca. 0.65x as long as cerci.

*Baetis (Margobaetis) facetus* Chang  
& Yang n. sp.  
(Figs. 9, 23)

### **Mature nymphs:** (Fig. 9)

Body length: male 3.7–4.0 mm; female 4.4–4.8 mm.

**Head:** Antennae: length ca. 3.5x width of head; scape and pedicel scatter with short fine setae. **Labrum** (Fig. 9A): ca. 0.63x as long as wide; dorsum with several long acute setae on the apical half. **Mandibles** (Fig. 9E): left incisor with 3(1)+1+3 denticles; right incisor with 3(1)+4 denticles; prostheca of right mandible manifold; edge between molar and prostheca with acute setae. **Maxillae** (Fig. 9C): maxillary palpus ca. 1.4x as long as galealancinia, 2-segmented, subequal in length. **Labium:** labial palpus slender, 3-segmented, the articulation between segments II and III obscure; mesial margin of segment III slightly concave (Fig. 9D); paraglossa, with 2 rows of long acute setae at the apex on the lateral and mesial margins (Fig. 9B).

**Thorax:** hind wing pads absent (Fig. 9J); nota brown, somewhat reddish; mesonotum with a large pale marking near anterior margin distinctly and with several pale dots on the lateral area and fore wing pads (Fig. 9F). **Legs:** tibiae and tarsi scatter with trapezoidal-based scales; hind claw ca. 0.36x as long as hind tarsus.

**Abdomen:** Terga: brown, somewhat reddish, color pattern as Figs. 9J and 23. Each

tergum with trapezoidal-based scales densely. Posterior spines triangular (Fig. 9K), present on terga II–X and sterna VIII and IX, obscure on tergum II. **Paraproct** (Fig. 9I): subtriangular, surface with trapezoidal-based scales and pores; posteromedial margin with 7–9 denticles distinctly. **Gills** (Fig. 9H): present on abdominal segments I–VII, slender, leaf-shaped, each gill subequal in size; tracheae distinct. **Caudal filaments:** terminal filament 0.58x as long as cerci; basal 3/5 of cerci fringe with long fine setae; distal segments of cerci slightly extend in length; cerci darkish medially, gradually light distally.

### **Type material:**

**Holotype:** mature female nymph (in alcohol), Shuangtung, Kuohsing, NTH, TW, (260 m), 20 Feb. 1991, HCC. In NCHU. **Paratypes** (mature nymph): 8♂♂, 12♀♀, same data as for holotype. 5♂♂, 8♀♀ in NCHU; 3♂♂, 4♀♀ in NMNS.

### **Other mature nymphal specimens examined:**

5♀♀, Saoleinchi, Taoyuan, KSH, TW, (660 m), 14 Dec. 1990, SCK; 1♂, 1♀, Shinyu, PTH, TW, (205 m), 17 Dec. 1990, SCK; 3♂♂, 1♀, Laochichiao, Shoufeng, HLH, TW, (85 m), 3 Apr. 1991, SCK; 2♀♀, Sani, MLH, TW, (265 m), 19 Apr. 1991, SCK; 7♂♂, 6♀♀, Dongshyhger, Pinghsi, TPH, TW, (280 m), 31 May 1991, SCK and HCC; 3♂♂, 1♀, Kueigo, Kuohsing, NTH, TW, (210 m), 16 Nov. 1991, SCK; 1♀, Shuili, NTH, TW, (290 m), 18 Nov. 1991, SCK; 1♂, 1♀, Meishan, CIH, TW, (815 m), 19 Nov. 1991, SCK; 1♂, 2♀♀, Weichuan, Liukuei, KSH, TW, (235 m), 20 Dec. 1991, SCK; 2♂♂, Tuungtour, Chushan, NTH, TW, (120 m), 27 Jul. 1993, SCK; 1♂, 4♀♀, Shanherchiaur, Liukuei, KSH, TW, (250 m), 27 Jul. 1993, SCK; 2♂♂, Chianrernguu, Maolin, KSH, TW, (205 m), 27 Jul. 1993, SCK; 2♀♀, Dungshyhger, Pinghsi, TPH, TW, (280 m), 10 Sept. 1993, SCK; 1♀, Shuicheliao, Sanhsia, TPH, TW, (420 m), 11 Sept. 1993, SCK.

### **Distribution:**

Taiwan.

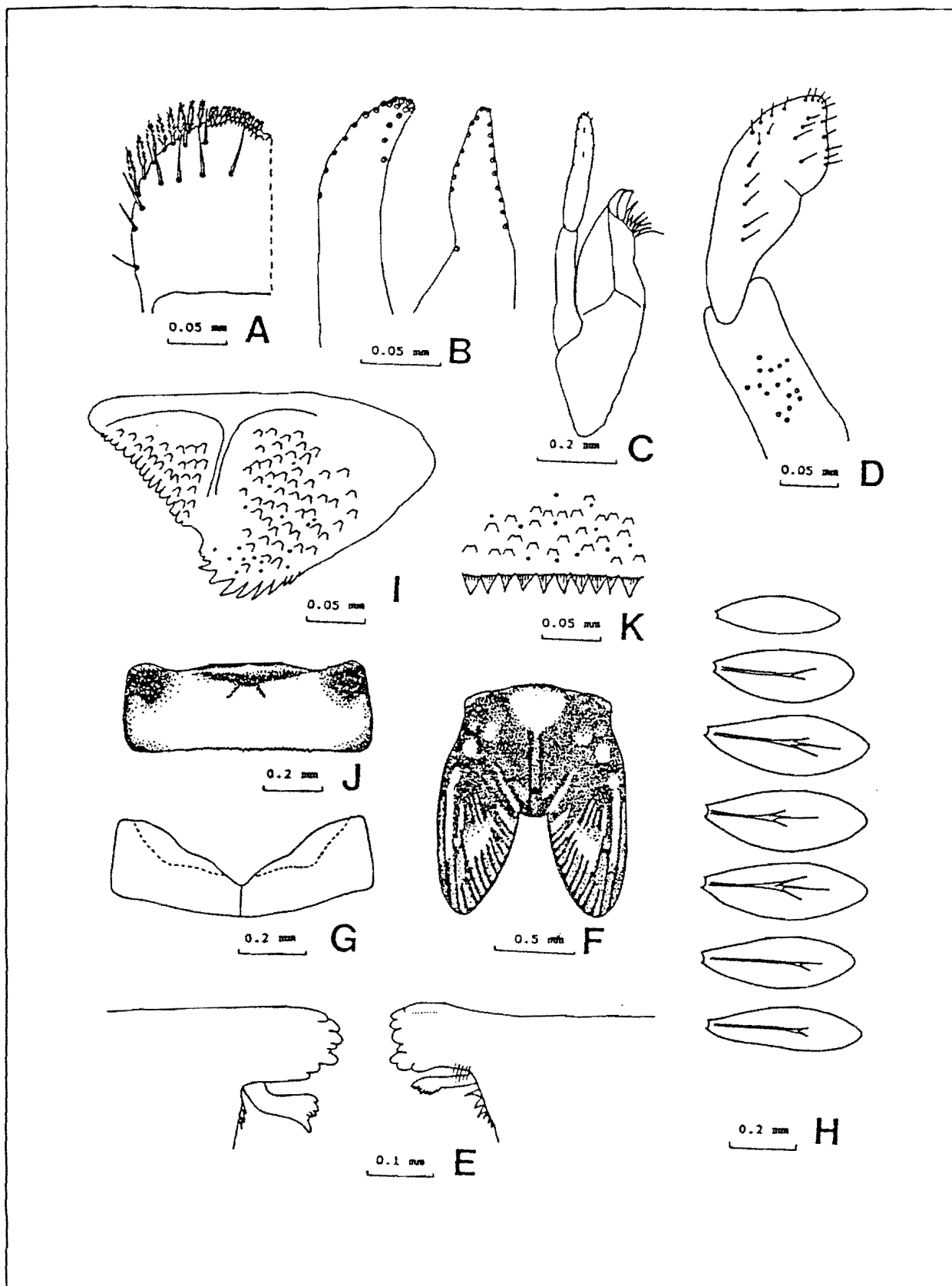


Fig. 9. Nymph of *Baetis facetus* n. sp. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, maxilla, ventral; D, labial palpus, dorsal; E, mandibular incisors and prosthecae, dorsal; F, mesonotum with fore wing pads, dorsal; G, metanotum with hind wing pads, dorsal; H, gills I-VII; I, paraproct; J, tergum V, dorsal; K, surface and posteromedial margin of tergum VI, dorsal.

Ety

gant

Rem

reco  
char  
sono  
medi  
sube

Type

(here

Descr

N

cute  
corne  
right  
ween  
tae (I  
segme  
Labia  
ween  
round  
III (I  
fine s  
Terga  
(Fig.  
Gills  
round  
and w

E  
refer

Sp  
*Baetis*  
the su

Remar

N

easily  
binatio  
(2) an

### Etymology:

Facetus. L., masculine, meaning fine or elegant.

### Remarks:

Nymph of this new species can easily be recognized from the following combination characters: (1) hind wing pads absent; (2) mesonotum with a large, pale marking antero-medially (Fig. 9F); (3) gills slender, each gill subequal in size; (4) color pattern of abdomen.

Subgenus *Tatubaetis* Kang and Yang,  
n. subgen.

### Type species:

*Baetis tatuensis* Müller-Liebenau, 1985  
(here designated).

### Description:

**Mature nymph.** — Labrum with 4 long acute setae, 2 submedially, 2 near anterolateral corner (Fig. 10A); apex of prostheca of the right mandible irregularly toothed, ridge between prostheca and molar smooth, without setae (Fig. 10L). Palpus of maxilla 2-segmented, segment II longer than segment I (Fig. 10D). Labial palpus 3-segmented, articulation between segment II and III obscure, segment III round, segment II shorter than 2× of segment III (Fig. 10C). Each femur with a tuft of fine setae on anteromesial corner (Fig. 10G). Terga and sterna scatter with lunate-based scales (Fig. 10I). Paraproct without scales (Fig. 10H). Gills 7 pairs, each gill without a dark band surrounding the margin; margins of gills serrated and with fine setae.

**Etymology.** — Masculine gender, "Tatu" a reference to the type species.

**Species included.** — Only the type species *Baetis tatuensis* Müller-Liebenau is included in the subgenus *Tatubaetis*.

### Remarks:

Nymphs of this subgenus *Tatubaetis* are easily recognizable from the following combination characters: (1) shape of labial palpus; (2) anteromesial corner of each femur with

tuft fine setae; (3) ridge between molar and prostheca smooth, without setae; (4) paraproct without scales.

*Baetis* (*Tatubaetis*) *tatuensis* Müller-Liebenau  
(Figs. 10, 24)

*Baetis tatuensis* Müller-Liebenau, 1985: 96.

### Mature nymphs: (Fig. 10)

Body length: male 3.5 – 6.6 mm; female 4.0 – 7.8 mm.

**Head:** Antennae: length ca. 2.8× width of head: scape and pedicel with fine setae sparsely. **Labrum** (Fig. 10A): ca. 0.63× as long as wide; dorsum with several long acute setae near anterior margin. **Mandibles** (Fig. 10L): left incisor with 3+4 denticles; right incisor with 3(1)+4 denticles; prostheca of right mandible maniform; edge between prostheca and molar without setae. **Maxillae** (Fig. 10D): maxillary palpus ca. 1.3× as long as galea-lancinia, 2-segment, segment I slightly shorter than segment II. **Labium:** labial palpus 3-segmented, segments III expanded, round (Fig. 10C); paraglossa with 2 rows of long acute setae along lateral margin: paraglossa 1.4× as wide as glossa (Fig. 10B).

**Thorax:** hind wing pads distinct (Fig. 10F); nota with more varied coloration, light brown to dark brown, yellowish or milky. **Legs:** each femur with a tuft of fine setae on the anterolateral corner (Fig. 10G) and with a row of clavate setae along the posterior margin (Fig. 10K); fore and middle tibiae with lunate-based scales sparsely; claw convex on mesial margin; hind claw ca. 0.44× as long as hind tarsus.

**Abdomen:** Terga: same as nota, with very varied coloration, color pattern as Figs. 10E and 24. Posterior spines invisible on terga I–VI (Fig. 10I), present on terga VII–X, obscure on terga VII and VIII. **Paraproct** (Fig. 10H): subtriangular, surface only with fine setae and pores: posteromedial margin with 4–6 denticles. **Gills** (Fig. 10J): present on abdominal segments I–VII, oval; tracheae obscure; **Caudal filaments:** terminal filament 0.67× as long as cerci; medial 2/5 of cerci fringe with long fine setae; the middle of cerci and the



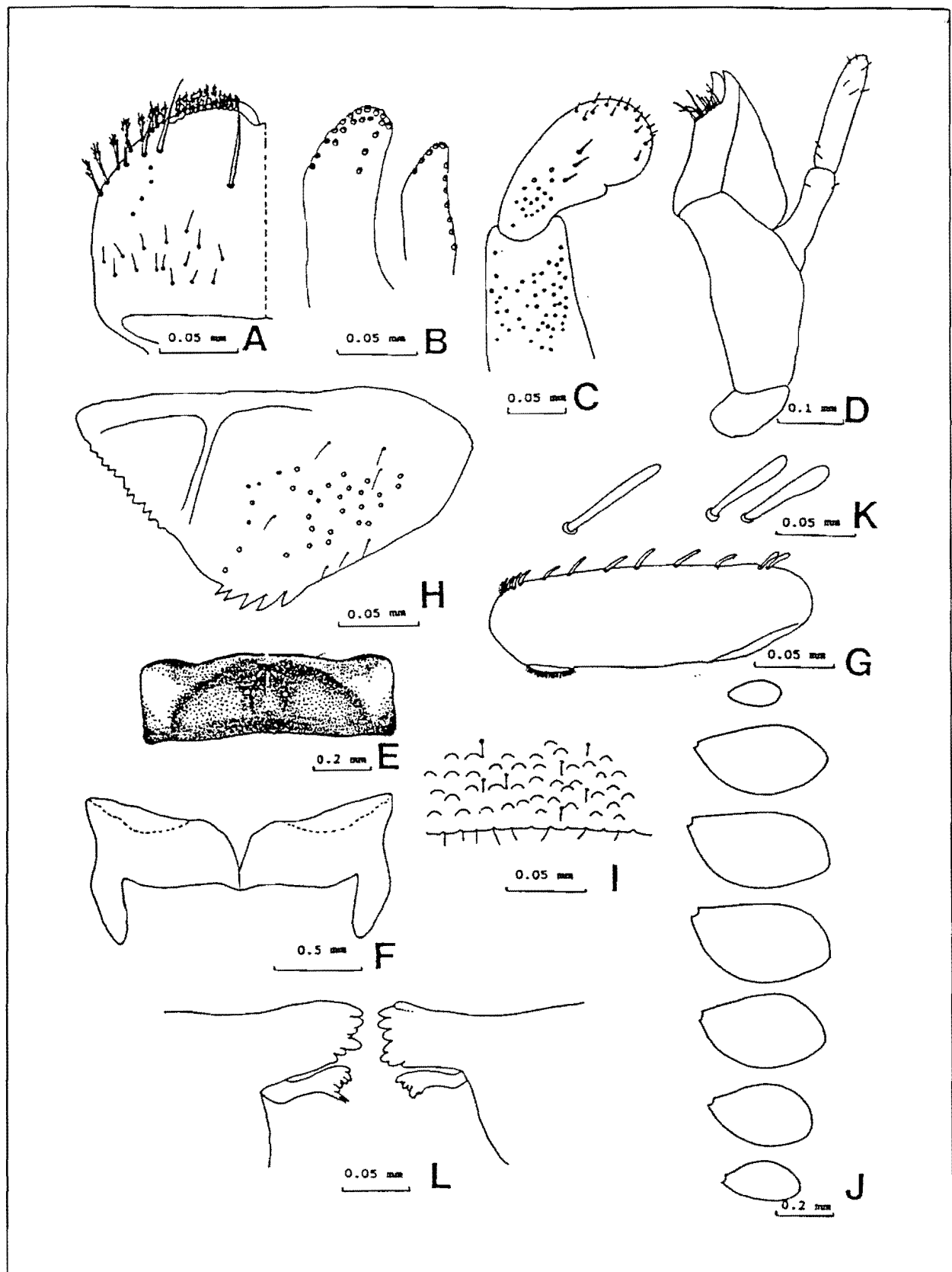


Fig. 10. Nymph of *Baetis tatuensis* Müller-Liebenau. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, labial palpus, dorsal; D, maxilla, ventral; E, tergum VI, dorsal; F, metanotum with hind wing pads, dorsal; G, femur, dorsal; H, paraproct; I, surface and posteromedial margin of tergum VI, dorsal; J, gills I–VII; K, setae of posterior margin of femur; L, mandibular incisors and prosthecae, dorsal.

end  
disti  
Matu  
I A:  
TW  
19  
18  
Hen  
SCK  
12.4  
Fuli  
566  
199  
TW  
Fuy  
199  
HLF  
Shua  
20 F  
TW  
chia  
199  
(1.4  
San  
366  
m),  
Thw  
199  
Tatu  
and  
ILH  
499  
m).  
chur  
HCC  
NTF  
299  
20  
Luk  
and  
TW  
466  
m).  
Luk  
SCK  
NTF  
HCC  
(1,0

end of terminal filament with a dark band distinctly.

**Mature nymphal specimens examined:**

2♂♂, 6♀♀, Chian, HLH, TW, (110 m), 1 Apr. 1990, SCK; 11♂♂, 17♀♀, Alishan, CIH, TW, (2,020 m), 25 Jul. 1990, HCC; 3♂♂, 1♀, Chih-tuan, Tatung, ILH, TW, (1,130 m), 18 Nov. 1990, SCK and HCC; 7♂♂, 4♀♀, Hengshan, SCH, TW, (220 m), 19 Nov. 1990, SCK; 3♀♀, Tienchi, Taoyuan, KSH, TW, (2,445 m), 14 Dec. 1990, SCK; 8♂♂, 12♀♀, Fuli, HLH, TW, (370 m), 16 Dec. 1990, SCK; 5♂♂, 5♀♀, Tungho, TTH, TW, (70 m), 16 Dec. 1990, SCK; 5♂♂, 8♀♀, Shinlu, Shityu, PTH, TW, (205 m), 17 Dec. 1990, SCK; 3♂♂, 2♀♀, Fuyuan, Juisui, HLH, TW, (280 m), 2 Jan. 1991, SCK; 1♂, 2♀♀, Kaunyuan, Hsiulin, HLH, TW, (2,350 m), 3 Jan. 1991, SCK; 3♂♂, Shuangtung, Kuohsing, NTH, TW, (260 m), 20 Feb. 1991, HCC; 19♂♂, 28♀♀, Peinan, TTH, TW, (40 m), 1 Apr. 1991, HCC; 1♀, Chenwu-chiao, Hoping, TCH, TW, (1,525 m), 4 Apr. 1991, SCK; 3♀♀, Chaiyan, Hoping, TCH, TW, (1,470 m), 17 Apr. 1991, HCC; 5♂♂, 6♀♀, Sani, MLH, TW, (265 m), 19 Apr. 1991, SCK; 3♂♂, 4♀♀, Chaiyan, Hoping, TCH, TW, (1,520 m), 28 May 1991, SCK and HCC; 16♂♂, 19♀♀, Thwen, Hoping, TCH, TW, (1,800 m), 29 May 1991, SCK and HCC; 13♂♂, 27♀♀, Chilan, Tatung, ILH, TW, (200 m), 30 May 1991, SCK and HCC; 17♂♂, 2♀♀, Nanhutashan, Tatung, ILH, TW, (2,450 m), 6 Jul. 1991, HCC; 2♂♂, 4♀♀, Nanhutashan, Tatung, ILH, TW, (2,285 m), 7 Jul. 1991, HCC; 7♂♂, 5♀♀, Hwesunlinchun, Lenai, NTH, TW, (750 m), 19 Aug. 1991, HCC; 16♂♂, 21♀♀, Hwesunlinchun, Lenai, NTH, TW, (750 m), 20 Aug. 1991, HCC; 3♂♂, 2♀♀, Tsaotun, Kuohsing, NTH, TW, (190 m), 20 Aug. 1991, HCC; 22♂♂, 37♀♀, Shanlinsi, Luku, NTH, TW, (850 m), 22 Aug. 1991, SCK and HCC; 12♂♂, 19♀♀, Shanlinhsi, Luku, NTH, TW, (950 m), 22 Aug. 1991, SCK and HCC; 4♂♂, 3♀♀, Shanlinhsi, Luku, NTH, TW, (870 m), 22 Aug. 1991, SCK and HCC; 2♂♂, 6♀♀, Luku, NTH, TW, (1,040 m), 30 Aug. 1991, SCK and HCC; 7♂♂, 13♀♀, Shanlinhsi, Luku, NTH, TW, (1,010 m), 30 Aug. 1991, SCK and HCC; 41♂♂, 46♀♀, Hsitou, Luku, NTH, TW, (1,010 m), 30 Aug. 1991, SCK and HCC; 7♂♂,

9♀♀, Tapa, Wufeng, HCH, TW, (1,755 m), 23 Oct. 1991, SCK and HCC; 13♂♂, 15♀♀, Wusichiao, Wufeng, TCH, TW, (185 m), 16 Nov. 1991, SCK; 1♂, 4♀♀, Pinglin, Tsaotun, NTH, TW, (190 m), 16 Nov. 1991, SCK; 6♂♂, 5♀♀, Shuili, NTH, TW, (290 m), 18 Nov. 1991, SCK; 3♂♂, 6♀♀, Sinchungheng, Hsini, NTH, TW, (540 m), 18 Nov. 1991, SCK; 6♂♂, 7♀♀, Alishan, CIH, TW, (2,135 m), 19 Nov. 1991, SCK; 9♂♂, 11♀♀, Shanping, Liukuei, KSH, TW, (515 m), 19 Dec. 1991, SCK; 5♂♂, 4♀♀, Maolin, KSH, TW, (180 m), 20 Dec. 1991, SCK; 11♂♂, 7♀♀, Wusichiao, Wufeng, TCH, TW, (165 m), 20 Jan. 1992, SCK; 4♀♀, Mayyuan, Chienshih, HCH, TW, (665 m), 11 Jul. 1992, SCK; 4♀♀, Holio, Chienshih, HCH, TW, (520 m), 11 Jul. 1992, SCK; 23♂♂, 30♀♀, Janghur, Kukeng, YLH, TW, (295 m), 26 Jul. 1993, SCK; 2♀♀, Tuung-tour, Chushan, NTH, TW, (255 m), 26 Jul. 1993, SCK; 1♂, 1♀, Tuungtour, Chushan, NTH, TW, (120 m), 27 Jul. 1993, SCK; 1♂, 2♀♀, Chairdierrguu, Liukuei, KSH, TW, (340 m), 27 Jul. 1993, SCK; 7♂♂, 9♀♀, Shanherchiaur, Liukuei, KSH, TW, (250 m), 27 Jul. 1993, SCK; 2♂♂, 1♀, Chianrernguu, Maolin, KSH, TW, (205 m), 27 Jul. 1993, SCK; 2♂♂, 1♀, Gauyaur, Fuhsing, TYH, TW, (400 m), 9 Sept. 1993, SCK; 1♂, Dahanchiao, Fuhsing, TYH, TW, (640 m), 9 Sept. 1993, SCK; 2♂♂, 3♀♀, Mirnchyr, Tatung, ILH, TW, (1,090 m), 9 Sept. 1993, SCK; 6♂♂, 7♀♀, Shitsun, Fuhsing, TYH, TW, (1,065 m), 9 Sept. 1993, SCK; 2♂♂, 2♀♀, Dungshyhger, Pinghsi, TPH, TW, (280 m), 10 Sept. 1993, SCK; 2♀♀, Kanchiao, Shuangchi, TPH, TW, (140 m), 10 Sept. 1993, SCK; 1♂, Parnshankeng, Shuangchi, TPH, TW, (145 m), 10 Sept. 1993, SCK; 4♂♂, 3♀♀, Kuolai, Pinglin, TPH, TW, (315 m), 10 Sept. 1993, SCK; 1♀, Shuicheliao, Sanhsia, TPH, TW, (420 m), 11 Sept. 1993, SCK; 3♂♂, 4♀♀, Chukun, Yuanshan, ILH, TW, (180 m), 15 Sept. 1993, SCK; 1♂, 3♀♀, Fushan, Yuanshan, ILH, TW, (570 m), 15 Sept. 1993, SCK; 3♂♂, 1♀, Fushan, Yuanshan, ILH, TW, (530 m), 15 Sept. 1993, SCK; 3♂♂, 3♀♀, Fushan, Yuanshan, ILH, TW, (480 m), 15 Sept. 1993, SCK; 2♀♀, Harpen, Wulai, TPH, TW, (570 m), 16 Sept. 1993, SCK; 3♂♂, 5♀♀, Jingyang, Nanao, ILH, TW, (145 m), 17 Sept. 1993, SCK; 2♂♂, 4♀♀, Jingyang, Nanao, ILH, TW, (220 m), 17 Sept. 1993,

SCK; 2♂♂, 1♀, Laochichiao, Shoufeng, HLH, TW, (85 m), 18 Sept. 1993, SCK; 1♂, 1♀, Fenglin, HLH, TW, (140 m), 18 Sept. 1993, SCK; 2♂♂, 4♀♀, Fuyuan, Juisui, HLH, TW, (280 m), 18 Sept. 1993, SCK; 2♂♂, 2♀♀, Charnghunchiao, Hsiulin, HLH, TW, (70 m), 19 Sept. 1993, SCK; 2♂♂, 1♀, Tienhsiang, Hsiulin, HLH, TW, (450 m), 19 Sept. 1993, SCK; 11♂♂, 16♀♀, Tzuyurnchiao, Hsiulin, HLH, TW, (1,300 m), 19 Sept. 1993, SCK; 2♀♀, Kanchiao, Shuangchi, TPH, TW, (140 m), 13 Nov. 1993, SCK.

**Distribution:**

Taiwan.

Subgenus *Tenuibaetis* Kang and Yang,  
n. subgen.

**Type species:**

*Baetis pseudofrequentus* Müller-Liebenau, 1985 (here designated).

**Description:**

**Mature nymph.** – Labrum with 4 long acute setae, 2 submedially, 2 near anterolateral corner (Figs. 11A, 13A, 14A); apex of prostheca of the right mandible irregularly toothed, ridge between prostheca and molar smooth, without setae (Figs. 11L, 13D, 14E, F). Palpus of maxilla 2-segmented, apex of segment II with numerous fine setae (Figs. 11E, 13H, 14C). Labial palpus 3-segmented, segment II slender, longer than 2× of segment III; anteromesial corner of segment II slightly jutting, the jutting with fine setae (Figs. 11D, 13D), segment III conical, apex somewhat acute. Each femur with a tuft of fine setae on anteromesial corner (Fig. 14I); denticles of claw progressively larger apically (Fig. 14H). Terga, sterna, dorsum of legs scatter with lunate-based scales (Figs. 11K, 13I, 14L). Paraproct with notched scales medially (Figs. 11I, 13J, 14K). Gills 7 pairs, each gill without a dark band surrounding the margin; margins of gills serrated and with fine setae.

**Etymology.** – Masculine gender, *tenuis* (slender or thin), in reference to the labial

palpus slender.

**Species included.** – Besides the type species *Baetis pseudofrequentus* Müller-Liebenau, 2 new species from Taiwan should be included in the subgenus *Tenuibaetis*, i.e., *B. inornatus* Kang and Yang, n. sp. and *B. arduus* Kang and Yang n. sp.

**Remarks:**

Nymphs of this subgenus *Tenuibaetis* are easily recognizable from the following combination characters: (1) shape of labial palpus; (2) anteromesial corner of each femur with tufty fine setae; (3) ridge between molar and prostheca smooth, without setae; (4) paraproct with notched scale medially. *Tenuibaetis* n. subgen. is closely related to *Tatubaetis* n. subgen. is closely related to *Tatubaetis* n. subgen. The main differences are the shape of labial palpus and paraproct with notched scale medially.

*Baetis (Tenuibaetis) pseudofrequentus*  
Müller-Liebenau  
(Figs. 11, 25)

*Baetis pseudofrequentus* Müller-Liebenau, 1985: 98.

**Mature nymphs:** (Fig. 11)

Body length: male 3.2 – 3.4 mm; female 3.0 – 3.2 mm.

**Head:** **Antennae:** length ca. 3× width of head; scape and pedicel scatter with short fine setae (Fig. 11C). **Labrum** (Fig. 11A): ca. 0.78× as long as wide; dorsum with 4 long acute setae, 2 submedially and 2 anterolaterally. **Mandibles** (Fig. 11F): left incisor with 3+1+3 denticles; right incisor with 3+3 denticles; prostheca of right mandible maniform; edge between molar and prostheca smooth, without setae. **Maxillae** (Fig. 11E): maxillary palpus ca. 1.3× as long as galea-lancinia, 2-segmented, segment II ca. 1.5× as long as segment I. **Labium:** labial palpus slender, 3-segmented, the articulation between segments II and III obscure, anteromesial corner of segment II slightly jutting (Fig. 11D); paraglossa 1.3× as wide as glossa,

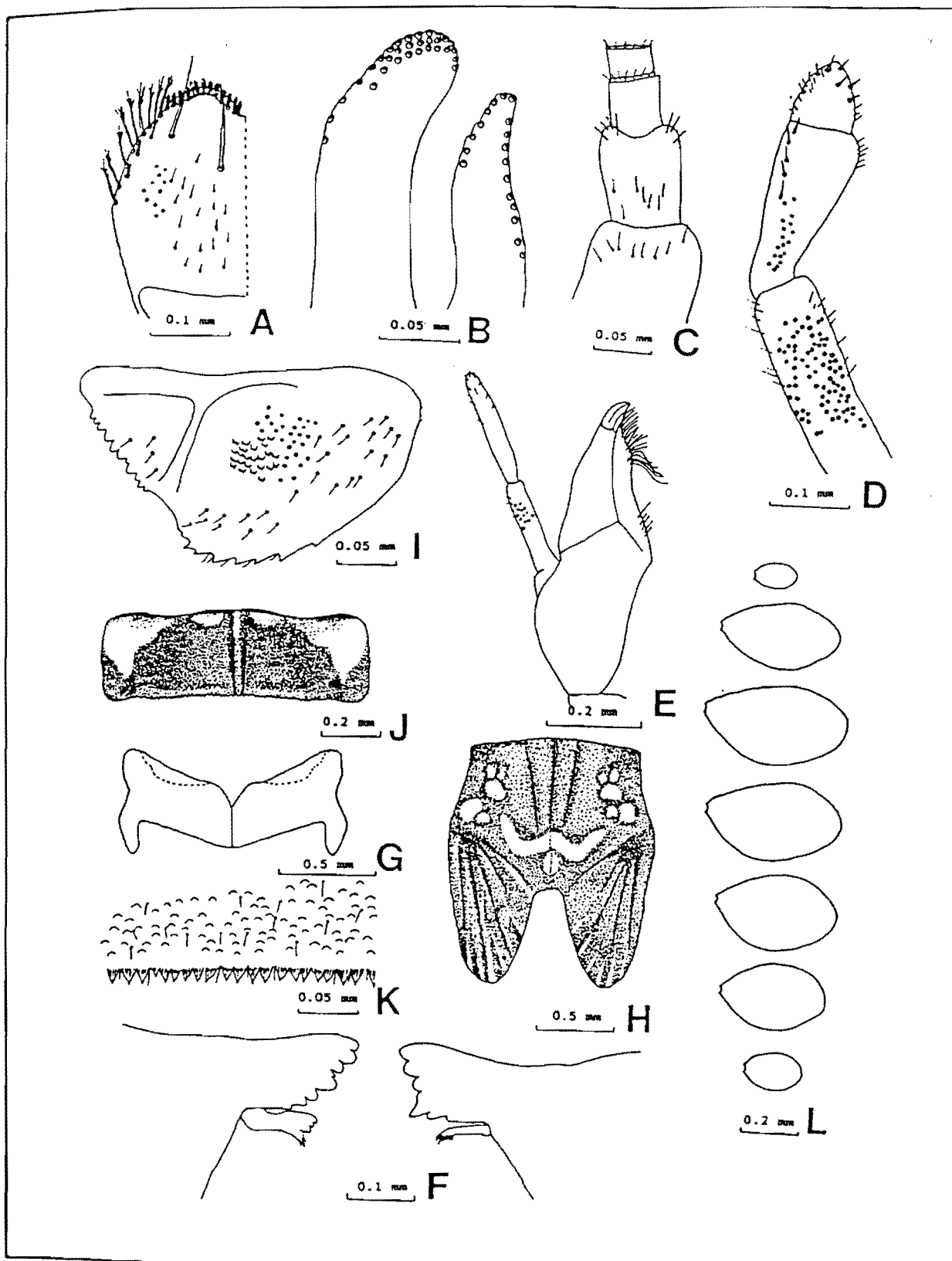


Fig. 11. Nymph of *Baetis pseudofrequentus* Müller-Liebenau. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, antennal scape and pedicel, dorsal; D, labial palpus, dorsal; E, maxilla, ventral; F, mandibular incisors and prosthecae, dorsal; G, metanotum with hind wing pads, dorsal; H, mesonotum with fore wing pads, dorsal; I, paraproct; J, tergum VI, dorsal; K, surface and posteromedial margin of tergum VI, dorsal; L, gills I-VII.

the species  
Liebenau, 2  
included  
*normatus*  
Kang and

*aetis* are  
ing com-  
l palpus;  
ur with  
olar and  
araproct  
*baetis* n.  
s n. sub-  
subgen.  
of labial  
le medi-

*urus*

u, 1985:

female

width of  
ort fine  
i. 0.78x  
e setae,  
indibles  
entacles;  
heca of  
a molar  
axillae  
as long  
II ca.

labial  
ulation  
antero-  
jutting  
glossa.

with 3 rows of long acute setae at the apex (Fig. 11B).

**Thorax:** hind wing pads distinct (Fig. 11G); nota light brown to dark brown; mesonotum with several pale dots laterally and with 1 W-shaped marking or pale posteriorly (Fig. 11H). **Legs:** each femur with a dark dot submedially, with a row of clavate setae posteriorly and with a tuft of close-set, fine setae on the anteromesial corner; tibiae and tarsi with acute setae; hind claw ca. 0.42× as long as hind tarsus.

**Abdomen:** Terga: light brown to dark brown, color pattern as Figs. 11J and 25. Each tergum with trapezoidal-based scales (Fig. 11K). Posterior spines acute (Fig. 11K), present on every tergum and sterna VII–IX, obscure on sternum VII. **Paraproct** (Fig. 11I): subtriangular; surface with notched-based scales, pores and short fine setae; posteromedial margin slightly serrate. **Gills** (Fig. 11L): present on abdominal segments I–VII, oval, gill I and VII much smaller than the remainder; tracheae obscure. **Caudal filaments:** terminal filament 0.60× as long as cerci; cerci darkish distally; basal 4/5 of cerci fringe with long fine setae.

#### Mature nymphal specimens examined:

3♂♂, 7♀♀, Liukuei, KSH, TW, (180 m), 7 Jan. 1989, SCK; 3♀♀, Maolin, KSH, TW, (180 m), 27 Jan. 1990, SCK; 28♂♂, 43♀♀, Chian, HLH, TW, (110 m), 1 Apr. 1990, SCK; 4♂♂, 2♀♀, Nanao, ILH, TW, (150 m), 2 Apr. 1990, SCK; 5♂♂, 8♀♀, Hsuehtien, Fuli, HLH, TW, (260 m), 16 Dec. 1990, SCK; 3♂♂, 7♀♀, Peinan, TTH, TW, (40 m), 1 Apr. 1991, HCC; 1♂, Shuangchi, TPH, TW, (450 m), 31 May 1991, SCK and HCC; 4♂♂, 8♀♀, Tsaotun, Kuohsing, NTH, TW, (190 m), 20 Aug. 1991, HCC; 5♂♂, 3♀♀, Wusichao, Wufeng, TCH, TW, (185 m), 16 Nov. 1991, SCK; 2♂♂, 3♀♀, Pinglin, Tsaotun, NTH, TW, (190 m), 16 Nov. 1991, SCK; 3♂♂, 6♀♀, Gutuyulin, Kuohsing, NTH, TW, (225 m), 16 Nov. 1991, SCK; 6♂♂, 5♀♀, Sinchungheng, Hsini, NTH, TW, (620 m), 18 Nov. 1991, SCK; 2♀♀, Eashan, Alishan, CIH, TW, (745 m), 19 Nov. 1991, SCK; 11♂♂, 9♀♀, Maolin, KSH, TW, (180 m), 20 Dec. 1991, SCK; 3♂♂, 4♀♀, Liukuei, KSH, TW, (210 m), 20 Dec. 1991, SCK; 2♀♀, Wusichiao, Wufeng,

TCH, TW, (165 m), 20 Jan. 1992, SCK; 3♂♂, 5♀♀, Pinling, Tsaotun, NTH, TW, (195 m), 20 Jan. 1992, SCK; 4♂♂, 2♀♀, Charnghunchiao, Hsiulin, HLH, TW, (70 m), 19 Sept. 1993, SCK; 1♂, 1♀, Tienhsiang, Hsiulin, HLH, TW, (450 m), 19 Sept. 1993, SCK.

#### Distribution:

Taiwan.

*Baetis (Tenuibaetis) inornaturs* Kang  
and Yang n. sp.  
(Figs. 12, 13, 26)

#### Mature nymphs: (Figs. 12, 13)

Body length: male 3.2–3.7 mm; female 3.5–4.2 mm.

**Head:** dark brown, lightish between eyes and antennae, frons with pale markings (Fig. 13B). **Antennae:** length ca. 2.57× width of head; scape pale, darkish laterally, scape and pedicel with short fine setae sparsely (Fig. 13C). **Labrum** (Fig. 13A): with a V-shaped dark marking medially; length ca. 0.8× as long as wide; dorsum with 4 long acute setae near anterior margin. **Mandibles** (Figs. 13D, 10E): left incisor with 3+3 denticles; right incisor with 3+3 denticles; prostheca of right mandible toothed; edge between prostheca and molar smooth, without setae. **Maxillae** (Fig. 13H): maxillary palpus ca. 1.15× as long as galealancinia, 2-segmented, segment II ca. 1.7× as long as segment I, brown apically. **Labium:** labial palpus slender, 3-segmented, segment II light brown, segment III dark brown, the articulation between segments II and III pale distinct; anterolateral corner of segment II slightly jutting (Fig. 13F); paraglossa ca. 2.2× as wide as glossa, venter with 2 rows of long acute setae at the apex (Fig. 13G).

**Thorax:** hind wing pads distinct; nota uniformly dark brown (Fig. 13). **Legs:** dorsum of fore femur brown, lightish apically, with 1 oval, pale marking near the base; each femur with tuft of fine setae on the anterolateral corner; tibiae and tarsi with acute setae; hind claw ca. 0.43× as long as hind tarsus.

**Abdomen:** Terga: uniformly brown, color pattern as Fig. 26; each tergum with lunate-

based scales. Posterior spines blunt (Fig. 13I), present on every tergum and sternum IX, obscure on tergum I. Paraproct (Fig. 13J): sub-triangular surface with notched scales, pores and short fine setae, the scale base very fine, nearly obscure; posteromedial margin with acute serrate. Gills (Fig. 13K): present on abdominal segments I–VII, oval, gill I and VII much smaller than the remainder; tracheae distinct. Caudal filaments: terminal filament 0.65× as long as cerci; cerci with dark band on the middle and the apex; basal 5/6 of cerci fringe with long fine setae.

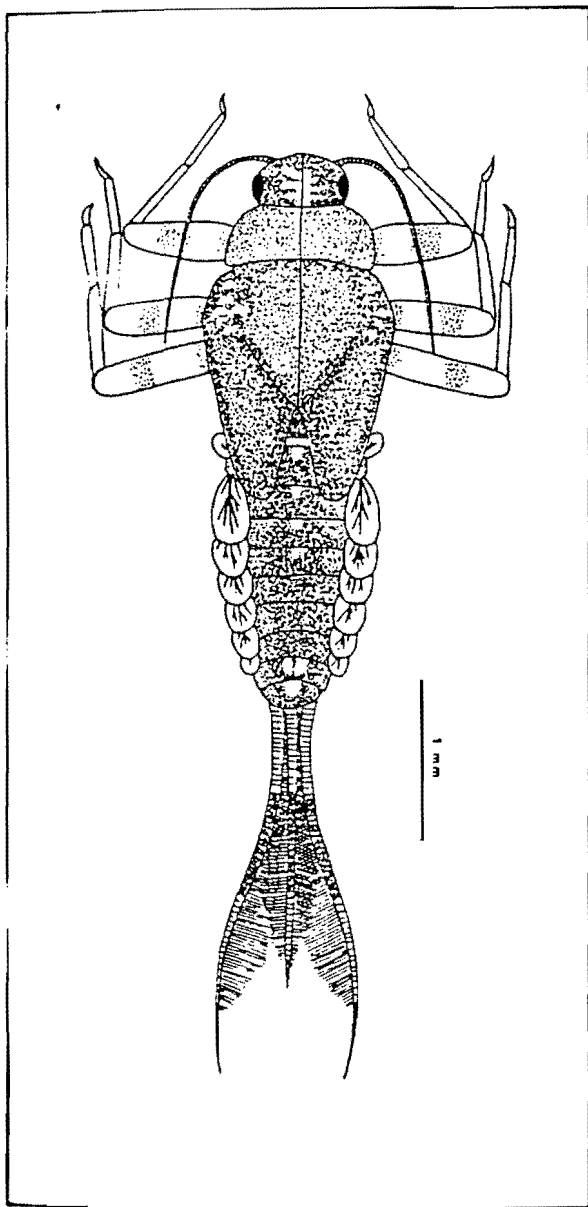


Fig. 12. Mature female nymph of *Baetis inornatus* n.sp.

#### Type material:

**Holotype:** mature male nymph (in alcohol), Shitsun, Fuhsing, TYH, TW, (1,065 m), 9 Sept. 1993, SCK. In NCHU. **Paratypes** (mature nymph): 3♂♂ (2 slidemounted), 2♀♀ (1 slidemounted), same data as for holotype; 1♀ (slidemounted), Fushan, Yuanshan, ILH, TW, (570 m), 15 Sept. 1993, SCK. 2♂♂, 2♀♀ in NCHU; 1♂, 1♀ in NMNS.

#### Distribution:

Taiwan.

#### Etymology:

*Inornatus*, L., masculine, meaning undorned.

#### Remarks:

This new species resembles *Baetis pseudofrequentus* Müller-Liebenau but can be differentiated in nymphs by the following characters: (1) anteromedial cleft of labrum deeper than in *B. pseudofrequentus*; (2) dorsum labrum with a V-shaped marking medially; (3) posterior spines blunt but acute in *pseudofrequentus*; (4) gill I much larger than in *pseudofrequentus*.

*Baetis (Tenuibaetis) arduus* Kang  
and Yang n. sp.  
(Figs. 14, 27)

#### Mature nymphs: (Fig. 14)

Body length: male 4.3–5.2 mm; female 4.5–5.8 mm.

**Head:** **Antennae:** length ca. 2× width of head; scape and pedicel with short fine setae sparsely. **Labrum** (Fig. 14A): ca. 0.8× as long as wide; dorsum with 4 long acute setae near anterior margin. **Mandibles** (Figs. 14E, 14F): left incisor with 3+1+3 denticles; right incisor with 3+1+3 denticles; prostheca of right mandible toothed; edge between the molar and the prostheca smooth, without setae. **Maxillae** (Fig. 14C): maxillary palpus a little longer than galea-lancinia, 2-segmented, segment II ca. 1.5× as long as segment I, apex with fine setae. **Labium:** labial palpus (Fig.

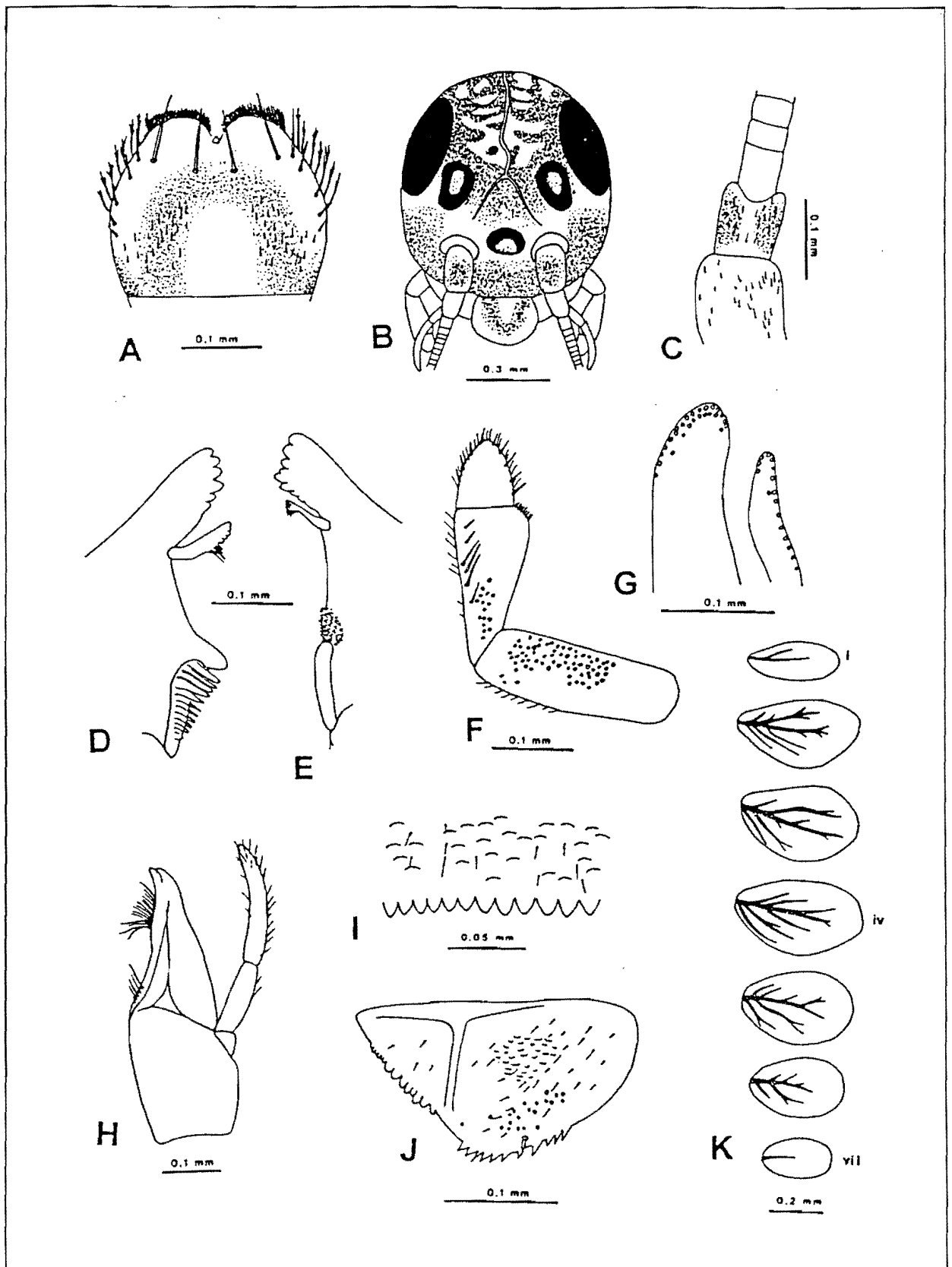


Fig. 13. Nymph of *Baetis inornatus* n. sp. A, labrum, dorsal; B, maxilla; C, antennal scape and pedicel, dorsal; D, left mandible, dorsal; E, right mandible, dorsal; F, labial palpus, dorsal; G, glossa and paraglossa, ventral; H, maxilla; I, surface and posteromedial margin of tergum VI, dorsal; J, paraproct; K, gills I-VII.

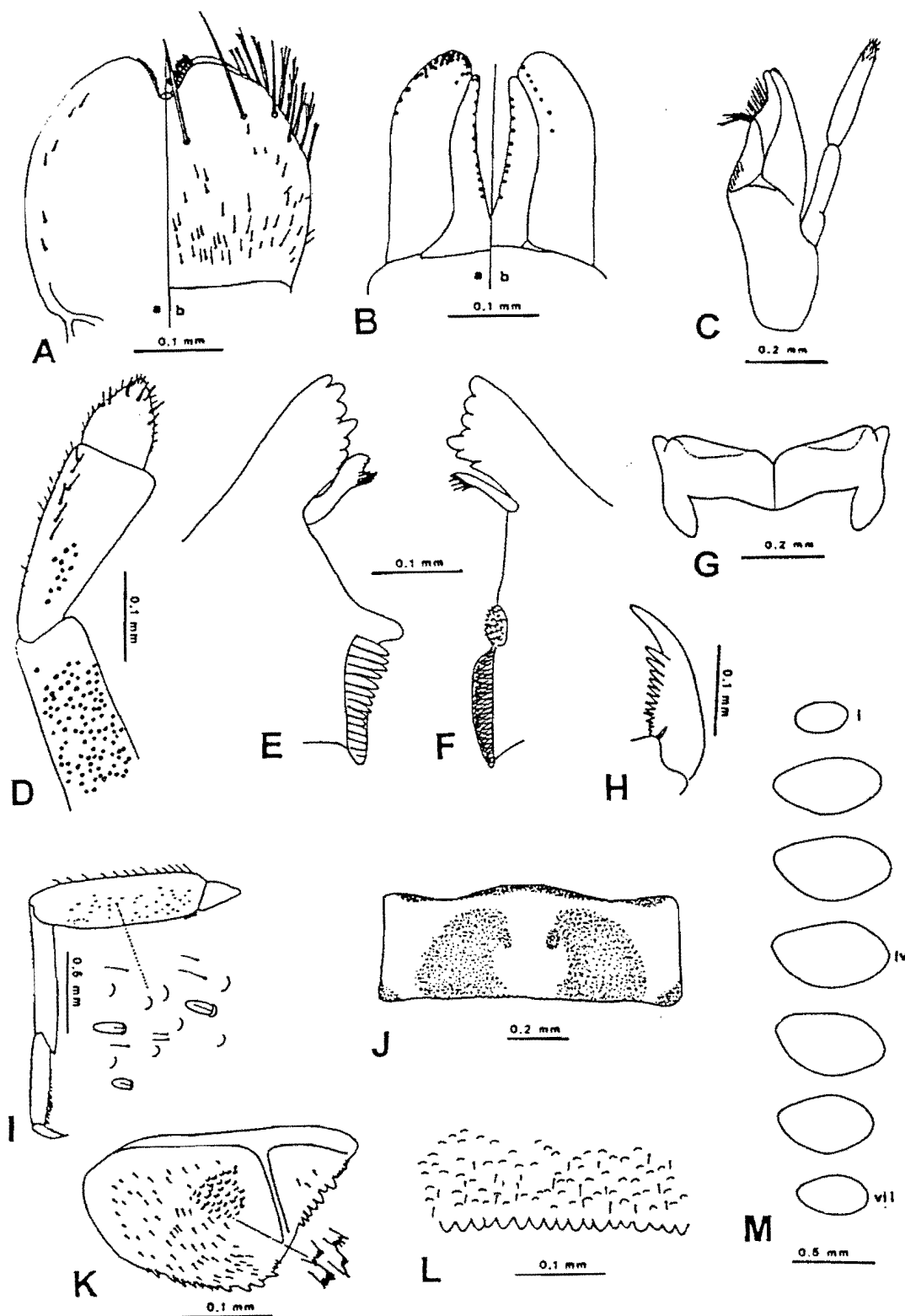


Fig. 14. Nymph of *Baetis arduus* n. sp. A, labrum (a, ventral; b, dorsal); B, glossa and paraglossa, (a, dorsal; b, ventral); C, maxilla; D, labial palpus, dorsal; E, left mandible, dorsal; F, right mandible, dorsal; G, metanotum with hind wing pads, dorsal; H, hind claw; I, hind leg, dorsal; J, tergum VI, dorsal; K, parapleuron; L, surface and posteromedial margin of tergum VI, dorsal; M, gills I-VII.

dorsal;  
iglossa,  
gills I-



14D) slender, 3-segmented; anterolateral corner of segment II slightly jutting; paraglossa ca. 2x as wide as glossa, venter with 3 rows of long acute setae at the apex (Fig. 14B).

**Thorax:** hind wing pads distinct (Fig. 14G); nota light brown to brown with pale markings. **Legs** (Figs. 14I, 14J): each femur with a transverse dark area on dorsum medially, with a row of clavate setae posteriorly and with a tuft of close-set, fine setae on the anteromesial corner; tibiae and tarsi with acute setae. Claw with a row of serration; hind claw ca. 0.40x as long as hind tarsus.

**Abdomen:** **Terga:** pale with brown markings, color pattern as Figs. 14J and 27; each tergum with lunate-based scales. Posterior spines blunt (Fig. 14L), present on terga II–X and sterna VIII, IX. **Paraproct** (Fig. 14K): subtriangular; surface with notched-based scales, pores and short fine setae; posteromedial margin slightly serrate. **Gills** (Fig. 14M): present on abdominal segments I–VII, oval, gill I much smaller than the remainder; tracheae obscure. **Caudal filaments:** terminal filament ca. 0.76x as long as cerci; basal 7/10 of cerci fringe with long fine setae; cerci darkish on the distal half.

#### Type material:

**Holotype:** mature female nymph (in alcohol), Tzuenchiao, Hsiulin, HLH, TW, (2,010 m), 19 Sept. 1993, SCK. In NCHU. **Paratypes** (mature nymph): 6♂♂, 12♀♀, same data as for holotype. 4♂♂, 8♀♀ in NCHU; 2♂♂, 4♀♀ in NMNS.

#### Distribution:

Taiwan.

#### Etymology:

Arduus, L., masculine, steep, towering or lefty.

#### Remarks:

This new species resembles both *Baetis pseudofrequentus* Müller-Liebenau and *B. inornatus* n. sp. but can be differentiated in nymphs from *pseudofrequentus* by the following characters: (1) anteromedial cleft of labrum deeper than in *B. pseudofrequentus*; (2) posterior

spines blunt but acute in *pseudofrequentus*; (3) sternum I without posterior spines; (4) color pattern of abdomen and thorax. In comparison with *inornatus*, we can differentiate them from the gills, color pattern of labrum, abdomen and caudal filaments.

#### Subgenus *Mullerbaetis* Kang and Yang, n. subgen.

#### Type species:

*Baetis molawinensis* Müller-Liebenau, 1982 (here designated).

#### Description:

**Mature nymph.** – Labrum with a row of close-set setae on each side and near anterior margin (Figs. 15A, 16A); Prosthema of the right mandible maniform, each denticle subequal in size, incisor of right mandible fringe with a row of long fine setae near mesial margin (Figs. 16H, 17H). Palpus of maxilla 2-segmented, mesial margin of segment II retuse near the apex (Figs. 15D, 16D). Labial palpus 3-segmented, articulation between segment II and III obscure; mesial margin of segment II with a large lobe almost as large as large as segment III (Figs. 15E, 16E). Glossa thin, much smaller than paraglossa (Figs. 15B, 16B, G). Terga, sterna, dorsum of legs scatter with (Fig. 15J) or without (Fig. 16L) postero-internal extension. Gills 6 or 7 pairs, each gill without a dark band surrounding the margin; margins of gills serrated and with fine setae.

**Etymology.** – Masculine gender, *Mullerbaetis* is named in recognition of Dr. I. Müller-Liebenau for her contributions to the oriental Baetidae.

**Species included.** – Besides the type species *Baetis molawinensis* Müller-Liebenau, 11 oriental species should be included in the subgenus *Mullerbaetis*, i.e., *B. morus* Chang and Yang, n. sp. [Taiwan], *B. borneoensis* Müller-Liebenau, 1984 [East Malaysia], *B. diffundus* Müller-Liebenau, 1984 [West Malaysia], *B. dif-*  
*ficilis* Müller-Liebenau, 1984 [West Malaysia],

B. c  
lays  
tak  
We  
198  
Lieb  
Mull  
rus

Ren

asil  
rs.  
near  
II of  
II of  
ly si  
grou  
(Mül

Baeti

Matu

1

6.8 –

1

head

scales

(Fig.

with

terior

lobe

15F).

4+1+

centi

form

smoo

maxil

lancin

segme

palpu

segme

segme

glossa

at the

*B. operosus* Müller-Liebenau, 1984 [West Malaysia]. *B. multus* Müller-Liebenau, 1982 [West Malaysia]. *B. moribarae* Müller-Liebenau, 1984 [West Malaysia]. *B. numeratus* Müller-Liebenau, 1984 [West Malaysia]. *B. geminatus* Müller-Liebenau, 1985 [Sri Lanka]. *B. pulchellus* Müller-Liebenau, 1985 [Sri Lanka]. *B. ordinatus* Müller-Liebenau, 1982 [Sri Lanka].

#### Remarks:

Species of this subgenus *Mullerbaetis* are easily recognizable from the nymphal characters, the labrum with a row of close-set setae near anterior margin; mesial margin of segment II of maxillary palpus retuse near apex; segment II of labial palpus with a large lobe. In previously studies, above named oriental species were grouped into *Baetis molawinensis* species group (Müller-Liebenau and Hubber, 1985).

#### *Baetis (Mullerbaetis) molawinensis* Müller-Liebenau (Figs. 15, 28)

*Baetis molawinensis* Müller-Liebenau, 1982: 76.

#### Mature nymphs: (Fig. 15)

Body length: male 6.4 – 6.8 mm; female 6.8 – 7.2 mm.

**Head:** Antennae: length ca. 3× width of head; scape and pedicel with trapezoidal-based scales and short fine setae (Fig. 15C). **Labrum** (Fig. 15A): ca. 0.70× as long as wide; dorsum with a row of close-set, clavate setae near anterior margin. **Hypopharynx:** lingua with a lobe and a tuft of close-set setae medially (Fig. 15F). **Mandibles** (Fig. 15H): left incisor with 4+1+3 denticles; right incisor with 3(1)+1+3 denticles; prostheca of right mandible manifold; edge between prostheca and molar smooth, without setae. **Maxillae** (Fig. 15F): maxillary palpus slightly longer than galealacinia, 3-segmented, the articulation between segments II and III obscure. **Labium:** labial palpus 3-segmented, the articulation between segments II and III obscure; mesial margin of segment II with a large lobe (Fig. 15E); paraglossa with 3 rows of fine comb-shaped setae at the apex (Fig. 15B).

**Thorax:** hind wing pads absent (Fig. 15I); nota light brown. **Legs:** femora, tibiae and tarsi with short fine setae, short acute setae and trapezoidal-based scales densely; hind claw ca. 0.26× as long as hind tarsus.

**Abdomen:** Terga: light brown, color pattern as Figs. 15G and 28. Each tergum with trapezoidal-based scales densely (Fig. 15L). Posterior spines blunt, present on terga I–X and sterna VII–IX, obscure on tergum I. **Paraproct** (Fig. 15J): triangular, projecting on posterior margin; surface with trapezoidal-based scales, pores and short fine setae; posteromedial margin with acute denticles. **Gills** (Fig. 15K): 6 pairs, absent on abdominal segment I, long oval; tracheae distinct. **Caudal filaments:** pale, dark distally; terminal filament 0.5× as long as cerci; basal 3/5 of cerci fringe with long fine setae.

#### Mature nymphal specimens examined:

3♂♂, 5♀♀, Sanmin, KSH, TW, (350 m), 12 Oct. 1990, WBY; 23♂♂, 35♀♀, Fushan, Yuanshan, ILH, TW (480 m), 18 Nov. 1990, SCK and HCC; 1♀, Piluchi, Lenai, NTH, TW, (2,300 m), 1 Dec. 1990, WBY; 1♂, 7♀♀, Tien-chih, Lenai, NTH, TW, (2,450 m), 26 Jan. 1991, SCK and HCC; 6♂♂, 2♀♀, Yehyu, Lanhyu, TTH, TW, (20 m), 3 Apr. 1991, HCC; 9♂♂, 11♀♀, Chiayan, Hoping, TCH, TW, (1,520 m), 28 May 1991, SCK and HCC; 13♂♂, 19♀♀, Hwesunlinchun, Lenai, NTH, TW, (750 m), 19 Aug. 1991, HCC; 5♂♂, 9♀♀, Wufeng, HCH, TW, (1,970 m), 24 Oct. 1991, SCK and HCC; 3♀♀, Dahanchiao, Fuhsing, TYH, TW, (640 m), 9 Sept. 1993, SCK; 2♀♀, Fushan, Yuanshan, ILH, TW, (530 m), 15 Sept. 1993, SCK; 1♀, Charngchunchiao, Hsiulin, HLH, TW, (70 m), 19 Sept. 1993, SCK.

#### Distribution:

Philippines, Taiwan [NEW RECORD].

#### *Baetis (Mullerbaetis) morus* Chang & Yang n. sp. (Figs. 16, 29)

#### Mature nymphs: (Fig. 16)

Body length: male 4.8 – 7.0 mm; female

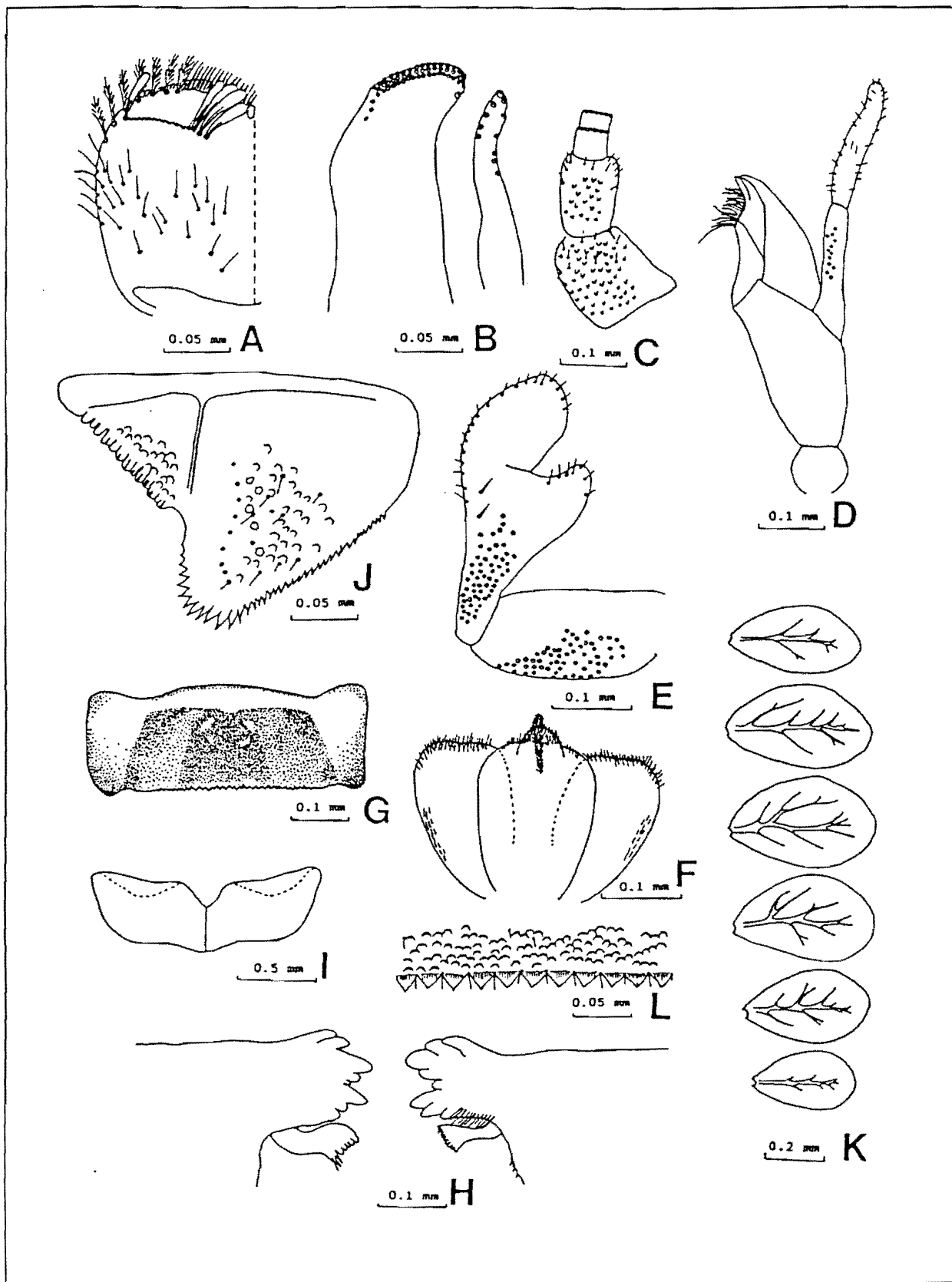


Fig. 15. Nymph of *Baetis molawinensis* Müller-Liebenau. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, antennal scape and pedicel, dorsal; D, maxilla, ventral; E, labial palpus, dorsal; F, hypopharynx, ventral; G, tergum VI, dorsal; H, mandibular incisors and prosthecae, dorsal; I, metanotum, dorsal; J, paraproct; K, gills II-VII; L, surface and posteromedial margin of tergum VI, dorsal.

head  
cal  
mar  
Lab  
don  
near  
ling  
med  
with  
1+2  
man  
sme  
max  
lan  
segr  
palp  
segr  
segr  
glos  
acu

nota  
fem  
med  
seta  
tibia  
seta  
as h

brov  
terg  
16M  
terg  
16L  
base  
regu  
abd  
muc  
or  
men  
band  
cere

Typ

col  
100  
typ

5.0–7.6 mm.

**Head:** Antennae: length ca. 2.7× width of head; scape and pedicel scatter with trapezoidal-based scales and short fine setae; lateral margin of scape with a distinct lobe (Fig. 16C). **Labrum** (Fig. 16A): ca. 0.60× as long as wide; dorsum with a row of close-set, forked setae near anterior margin. **Hypopharynx** (Fig. 16F): lingua with a lobe and a tuft of close-set setae medially. **Mandibles** (Fig. 16H): left incisor with 3+1+3 denticles; right incisor with 3(1)+1+3 denticles; prosthema of right mandible maniform; edge between molar and prosthema smooth, without setae. **Maxillae** (Fig. 16D): maxillary palpus ca. 1.3× as long as galeal-lancina, 3-segmented, the articulation between segments II and III obscure. **Labium:** labial palpus 3-segmented, the articulation between segments II and III obscure; mesial margin of segment II with a large lobe (Fig. 16E); paraglossa 4× as wide as glossa, with 3 rows of long acute setae at the apex (Figs. 16B, 16G).

**Thorax:** hind wing pads distinct (Fig. 16I); nota light brown to dark brown. **Legs:** each femur with a dark triangular marking antero-medially, with short acute setae and coniform setae, dorsum with trapezoidal-based scales; tibiae and tarsi with short acute setae and fine setae (Fig. 16J); hind claw ca. 0.45× as long as hind tarsus.

**Abdomen:** Terga: light brown to dark brown, color pattern as Figs. 16K and 29. Each tergum with lunate-based scales densely (Fig. 16M). Posterior spines acute, present on every tergum and sterna VII–IX. **Paraproct** (Fig. 16L): subtriangular, surface with trapezoidal-based scales; posteromedial margin with irregular denticles. **Gills** (Fig. 16N): present on abdominal segments I–VII, long oval, gill I much smaller than other gills; tracheae distinct or invisible. **Caudal filaments:** terminal filament 0.70× as long as cerci; cerci with dark bands on middle and the end; basal 7/10 of cerci fringe with long fine setae.

#### Type material:

**Holotype:** mature female nymph (in alcohol), Kuohsing, NTH, TW, (240 m), 20 Feb. 1991, HCC. In NCHU. **Paratypes** (mature nymph): 6♂♂, 15♀♀, same data as for holotype.

4♀♀, 10♀♀ in NCHU; 2♂♂, 5♀♀ in NMNS.

#### Other mature nymphal specimens examined:

9♂♂, 11♀♀, same data as for holotype. 15♂♂, 26♀♀, Chukun, Yuanshan, ILH, TW, (180 m), 18 Nov. 1990, SCK and HCC; 1♂, Tehyu, Lanhyu, TTH, TW, (20 m), 3 Apr. 1991, HCC; 5♂♂, 7♀♀, Hungtou, Lanhyu, TTH, TW, (25 m), 3 Apr. 1991, HCC; 12♂♂, 6♀♀, Tsao-tun, Kuohsing, NTH, TW, (190 m), 20 Aug. 1991, HCC; 1♂, 3♀♀, Tapa, Wufeng, HCH, TW, (1,775 m), 23 Oct. 1991, SCK and HCC; 2♂♂, 2♀♀, Shuili, NTH, TW, (290 m), 18 Nov. 1991, SCK; 4♂♂, 3♀♀, Wusichao, Wufeng, TCH, TW, (90 m), 22 Nov. 1991, SCK; 8♂♂, 7♀♀, Kanchiao, Shuangchi, TPH, TW, (140 m), 13 Nov. 1993, SCK.

#### Distribution:

Taiwan.

#### Etymology:

Morus, L., masculine, meaning silly or foolish.

#### Remarks:

This new species resembles Malaysian species *Baetis operosus* Müller-Liebenau but can be differentiated in nymphs from labrum with forked setae near anterior margin but with branched setae in *operosus*.

Subgenus *Acerbaetis* Kang and Yang,  
n. subgen.

#### Type species:

*Baetis* (*Acerbaetis*) *clivus* Chang and Yang, n. sp. (here designated).

#### Description:

**Mature nymph.** – Prosthema on the right mandible reduced to two fine spicate setae, incisor of right mandible fringe with a row of long fine setae near mesial margin (Figs. 17, 18F). Palpus of maxilla 3-segmented, articulation between segment II and III oblique,

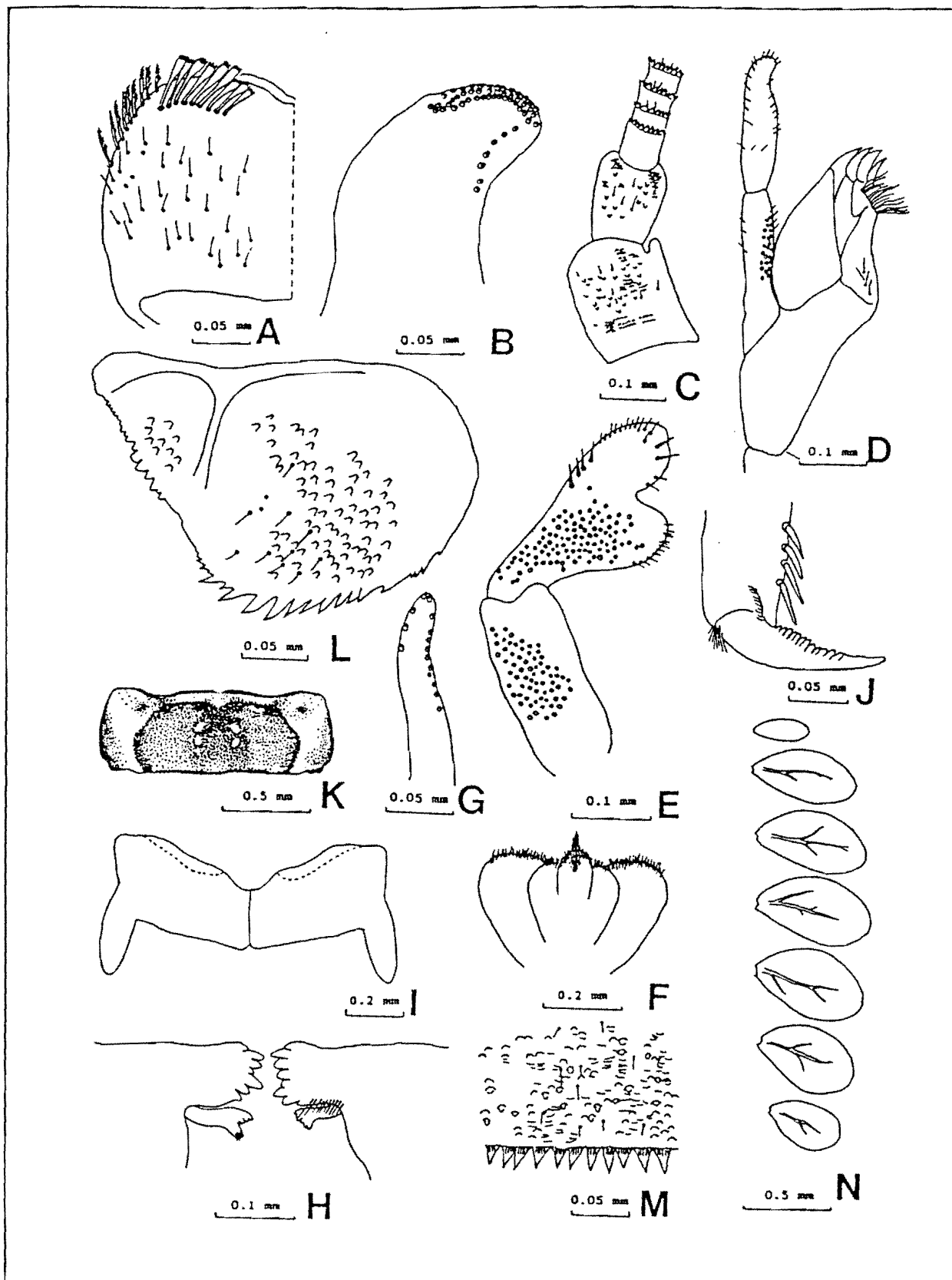


Fig. 16. Nymph of *Baetis morus* n. sp. A, labrum (left half), dorsal; B, paraglossa, ventral; C, antennal scape and pedicel, dorsal; D, maxilla, ventral; E, labial palpus, dorsal; F, hypopharynx, ventral; G, glossa, ventral; H, mandibular incisors and prosthecae, dorsal; I, metanotum, dorsal; J, hind claw; K, tergum VI, dorsal; L, paraproct; M, surface and posteromedial margin of tergum VI, dorsal; N, gills I-VII.

obscure (Fig. 18D). Labial palpus 3-segmented, articulation between segment II and III obscure; segment III wider than segment II (Figs. 17C, 18C). Terga, sterna, dorsum of legs scattered with trapezoidal-based scales (Figs. 17H, I; 18G, H, J). Paraproct with a acute, postero-internal extension (Figs. 17G, 18I). Gills 6 or 7 pairs, each gill with a dark band surrounding the margin (Figs. 17K, 18K); margins of gills serrated and with fine setae.

**Etymology.** — Masculine gender, acer (sharp or cutting), in reference to the paraproct with a acute postero-internal extension.

**Species included.** — Besides the type species *Baetis clivus* n. sp., 3 oriental species and 4 European species should be included in the subgenus *Acerbaetis*, i.e., Europe: *B. muticus* (Linnaeus, 1758), *B. navasi* Müller-Liebenau, 1974, *B. albinatii* Sartori and Thomas, 1989 and *B. oukaimeden* Thomas and Sartori, 1991; Orient: *B. yehi* n. sp. [Taiwan], *B. laetificus* Müller-Liebenau, 1984 [Malaysia]; *B. florens* Imanishi, 1937 [Japan].

#### Remarks:

Species of this subgenus *Acerbaetis* are easily recognizable from the nymphal characters, the prostheca of right mandible reduced to two fine spicate setae and paraproct with a acute, postero-internal extension. In previously study, above European species were grouped into *Baetis muticus* species group (Müller-Liebenau, 1973; Sartori and Thomas, 1991).

#### *Baetis (Acerbaetis) clivus* Chang & Yang n. sp. (Figs. 17, 30)

**Mature nymphs:** (Fig. 17)

Body length: male 4.2–5.8 mm; female 4.8–6.2 mm.

**Head:** Antennae: length ca. 3.7× width of head; scape and pedicel scatter with short fine setae. Labrum (Fig. 17A): ca. 0.64× as long as wide; dorsum with 6 long acute setae, 4 near anterolateral corners and 2 in submedian area. Mandibles (Fig. 17F): left incisor with 3–4 denticles; right incisor with 3(1)+3

denticles; prostheca of right mandible like biforked hair. Maxillae (Fig. 17D): maxillary palpus ca. 1.2× as long as galea-lacinia, 3-segmented, the articulation between segments II and III obscure. Labium: labial palpus (Fig. 17C) 3-segmented, the articulation between segments II and III obscure; paraglossa 1.5× as wide as glossa, with 3 rows of long acute setae along lateral margin (Fig. 17B).

**Thorax:** hind wing pads distinct (Fig. 17E); nota dark brown; mesonotum with a pale marking medially. Legs: each femur (Fig. 17H) with large, light brown markings and shagreened area, with numerous acute setae near anterior margin; dorsum of femora, tibiae and tarsi with short setae and with trapezoidal-based scales densely; claw with 11–13 denticles; hind claw ca. 0.34× as long as hind tarsus.

**Abdomen:** Terga: dark brown, lightish on anterior and lateral areas of each tergum, color pattern as Fig. 30; each tergum with a Y-shaped marking medially (Fig. 17J) and with M-shaped based scales densely (Fig. 17I); posterior spines triangular, present on terga II–X (Fig. 17I) and sternum IX. Paraproct (Fig. 17G): triangular, surface with trapezoidal-based scales and pores densely; posteromedial margin with irregular denticles and with a acute extension lobe. Gills (Fig. 17K): present on abdominal segments I–VII, long oval, gill I much smaller than other gills; each gill with a dark band surrounding the margin; margins of gills serrated and with fine setae. Caudal filaments: uniformly light brown, lightish distally; terminal filament 0.45× as long as cerci; basal half of cerci fringe with long fine setae.

#### Type material:

**Holotype:** mature female nymph (in alcohol), Shanlinsi, Luku, NTH, TW, (850 m), 22 Aug. 1991, SCK and HCC. in NCHU. **Paratypes** (mature nymph): 5♂♂, 5♀♀, Shuili, NTH, TW, (290 m), 18 Nov. 1991, SCK: 6♂♂, 5♀♀, Weichuan, Liukuei, KSH, TW, (235 m), 20 Dec. 1991, SCK. 7♂♂, 7♀♀ in NCHU: 4♂♂, 3♀♀ in NMNS.

#### Other mature nymphal specimens examined:

1♂, 2♀♀, Sanmin, KSH, TW, (350 m), 12 Oct. 1990, WBY: 5♂♂, 4♀♀, Taian-Wen-

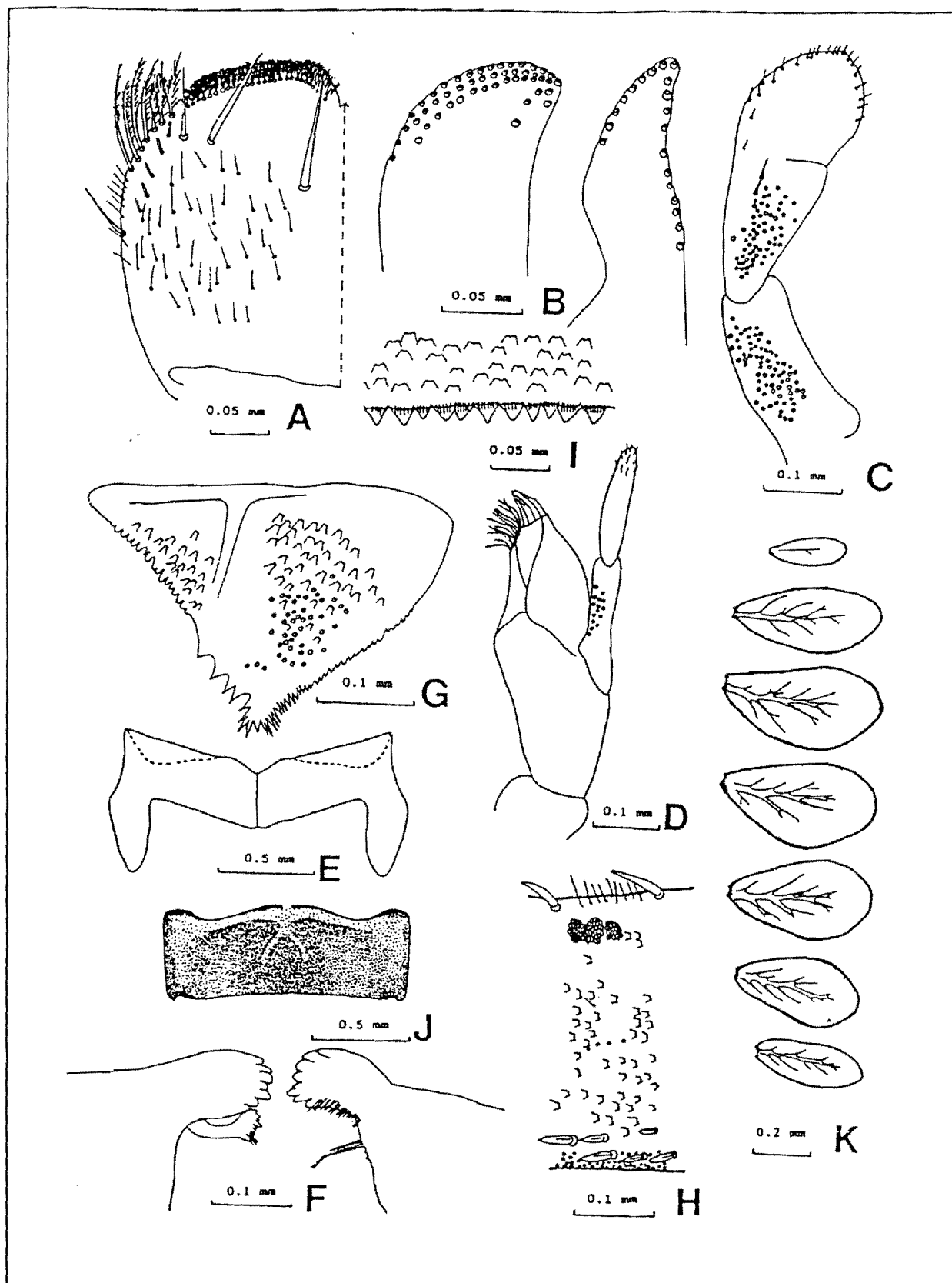


Fig. 17. Nymph of *Baetis clivus* n. sp. A, labrum (left half), dorsal; B, glossa and paraglossa, ventral; C, labial palpus, dorsal; D, maxilla, ventral; E, metanotum with hind wing pads, dorsal; F, mandibular incisors and prosthecae, dorsal; G, paraproct; H, medial section of hind femur, dorsal; I, surface and postero-medial margin of tergum VI, dorsal; J, tergum VI, dorsal; K, gills I-VII.

chuan, Taian, MLH, TW, (500 m), 31 Oct. 1990, SCK: 5♂♂, 6♀♀, Saoleinchi, Taoyuan, KSH, TW, (660 m), 14 Dec. 1990, SCK: 1♂, 4♀♀, Sinwuchaio, Haituan, TTH, TW, (500 m), 15 Dec. 1990, SCK: 2♂♂, 5♀♀, Fenchifu, Ali-shan, CIH, TW, (1,585 m), 8 Feb. 1991, HCC: 4♂♂, 7♀♀, Sunchitsun, Tatung, ILH, TW, (750 m), 30 May 1991, SCK and HCC: 6♂♂, 7♀♀, Sunchit, Tatung, ILH, TW, (720 m), 30 May 1991, SCK and HCC: 3♂♂, 3♀♀, Hwo-shauliao, Pingshi, TPH, TW, (380 m), 31 May 1991, SCK and HCC: 4♂♂, 3♀♀, Sinchungheng, Hsiui, NTH, TW, (620 m), 18 Nov. 1991, SCK: 3♂♂, 6♀♀, Weichuan, Liukuei, KSH, TW, (235 m), 20 Dec. 1991, SCK: 3♀♀, Wusichiao, Wufeng, TCH, TW, (165 m), 20 Jan. 1992, SCK: 1♂, 1♀, Chianrerngu, Maolin, KSH, TW, (205 m), 27 Jul. 1993, SCK: 1♂, 2♀♀, Gauiyaur, Fuhsing, TYH, TW, (400 m), 9 Sept. 1993, SCK: 1♂, 1♀, Mirnchyr, Tatung, ILH, TW, (1,090 m), 9 Sept. 1993, SCK: 6♂♂, 8♀♀, Fushan, Yuanshan, ILH, TW, (480 m), 15 Sept. 1993, SCK: 3♂♂, 5♀♀, Harpen, Wulai, TPH, TW, (570 m), 16 Sept. 1993, SCK: 2♂♂, 4♀♀, Jingyang, Nanao, ILH, TW, (220 m), 17 Sept. 1993, SCK: 1♀, Tienhsiang, Hsiulin, HLH, TW, (450 m), 19 Sept. 1993, SCK: 4♂♂, 8♀♀, Tzuenchiao, Hsiulin, HLH, TW, (2,010 m), 19 Sept. 1993, SCK: 2♂♂, 2♀♀, Kanchiao, Shuangchi, TPH, TW, (140 m), 13 Nov. 1993, SCK.

#### Distribution:

Taiwan.

#### Etymology:

Clivus, L., masculine, meaning hilly or steep.

#### Remarks:

This new species resembles *Baetis yehi* n. sp. but can be differentiated in nymphs by the following characters: (1) gills 7 pairs but with 6 pairs in *yehi*; (2) right mandible without or with few setae on the ridge between prostheca and molar; (3) abdomen with posterior spines on terga II–X but only on terga IX and X in *yehi*; (4) anterior margin of femora with numerous acute setae.

### *Baetis (Acerbaetis) yehi* Kang and Yang n. sp. (Figs. 18, 31)

#### Mature nymphs: (Fig. 18)

Body length: male 4.0–5.5 mm; female 4.7–6.0 mm.

**Head:** Antennae: pale, scale with dark brown area laterally; scape and pedicel with few short fine setae. **Labrum** (Fig. 18A): ca. 0.64× as long as wide; dorsum with 6 long acute setae, 4 near anterolateral corners and 2 in submedian area. **Hypopharynx** (Fig. 18B): superlingua with fine setae along mesial margin and on apex of dorsum; lingua with a medial lobe anterodorsally. **Mandibles** (Figs. 18E, 18F): left incisor with 4+3 denticles; right incisor with 4+3 denticles; prosthema of right mandible like biforked hair. **Maxillae** (Fig. 18D): maxillary palpus ca. 1.2× as long as galeal-lancina, 3-segmented, the articulation between segments II and III oblique, obscure. **Labium**: labial palpus (Fig. 18C) 3-segmented, the articulation between segments II and III obscure; paraglossa 1.5× as wide as glossa, with 3 rows of long acute setae on lateral margin (Fig. 18G).

**Thorax:** hind wing pads distinct; nota brown. **Legs:** each femur uniformly pale, slender, dorsum with a few trapezoidal-based scales, anterior margin without setae (Fig. 18H); claw with 6–7 denticles.

**Abdomen:** Terga: uniformly light brown, color pattern as Fig. 31; posterior spines triangular, only present on terga IX, and X, tergum IX few, sterna I–IX without posterior spine. **Paraproct** (Fig. 18I): triangular, surface with a few trapezoidal-based scales and pores; posteromedial margin with irregular denticles and with a acute lobe. **Gills** (Fig. 18K): 6 pairs, present on abdominal segments II–VII, long oval, gill I much smaller than other gills; each gill with a dark band surrounding the margin. **Caudal filaments:** broken, data unknown.

#### Type material:

**Holotype:** mature female nymph (in alcohol), Sanmin, KSH, TW, (350 m), 12 Oct. 1990, WBY. In NCHU. **Paratypes** (mature



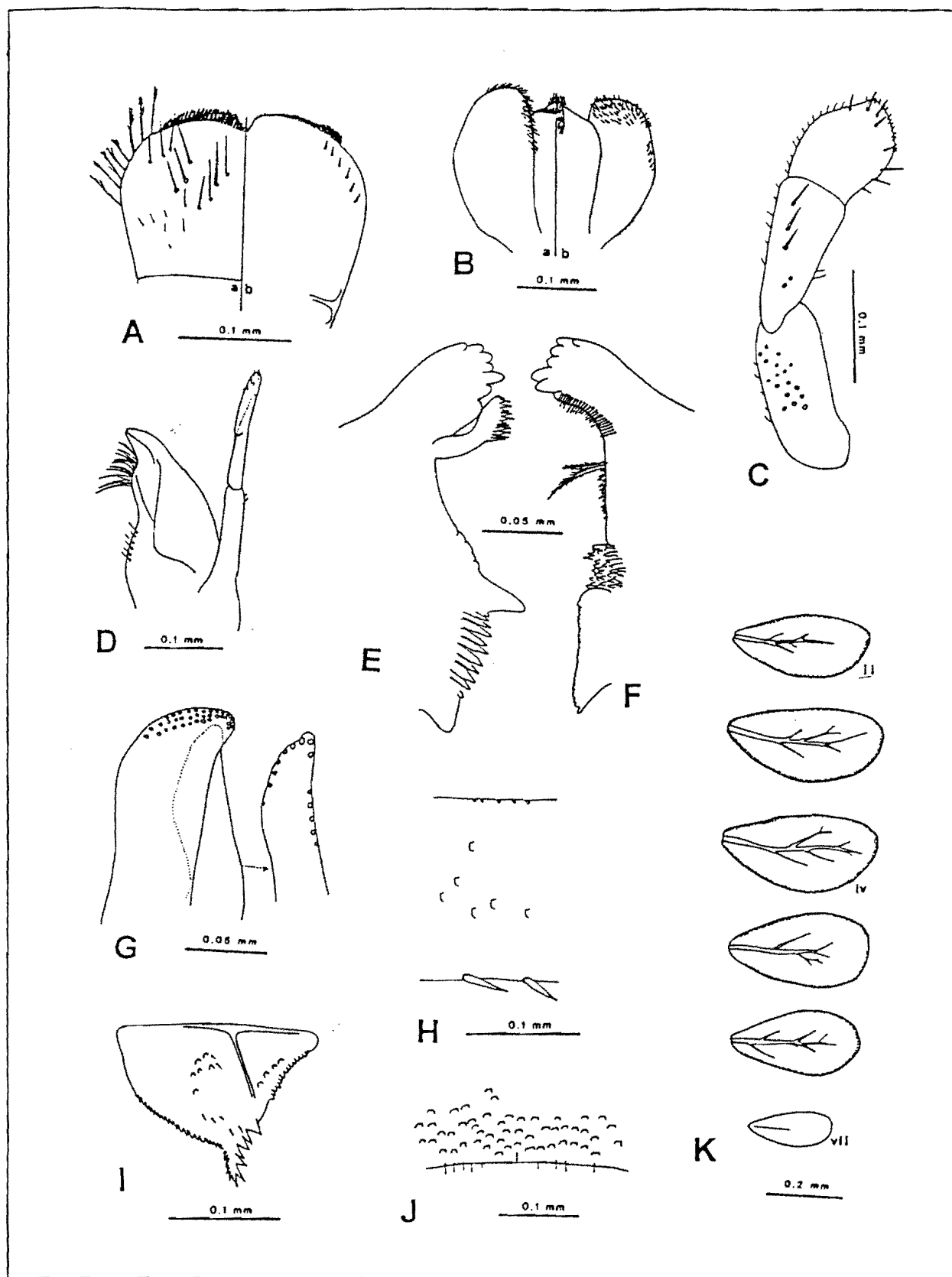
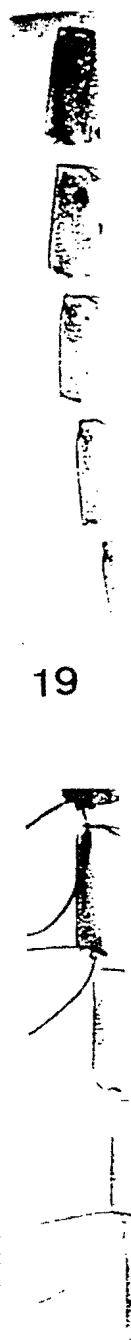


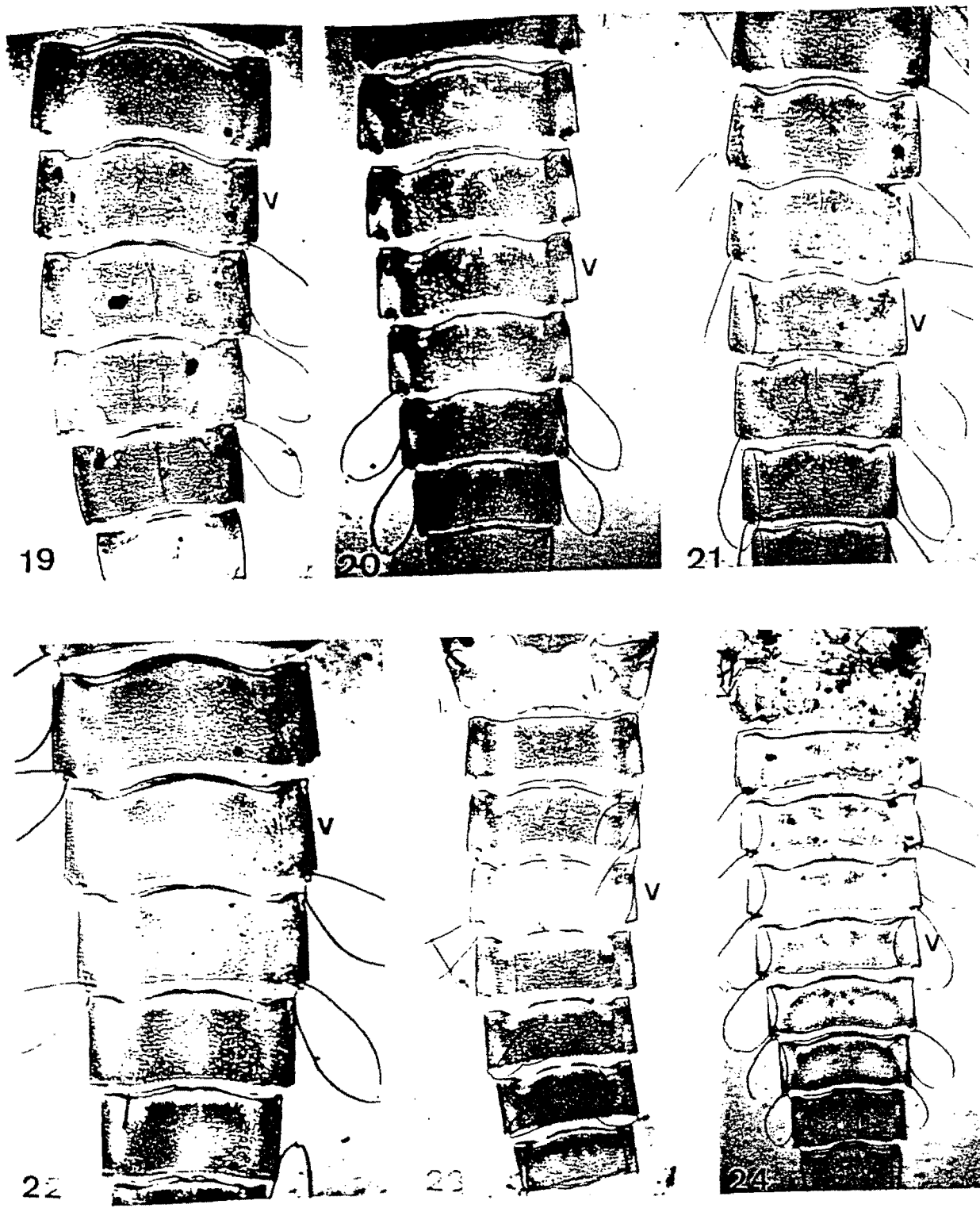
Fig. 18. Nymph of *Baetis yehi* Kang and Yang n. sp. A, labrum (a, dorsal; b, ventral); B, hypopharynx (a, dorsal; b, ventral); C, labial palpus, dorsal; D, maxilla; E, left mandible, dorsal; F, right mandible, dorsal; G, glossa and paraglossa, ventral; H, medial section of hind femur, dorsal; I, paraproct; J, surface and post-eromedial margin of tergum VI, dorsal; K, gills II-VII.



19

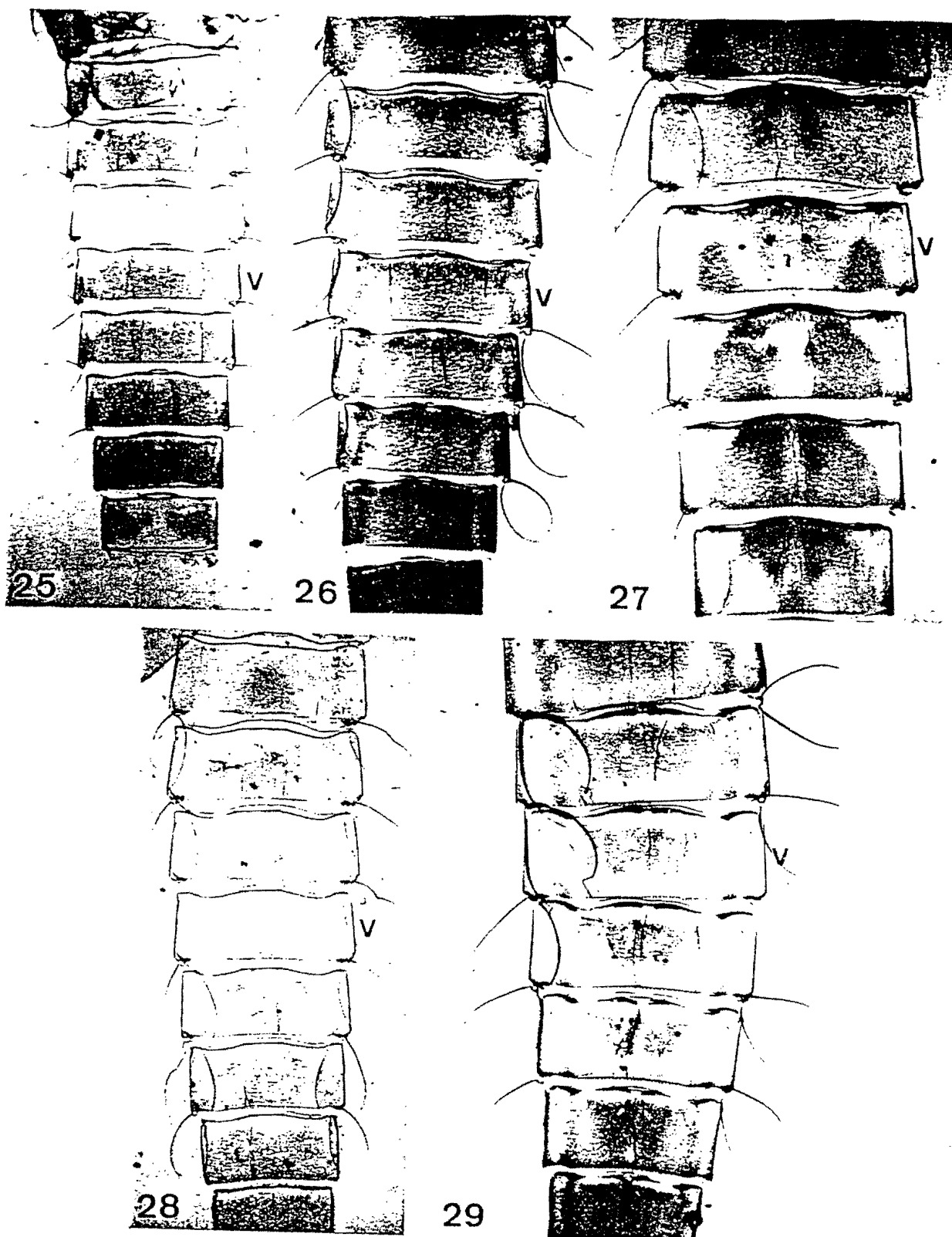
22

Figs. 19



Figs. 19–24. Color pattern of nymphal terga. 19, *Baetis mundus* n. sp.; 20, *B. taiwanensis* Müller-Liebenau; 21, *B. gracilentus* n. sp.; 22, *B. terminus* n. sp.; 23, *B. facetus* n. sp.; 24, *B. tatuensis* Müller-Liebenau.

.. dorsal;  
rsal; G.  
nd post-



Figs. 25–29. Color pattern of nymphal terna. 25, *Baetis pseudofrequentus* Müller-Liebenau; 26, *B. inornatus* n. sp.; 27, *B. arduus* n. sp.; 28, *B. molawinesis* Müller-Liebenau; 29, *B. morus* n. sp.

nymph): 3♂♂ (2 slidemounted), 3♀♀, same data as for holotype. 3♂♂, 2♀♀ in NCHU; 1♀ in NMNS.

#### Distribution:

Taiwan.

#### Etymology:

Name after Mr. Win-Bin Yeh, in recognition of his collection. Masculine.

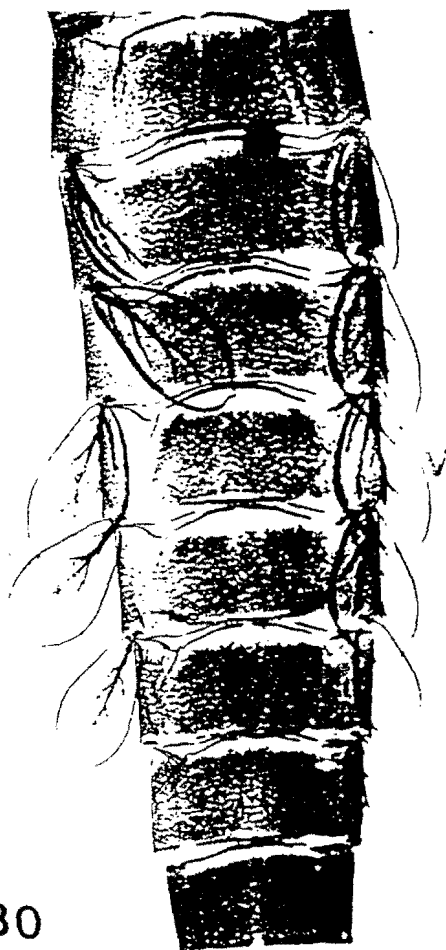
#### Remarks:

This new species resembles Malaysian species *Baetis laetificus* Muller-Liebenau but can be differentiated in nymphs by the following characters: (1) posterior spines only present on terga IX and X but on terga VI–X in *laetificus*; (2) anterior margin of femora without setae.

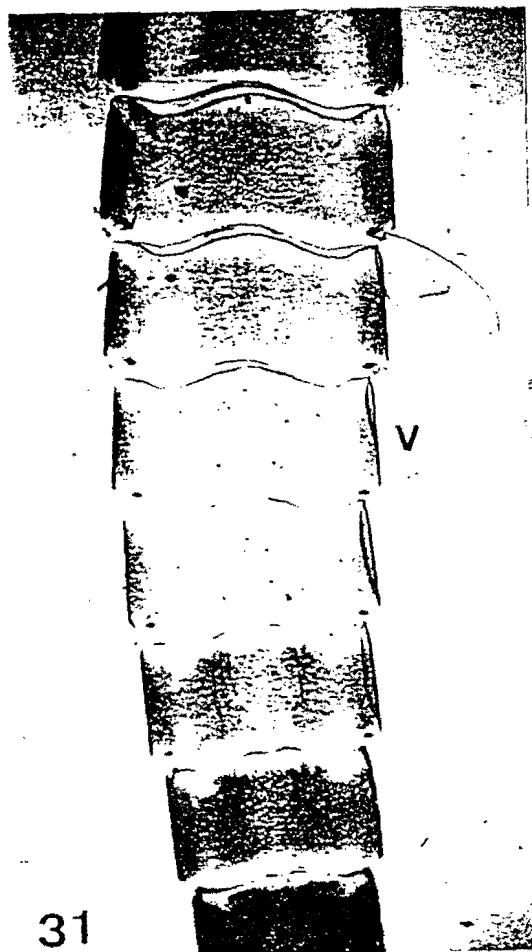
lowing characters: (1) posterior spines only present on terga IX and X but on terga VI–X in *laetificus*; (2) anterior margin of femora without setae.

#### Acknowledgements

This research was financially supported by the National Science Council (NSC) under project NSC82-0409-B-005-11. We also thank Dr. Liang-Yih Chou, Taiwan Agricultural Research Institute, Taichung, Taiwan, for assisting scanning electron microscopy in the studying of eggs. Thanks are also extended to our colleague Mr. Wen-Bin Yeh for his collections.



30



31

1 mm

Figs. 30–31. Color pattern of nymphal terga. 30, *Baetis clivosus* n. sp.; 31, *B. yehi* n. sp.

## References

- Edmunds, G. F., Jr., S. L. Jensen and L. Berner. 1976. The mayflies of North and Central America. Minneapolis (Univ. Minnesota press) x+ 330 pp.
- Morihara, D. K. and W. P. McCafferty. 1979. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Trans. Amer. Entomol. Soc. 105(2): 139-221.
- Müller-Liebenau, I. 1973. Morphological characters used in revising the European species of the genus *Baetis* Leach, pp. 182-198. In: Peters W. L. and Peters J. G. (eds.). Proceeding of the first International Conference on Ephemeroptera. Btil. Leiden.
- , 1981. Review of the Original Material of the baetid genera *Baetis* and *Pseudocloeon* from the Sunda Islands and the Philippines described by G. Ulmer, with some general remarks (Insecta: Ephemeroptera). Mitt. Hamburg Zool. Mus. Inst. 78: 197-208.
- , 1982. New species of the family Baetidae from the Philippines (Insecta, ephemeroptera). Arch. Hydrbiol. 94(1): 70-82.
- , 1984a. New genera and species of the family Baetidae from West-Malay (River Gombak). (Insecta: Ephemeroptera). Spixiana 7(3): 253-284.
- , 1984b. Baetidae from Sabah (E. Malaysia) (Ephemeroptera). pp. 85-94. In: V. Landa, T. Soldan & M. Tonner (Eds.). Proc. 4th Intern. Conf. Ephemeroptera. Czechoslovak Acad. Sci., Cseke Budejovice, Czechoslovakia.
- , 1985. Baetidae from Taiwan with remarks on *Baetiella* Uéno, 1931 (Insecta Ephemeroptera). Arch. Hydrbiol. 104(1): 93-110.
- Müller-Liebenau, I. and M. D. Hubbard. 1983. Baetidae from Sri Lanka with some general remarks on the Baetidae of the orient region (Insecta: Ephemeroptera). Florida Entomol. 68(4): 537-561.
- Sartori, M. and A. G. B. Thomas. 1991. Contribution to the systematics of *Baetis muticus* (L.) and allied species from South Western Palearctic region (Ephemeroptera: Baetidae). pp. 223-224. In: J. Alba Terceder & A. Sanchez-Ortega (eds.). Overview and Strategies of Ephemeroptera and Plecoptera. Sandhill Crane press, Florida. 588 pp.