

Ephemeroidea of Taiwan (Ephemeroptera)

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ABSTRACT

Only three species of the superfamily Ephemeroidea have been found in Taiwan: two belonging to Ephemeridae, i.e., *Ephemera formosana* Ulmer and *E. sauteri* Ulmer; one belonging to Potamanthidae, i.e., *Potamanthus (Potamanthodes) idiocerus* Bae & McCafferty. All species have been described herein based on nymphal and egg stages. This paper gives the first description of the egg of above species and the nymph of *E. sauteri*.

Key words: Ephemeroidea, *Ephemera*, *Potamanthus*, nymph, egg, Taiwan.

台灣的蜉蝣總科(蜉蝣目)

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摘 要

蜉蝣總科僅知有三種分布於台灣，兩種屬於蜉蝣科(Ephemeridae)，分別為 *Ephemera formosana* Ulmer 及 *E. sauteri* Ulmer；一種屬於花鰓蜉蝣科(Potamanthidae)，為 *Potamanthus (Potamanthodes) idiocerus* Bae & McCafferty。本文根據稚蟲及卵的特徵描述以上三種，所有種類的卵及 *E. sauteri* 的稚蟲為首次描述。

關鍵詞：Ephemeroidea、*Ephemera*、*Potamanthus*、稚蟲、卵、台灣。

Introduction

We had collected over three hundred localities within five years, only three species of the superfamily Ephemeroidea were found in Taiwan. One belongs to the family Potamanthidae, i.e., *Potamanthus* (*Potamanthodes*) *idiocerus* Bae & McCafferty; and two belong to the family Ephemeridae, i.e., *Ephemer* *formosana* Ulmer and *E. sauteri* Ulmer. For *P. idiocerus*, Bae and McCafferty (1991) had provided imaginal and nymphal descriptions. *E. formosana* had been described on the imaginal specimens (Ulmer, 1920; 1925; Hsu, 1936-37; Uéno, 1969) and nymphal specimens (Uéno, 1938; Gose, 1981). For *E. sauteri*, only imaginal specimens had been described (Ulmer, 1912, 1925). The egg of all above species remained unknown. In this work, we provide more detailed description of nymphal specimens of *P. idiocerus* and *E. formosana* and the first description of the nymph of *E. sauteri* and the egg of all these species.

All specimens examined in this work were nymphs. Egg materials were acquired from mature female nymphs (with black wing pads) and observed via a scanning electron microscope. All specimens have been deposited in National Chung Hsing University, Taichung, Taiwan.

Abbreviations of collection localities and collectors are: Taiwan (TW), Taipei Hsien (TPH), Ilan Hsien (ILH), Hualien Hsien (HLH), Taitung Hsien (TTH), Kaohsiung Hsien (KSH), Chiai Hsien (CIH), Nantou Hsien (NTH), Hsinchu Hsien (HCH), Shih-Chang Kang (SCK), Hsien-Cheng Chang (HCC) and Wen-Bin Yeh (WBY).

Family Potamanthidae

Potamanthus (*Potamanthodes*) *idiocerus* Bae & McCafferty (Figs. 1, 4)

Potamanthus idiocerus Bae & McCafferty, 1991: 64.

? *Potamanthus* sp. Uéno, 1928: 25.

Potamanthodes formosus (Eaton): Uéno, 1931a: 191; 1931b: 210; 1969: 232. (misidentification)

Mature nymphs (Fig. 1): body length, female 9.20-13.35 mm, male 8.50-11.30 mm; cerci length, female 5.02-7.21 mm. General coloration brown, with numerous pale markings dorsally.

Head: brown, pale beside eyes, with a round pale marking in front of middle ocellus; vertex with a broad pale marking medially. **Labrum:** uniform dark brown; anterior margin with a shallow emargination; dorsum with long setae, closely set anteriorly; a row of long, fine pinnate setae along anterior margin (Fig. 1B). **Hypopharynx:** lingua cordate, superlinguae with a row of long fine setae along anterior margin (Fig. 1C). **Mandibles** (Figs. 1D, 1E): outer and inner incisors of left mandible triforked; outer incisor of right mandible triforked, inner incisor biforked; lateral margin of mandibles each with a huge spine, directed anteriorly and beyond head, with acute setae numerous and several long setae on lateral margin. **Maxillae** (Fig. 1F): with 2 acute canine teeth at apex, with crooked acute setae on cardo; maxillary palpus 3-segmented, segment I subequal in length of segment III, longer than segment II; lateral margins of each segment and mesal margins of segments II, III with long setae. **Labium** (Fig. 1G): glossa oval, venter with acute setae densely, dorsum with a row pinnate acute setae along anterior margin; paraglossa semicircular, mesal margin concave, apical half of dorsum with closely set acute setae, apical half of venter with fine setae; labial palpus 3-segmented, segments II and III subequal in length, shorter than segment I.

Thorax: dorsum with pale markings; pronotum with a pair of reniform marking

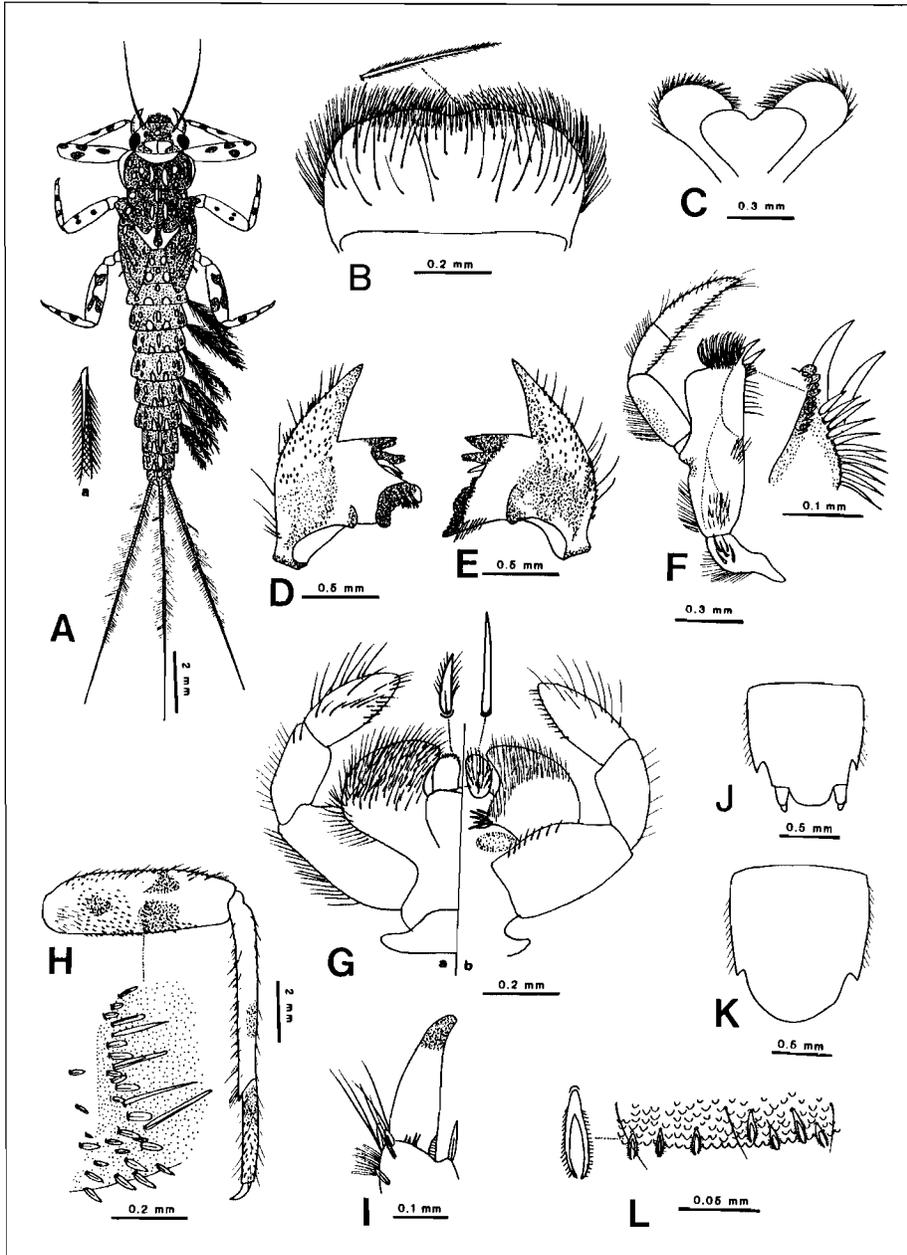


Fig. 1. Nymph of *Potamanthus (Potamanthodes) idiocerus* Bae & McCafferty. A, female nymph, (a, gill IV); B, labrum, dorsal; C, hypopharynx, ventral; D, left mandible, dorsal; E, right mandible, dorsal; F, right maxilla, ventral; G, labium (a, dorsal, b, ventral); H, fore leg, left, dorsal; I, fore claw; J, abdominal sternum IX, male; K, abdominal sternum IX, female; L, posteromedian margin of abdominal tergite X.

medially, with 4 pairs of round markings laterally. **Fore legs** (Fig. 1H): pale, with

several brown markings; femur with 3 markings medially, basal area with fine

setae, central area and anterior margin with acute setae, median area with a row of acute and blunt setae longitudinally; tibia slightly longer than femur, with brown bands at base and on distal 1/3; tarsus brown on distal half; claw without denticle (Fig. 1I). **Middle and hind legs:** marking same as in fore leg but on middle leg smaller and vague; anterior margin of femur with long acute setae; mesal margin of hind tibia with closely set comb-shaped setae on basal half and with long pinnate setae on distal half.

Abdomen: brown, each segment with distinct pale markings as Fig. 1A; dorsum of terga scatter with biforked pinnate setae and long fine setae (Fig. 1L); abdominal segment VII to IX each with posterolateral projection; abdominal sterna pale to yellow without any markings, lateral margin with loosely set fine setae; sternum IX convex smoothly (Figs. 1J, 1K). **Gills:** present on abdominal segment I to VII, gill I rudimentary, with several long fine setae; gills II-VII biforked pinnate. **Caudal filaments:** length slightly longer than 1/2 of body; basal 2/3 of lateral margins of each filament fringe with long fine setae (Fig. 1A).

Eggs (Fig. 4): general shape long olivary; with 2 large polar caps; chorionic surface with fine uniform granules, with 6-10 round, hump-like KCTs (knob-terminated coiled threads) on equatorial and subequatorial area; a visible large micropyle on subequatorial area.

Mature nymphal specimens examined: 6♂♂, 5♀♀, Nanao, ILH, TW, 2-IV-1990, SCK; 1, Hsinpu, HCH, TW, (120 m), 19-XI-1990, SCK; 4♂♂, 5♀♀, Kungliao, TPH, TW, 30-V-1991, SCK & HCC; 4♂♂, 3♀♀, Kanchiao, Shuangchi, TPH, TW, 30-V-1991, SCK & HCC; 3♂♂, 7♀♀, Pinling, TPH, TW, 31-V-1991, SCK & HCC; Kuanwu, Wufeng, HCH, TW, (795 m), 24-X-1991, SCK & HCC.

Distribution: Taiwan.

Note: Before Bae and McCafferty (1991) reviewed this family, the only species

from Taiwan had been misidentified as *Potamanthodes formosus* (Eaton) (Uéno, 1931b, 1969). Bae and McCafferty also showed that imagoes of *P. idiocerus* could not be distinguished from those of *P. formosus*, but they could be separated by nymphal characters. Egg appears the same as for known species of this family, with two polar caps and one large micropyle. The thread twines round the knob-terminal.

Family Ephemeridae

Key to the species of *Ephemera* of Taiwan (for nymph only)

1. Gills light pink or nearly white; in dorsal view, gills subequal in size; frontal process about 1/3 as wide as head, with a deep notch and anterolateral point acute (Figs. 2A, 2B); in the middle part of left molar, the width of grooves about 1/3-1/2 of ridges (Fig. 2E)..... *E. formosana* Ulmer
- Gills dark pink or purple; in dorsal view, anterior gills large than posterior ones distinctly; frontal process about 1/2 as wide as head, with a shallow notch and anterolateral point blunt (Figs. 3A, 3B); in the middle part of left molar, the width of grooves about 1/6 of ridges (Fig. 3E).....
..... *E. sauteri* Ulmer

***Ephemera formosana* Ulmer** (Figs. 2, 5, 6)

Ephemera formosana Ulmer, 1919(1920): 6; 1925: 92; Uéno, 1931a: 191; 1931b: 210; Hsu, 1936-37: 129; Uéno, 1938: 97; 1969: 233; Gose, 1981: 13.

Mature nymphs (Fig. 2): body length, female 15.30-19.25 mm, male 12.80-15.40 mm. General coloration light yellow to yellow.

Head: frontal process about 1/3 as wide as head, with a deep notch and

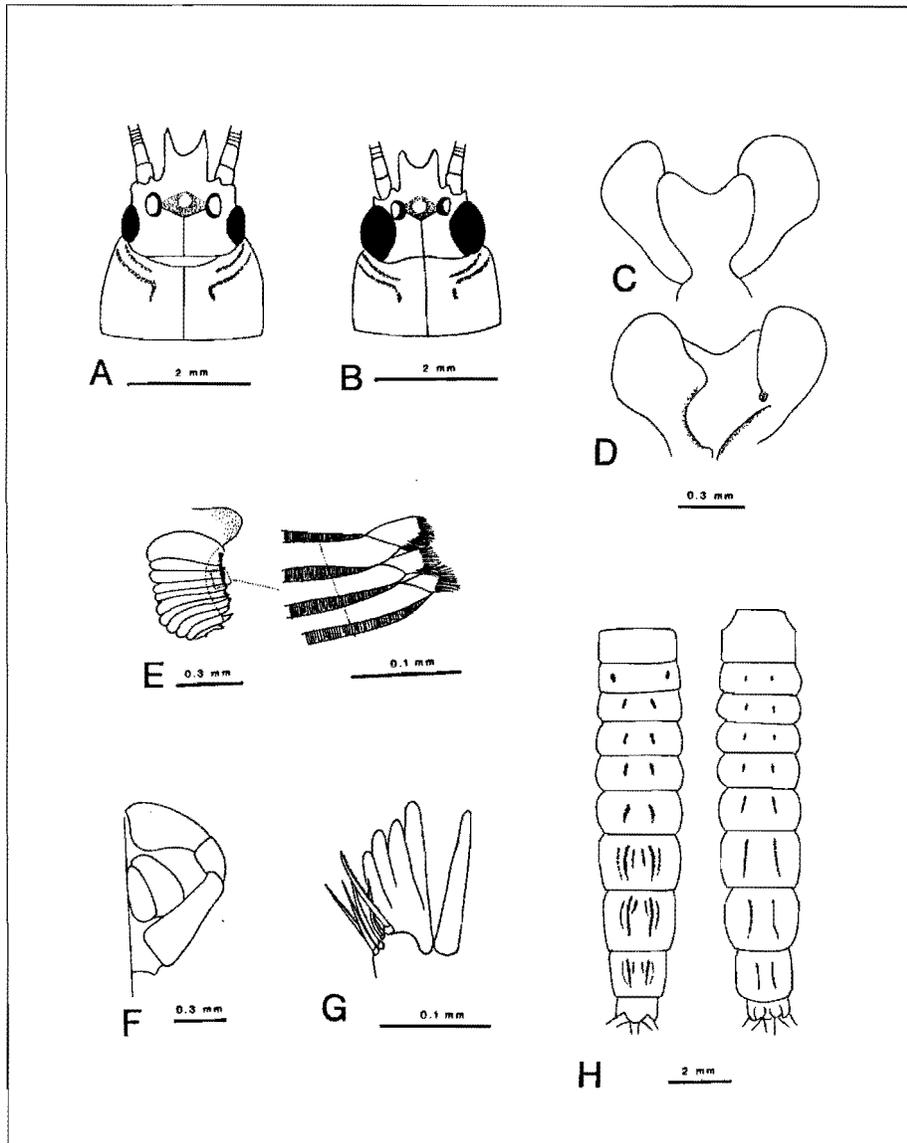


Fig. 2. Nymph of *Ephemera formosana* Ulmer. A, head and pronotum, female; B, head and pronotum, male; C, hypopharynx, ventral; D, hypopharynx, dorsal; E, molar of left mandible, anterior view; F, labium, ventral; G, maxillary apical canine teeth, lateral; H, abdomen, female (left-dorsal, right-ventral).

anterolateral point acute; lateral margins of frontal process nearly parallel (Figs. 2A, 2B). **Labrum:** lateral margins convex; anterior margin with a broad emargination. **Hypopharynx:** in dorsal view, left and right superlinguae with different shape (Figs. 2C, 2D). **Mandibles:** molar

of left mandible with ridges and grooves alternately, at middle part, the width of groove about $1/3-1/2$ of neighboring ridges (Fig. 2E). **Maxillae:** apical corner of galea-lacinia with blunt canine teeth, in lateral view with 5 canine teeth, 4 fused, 1 separated (Fig. 2G).

Abdomen (Fig. 2H): dorsum light yellow, terga I and X without any marking; tergum II with 2 black dots on lateral area; terga III-VI with 2 black stripes on submedian area, stripes converge anteriorly; terga VII-IX each with 6 stripes, median 2 short, about 1/2 as long as laterals; submedian 2 distinct; lateral 2 fine, somewhat slight in color; sternum I without marking; sterna II-IV each with 2 black dots on median area; sterna V-IX each with 2 long black stripes on submedian area, length of stripes of sterna VII, VIII longer than others. **Gill**: light pink or nearly white; in dorsal view, gills subequal in size.

Eggs (Figs. 5, 6): general shape columnar, poles truncate, chorionic surface with 6 longitudinal ridges; a visible small micropyle on equatorial area.

Mature nymphal specimens examined: 34♂♂, 26♀♀, Hanchanchiao, Hsincheng, HLH, TW, 1-IV-1990, SCK; 4♂♂, 8♀♀, Nanao, ILH, TW, 2-IV-1990, SCK; 5♂♂, 2♀♀, Pinglin, TPH, TW, 17-XI-1990, SCK & HCC; 3♂♂, 2♀♀, Kuanhsi, HCH, TW, (205 m), 19-XI-1990, SCK; 3♂♂, 6♀♀, Kuanhsi, HCH, TW, (460 m), 19-XI-1990, SCK; 4♂♂, 6♀♀, Peipu, HCH, TW, (190 m), 19-XI-1990, SCK; 3♂♂, 3♀♀, Sinwu, Haituan, TTH, TW, (505 m), 15-XII-1990, SCK; 2♂♂, 4♀♀, Kuohsing, NTH, TW, 20-II-1991, HCC; 2♂♂, 4♀♀, Tienlongchiao, Haituan, TTH, TW, (775 m), 2-IV-1991, SCK; 8♂♂, 11♀♀, Sanchan, Hsincheng, HLH, TW, (65 m), 3-IV-1991, SCK; 3♂♂, 4♀♀, Kanchiao, Shuangchi, TPH, TW, 30-V-1991, SCK & HCC; 6♂♂, 7♀♀, Pingsin, Shuangchi, TPH, TW, 31-V-1991, SCK & HCC; 2♂♂, 4♀♀, Hwesunlinchun, Lenai, NTH, TW, (750 m), 19-VIII-1991, HCC; 5♂♂, 3♀♀, Alishan, CIH, TW, (710 m), 19-XI-1991, SCK; 4♂♂, 3♀♀, Tona, Maolin, KSH, TW, (335 m), 20-XII-1991, SCK; 9♂♂, 6♀♀, Kanchiao, Shuangchi, TPH, TW, (140 m), 28-III-1992, SCK; 4♂♂, 7♀♀, Changyuan, Shuangchi, TPH, TW, (145 m),

29-III-1992, SCK; 2♂♂, 2♀♀, Hontung, Juifang, TPH, TW, (120 m), 29-III-1992, SCK.

Distribution: Taiwan, Ryukyu Island.

***Ephemera sauteri* Ulmer** (Figs. 3, 7)

Ephemera sauteri Ulmer, 1912: 369; Ulmer, 1925: 92; Uéno, 1931a: 191; 1931b: 210; Uéno, 1969: 237.

Mature nymphs (Fig. 3): body length, female 19.25-25.30 mm, male 15.35-22.10 mm. General coloration yellow to darkish yellow.

Head: frontal process with a rather shallow notch and blunt anterolateral point, about 1/2 as wide as head; lateral margins of frontal process convex; the widest about at apical 1/3 (Figs. 3A, 3B). **Labrum**: lateral margins convex; anterior margin with a broad emargination. **Hypopharynx**: in dorsal view, left and right superlinguae with different shape (Figs. 3C, 3D). **Mandibles**: molar of left mandible with ridges and grooves alternately, at middle part, groove narrow, about 1/6 of neighboring ridges (Fig. 3E). **Maxillae**: apical corner of galea-lacinia with blunt canine teeth, in lateral view, with 5 canine teeth, 3 fused, 2 separated (Fig. 3G).

Abdomen (Fig. 3H): dorsum yellow to darkish yellow, tergum I with 2 dots on submedian area; tergum II with 4 markings, 2 on submedian area, 2 on lateral area; tergum III with 2 dots on anterior area and 2 V-shaped markings on median area; tergum IV with 2 Y-shaped markings on median area; tergum V with 4 markings, 2 lateral, faint, 2 medial, Y-shaped; terga VI-IX each with 6 stripes, median 2 divergent posteriorly, submedian 2 and lateral 2 convergent posteriorly; stripes of terga VII, VIII fused posteriorly, between median and submedian stripes with a short transversal band connect them; tergum X with 4 dots medially, sometimes only 2 dots

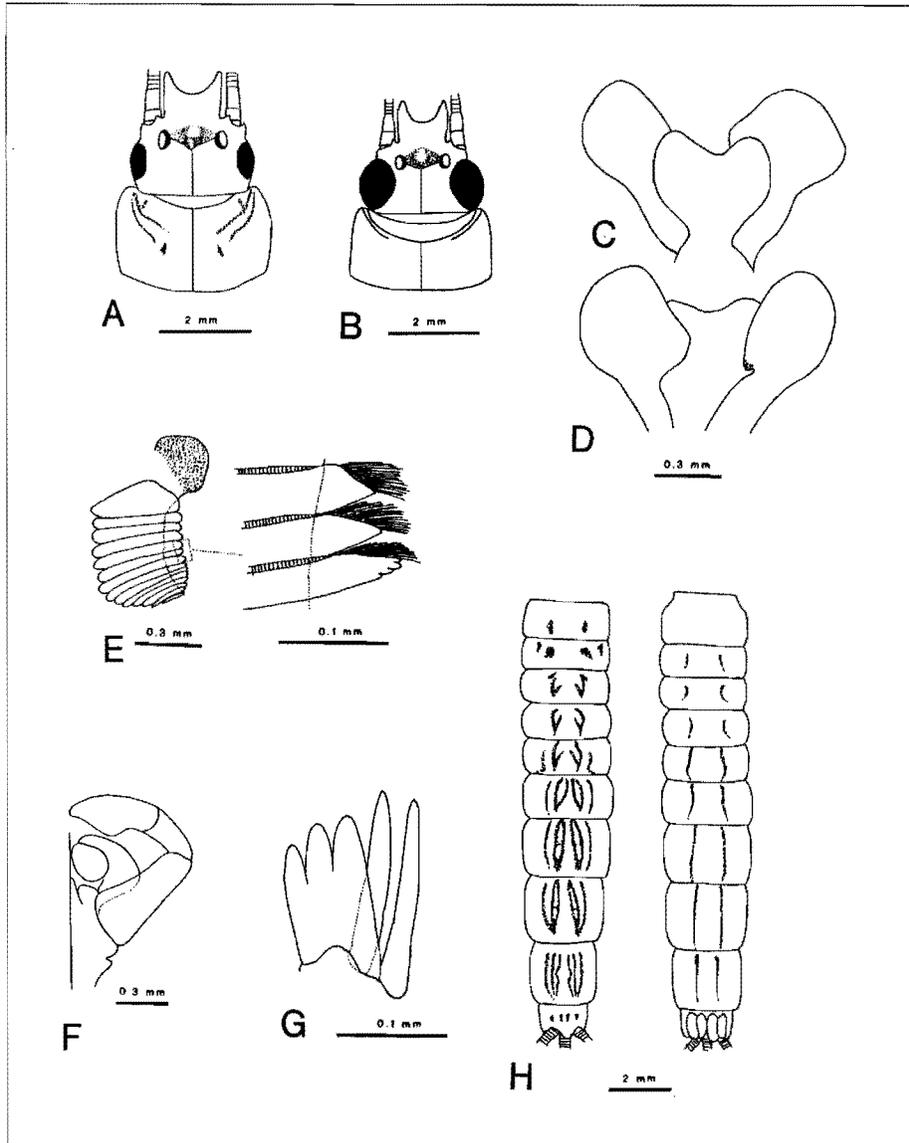


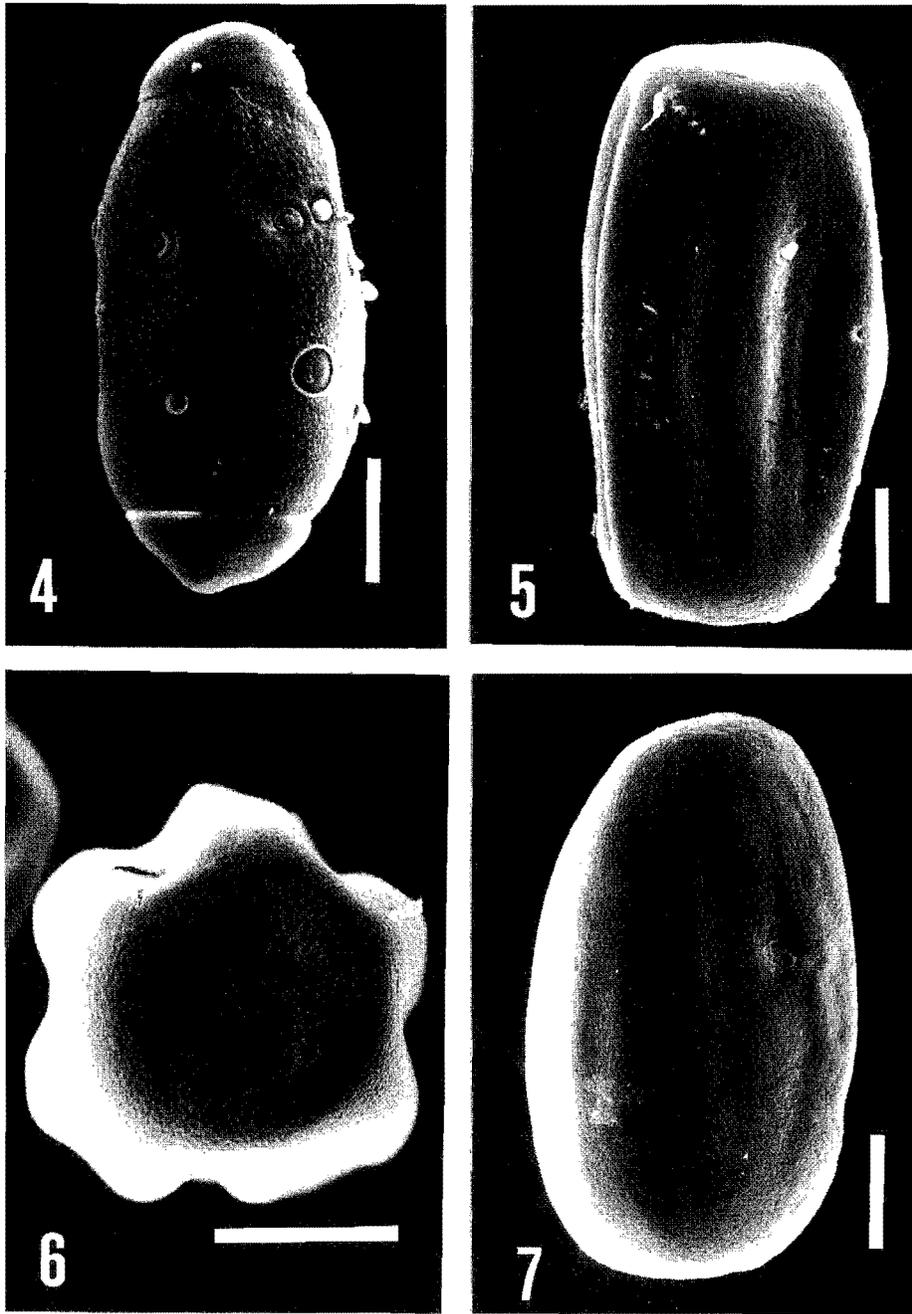
Fig. 3. Nymph of *Ephemerella sauteri* Ulmer. A, head and pronotum, female; B, head and pronotum, male; C, hypopharynx, ventral; D, hypopharynx, dorsal; E, molar of left mandible, anterior view; F, labium, ventral; G, maxillary apical canine teeth, lateral; H, abdomen, female (left-dorsal, right-ventral).

visible. Sternum I without marking; sternum II-VI each with 2 stripes, divergent posteriorly; sternum VII-IX with 2 long black stripes, nearly parallel. **Gills:** dark pink or purple, in dorsal view, anterior gills large than posterior ones distinctly.

Eggs (Fig. 7): general oval, chorionic

surface without any distinct structure; a visible small micropyle on subequatorial area.

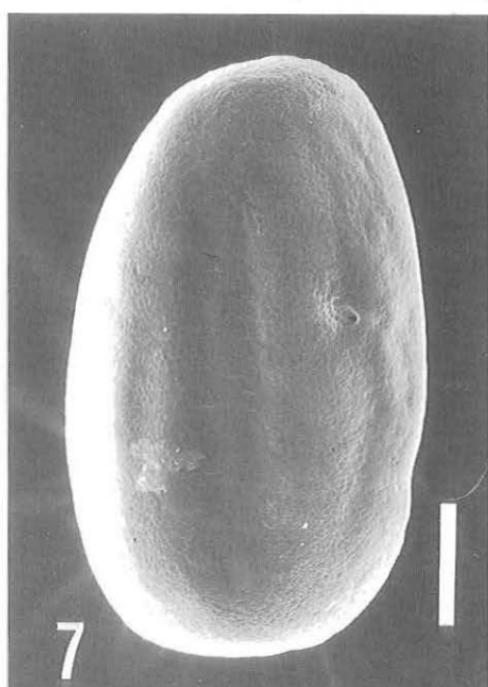
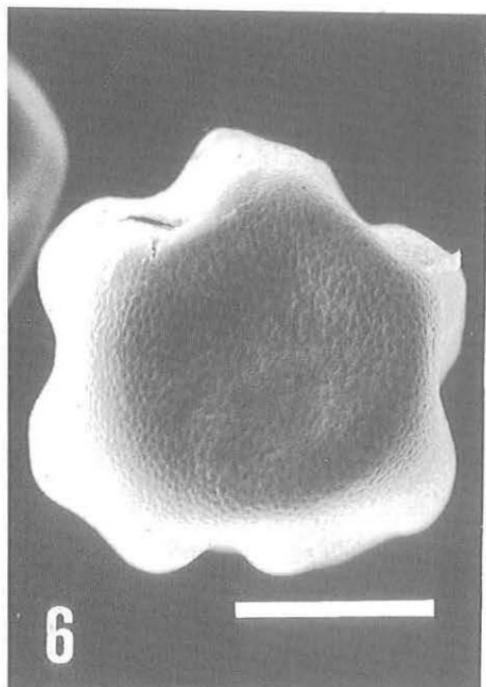
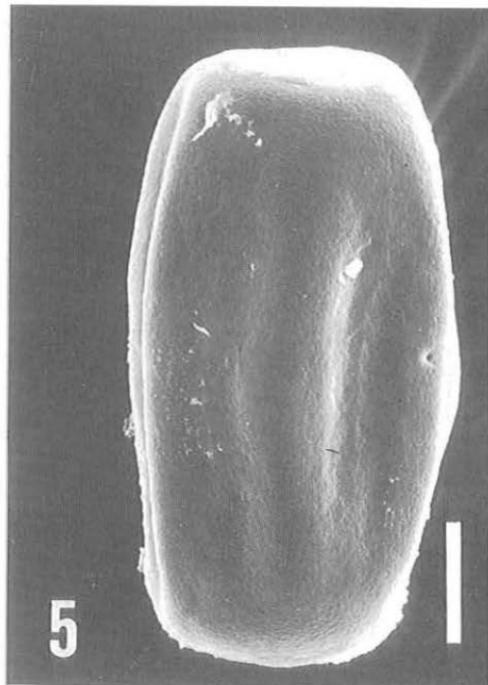
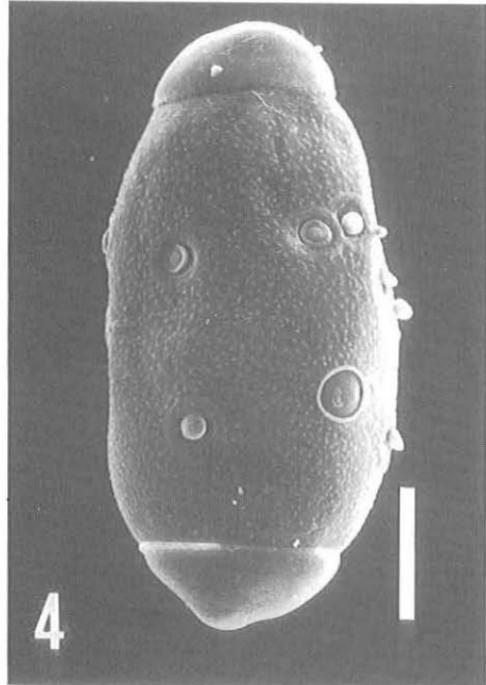
Mature nymphal specimens examined: 4♂♂, 3♀♀, Tienchih, Lenai, NTH, TW, (2,450 m), 26-I-1990, SCK & HCC; 12♂♂, 10♀♀, Nanhutashan, Tatu-



Figs. 4-7. Eggs. 4, *Potamanthus (Potamanthodes) idiocerus* Bae & McCafferty; 5-6, *Ephemera formosana* Ulmer, (5, general view; 6, anterior view); 7, *E. sauteri* Ulmer. [each scale = 50 μ m].

ng, ILH, TW, (2,300 m), 8-V-1990, WBY;
4♂♂, 6♀♀, Tienchih, Taoyuan, KSH,

TW, (2,445 m), 14-XII-1990, SCK; 5♂♂, 4
♀♀, Tienchih-Kuailin, Hsiulin, HLH,



Figs. 4-7. Eggs. 4, *Potamanthus (Potamanthodes) idiocerus* Bae & McCafferty; 5-6, *Ephemera formosana* Ulmer, (5, general view; 6, anterior view); 7, *E. sauteri* Ulmer. [each scale = 50 μ m].

TW, (2,435 m), 27-I-1991, SCK & HCC; 8 ♂♂, 10 ♀♀, Fenchifu, Chuchi, CIH, TW, (1,339 m), 9-II-1991, HCC; 3 ♂♂, 3 ♀♀, Nanhutashan, Tatung, ILH, TW, (2,450 m), 6-VII-1991, HCC; 7 ♂♂, 4 ♀♀, Tapachienshan, Wufeng, HCH, TW, (1,835 m), 24-X-1991, SCK & HCC; 2 ♂♂, 3 ♀♀, Alishan, CIH, TW, (1,845 m), 19-XI-1991, SCK.

Distribution: Taiwan, Mainland China (Kuanton).

Note: This species resembles *Ephemera formosana* Ulmer. Distinguishing them from nymph characters is rather difficult but they can be clearly differentiated in the shape of eggs. Localities of these two species are different in Taiwan, *E. formosana* lives in < 1,000 m of altitude; *E. sauteri* lives in high mountain. Minor characters to be considered in distinguishing their nymphs are: (1) in dorsal view, anterior gills distinctly larger than posterior ones in *E. sauteri* but subequal in *E. formosana*; (2) markings of terga; (3) frontal process of head; (4) molar of left mandible; (5) canine teeth of maxillae. Ulmer (1912) also recorded the other two species, *E. japonica* McLachlan and *E. supposita* Eaton from Taiwan. He seemed to have misidentified them because he no longer mentioned them in later reports (1920, 1925).

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