

EPHEMERELLIDAE OF TAIWAN (INSECTA, EPHEMEROPTERA)

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ABSTRACT—A new genus and seven new species of Ephemerellidae from Taiwan have been described. They are *Acerella glebosa* n.sp., *A. montana* n.sp., *Cincticostella fusca* n.sp., *C. colossa* n.sp., *Eburella brocha* n.gen., n.sp., *Torleya glareosa* n.sp., and *T. lutosa* n.sp. Descriptions of all species are based on nymphal stage. Eggs were obtained from mature female nymphs and were observed using scanning electron microscopy. Key to the nymphs is provided for these genera and species.

KEY WORDS: Ephemeroptera, Ephemerellidae, *Acerella*, *Cincticostella*, *Torleya*, *Eburella*, new genus, new species, Taiwan.

INTRODUCTION

The widespread family Ephemerellidae has been poorly known in Taiwan, although a few undetermined species from some faunistic studies (Her & Hsu, 1977; Yang *et al.* 1980). In Northeastern Asia, including Japan, Korea, Manchuria, and Siberia, the Ephemerellidae have been the subject of numerous investigations Ueño, 1928, 1931; Imanishi, 1937, 1938, 1940; Baikova, 1967; Tshernova, 1973; Yoon & Kim, 1981; Yoon & Bae, 1988). Allen & Edmunds (1963) reported the Ephemerellidae from Himalayas, Indochina and southern China. Allen (1971) reviewed Asian Ephemerellidae, in general of this family of southern China have been reported (Xu *et al.* 1980, 1984; You & Su, 1987; Su & You, 1988, 1989). Despite of these numerous studies in Asia, there has been no report of Taiwanese species.

We followed Allen (1980) classification of the Ephemerellidae who adopted an extended generic system. In recent five years, we have conducted a full-scale collection project throughout Taiwan, and obtained a good series of materials including seven species of Ephemerellidae that are to be described in this paper. In addition, we prepared diagnostic descriptions of the genera that include those Taiwanese ephemerellids. The nymphal stage of

Acerella and *Cincticostella* were described and reviewed by Allen (1971, 1975); *Torleya* was mentioned by Allen & Edmunds (1963) and discussed by Alba-Tercedor & Sanchez-Ortega (1982).

Eggs of all those species, were taken from mature female nymphs (with black wing pads), have been examined by scanning electron microscopy (SEM).

All holotypes of the following named species are deposited at Entomology Department of Chung Hsing University, Taichung, Taiwan (NCHU). Part of the paratypes are deposited at National Museum of Natural Science, Taichung, Taiwan (NMNS) and at Zoological Museum Lausanne, Switzerland (ZML).

KEY TO THE GENERA AND SPECIES OF EPHEMERELLIDAE OF TAIWAN (for nymphs only)

1. Maxillary palpi absent.....2
- Maxillary palpi present.....4
2. Gill III large, covering most of other gills; labrum semicircular (Figs. 6D; 7C); apex of maxilla with canine teeth (Figs. 6F; 7F) (*Torleya*).....3
- Gill III moderate in size, gills IV-VI visible; labrum trapezoidal (Fig. 5G); apex of maxilla without canine teeth (Fig. 5D) (*Eburella* n.gen)

-*Eburella brocha* n.sp.
3. Caudal filaments 1/2x-1x length of body, with 3-5 brown annular pigmented areas (Fig. 6L); lateral margins of mandibles without setae (Figs. 6A, 6B); dorsal body without bubble-like setae.....*Torleya glareosa* n.sp.
4. Caudal filaments about 1/4x as long as body, with 1 or 2 brown annular pigments (Fig. 7L); lateral margins of mandibles with long fine setae distinctly (Figs. 7A, 7B); dorsal body with numerous bubble-like setae (Fig. 7I).....*Torleya lutosa* n.sp.
5. Anterolateral corners of mesonotum produced anteriorly (Fig. 3B), lateral margins with a blunt process (Figs. 3B, 4F); maxillae with broad plate on crown of galea-lacinia (Figs. 3C, 4E) (*Cincticostella*).....5
6. Anterolateral corners and lateral margins of mesonotum not as above; maxillae with narrow, crenate process on crown of galea-lacinia (Figs. 1E, 2E) (*Acerella*).....6
7. Margins of gena round (Fig. 3A); vertex to abdominal terga I-II with a pale, discontinuous stripe medially (Fig. 3B).....*Cincticostella fusca* n.sp.
8. Margins of gena angled (Fig. 4A); dorsum without a pale, discontinuous stripe (Fig. 4B).....*Cincticostella colossa* n.sp.
9. Maxillary palpi well developed, subequal or slightly longer than galea-lacinia (Fig. 1E); posterior margin of abdominal tergum X without tubercle (Fig. 1M).....*Acerella glebosa* n.sp.
10. Maxillary palpi reduced in length, about half of length of galea-lacinia (Fig. 2E); posterior margin of abdominal tergum X with pair of small, blunt median tubercles (Fig. 2K).....*Acerella montana* n.sp.

Genus *Acerella* Allen, 1971

Ephemerella (*Acerella*) Allen, 1971:517.

Acerella Allen, 1980:82; Yoon & Bae, 1988:30.

Type species: *A. longicaudata* (Uéno)

The generic characters of nymphs outlined by Allen (1971) are modified as follows.

Mature nymphs: head with or without tubercles, and without frontal projections. Labrum oblong, anterolateral corner round, anterior margin slightly retuse (Figs. 1B, 2B). Superlinguae of hypopharynx moderate, lingua oval (Fig. 1C). Maxillary palpi well

developed or vestigial (Figs. 1E, 2E), galea-lacinia with a narrow process on crown (Figs. 1E, 2E). Labial palpus 3-segmented, segments I and II subequal in length and size, much larger than segment III (Figs. 1F, 2F). Not a with or without tubercles, lateral margins of mesonotum with a distinct projection near anterolateral corner (Fig. 2A). Claw with serrate denticles (Figs. 1J, 2J). Abdominal terga with paired dorsal tubercles on posterior margins (Figs. 1D, 2D). Gills 5 pairs, present on abdominal segments III-VII, gills III-VI alike, subequal in size and visible distinctly; gill VII small, covered by gill VI. Caudal filaments longer or slightly shorter than body, each articulation with whorled long acute setae.

Acerella glebosa Kang & Yang n.sp

Figs. 1, 8

Mature nymphs: (Fig. 1) body length, female 12.50-13.80mm, male 10.50-12.40mm. General coloration darkish yellow to dark brown.

Head: vertex with a pair of tubercles and long fine setae; anterior margin of clypeus with long fine setae; eyes of male divided into 2 portions, upper portion pink, lower black. **Labrum:** anterior margin slightly concave, dorsum with closely set anterior fine pinnate setae and median fine setae except a third of base. **Hypopharynx:** superlinguae oval, apical third with closely set acute setae; lingua round, anterior margin slightly convex, dorsum and a third of venter with short fine setae densely. **Mandibles:** incisors short and blunt; basal half with numerous pores; lateral half with numerous fine setae medially. **Maxillae:** maxillary palpus 3-segmented, well developed, apex of palpus reach or over the apex of galea-lacinia; venter of galea-lacinia with a large process near apex, the process crenate at mesal margin. **Labium:** paraglossa oval, dorsum with closely set acute setae, venter with loosely set fine setae; glossae oval; labial palpus 3-segmented, segment I as long as segment II, segment III small, about a quarter the length of segment II; dorsum of segment I with numerous pores medially, lateral margins of segments I and II with acute setae; segment III with short blunt setae sparsely.

Thorax: pronotum with 3 tubercles, 1 subanteromedially, 2 submedially; mesonotum with 7 tubercles, 2 submedially, 2 medially, 2 laterally and 1 subposteromedially; mesonotum with a pair of small

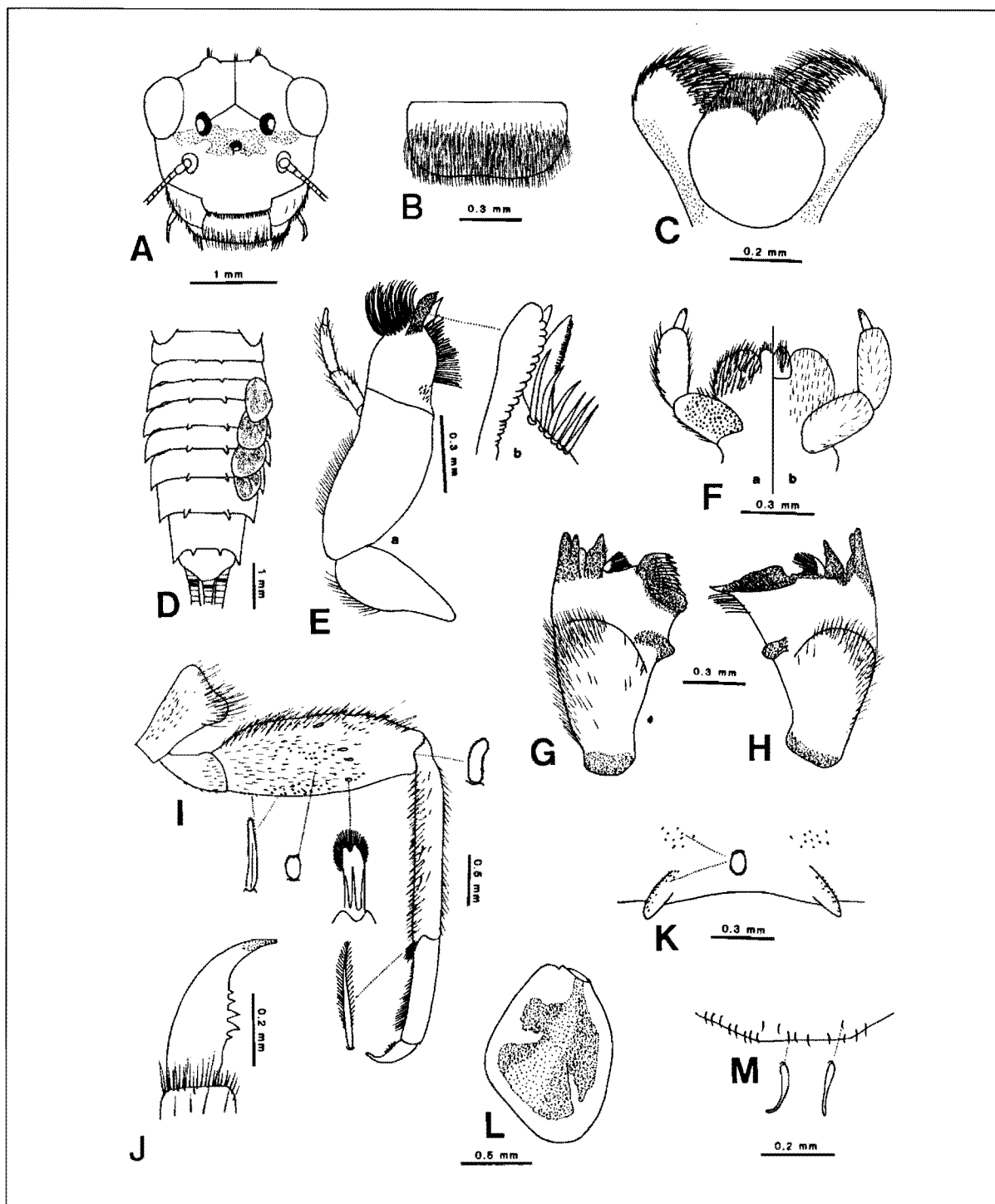


Figure 1. Nymph of *Acerella glebosa*. A, head, female, anterior view; B, labrum, dorsal; C, hypopharynx, ventral; D, abdomen, female, dorsal; E, a, right maxilla, ventral, b, magnification of apex; F, labium, a, dorsal, b, ventral; G, left mandible, dorsal; H, right mandible, dorsal; I, left fore leg; J, fore claw; K, posteromedian margin of abdominal tergum VI; L, gill III; M, posteromedian margin of abdominal tergum X.

processes near anterolateral corner; posterior margin of mesonotum with a cleft. Fore legs: coxa with a lobe, the lobe with long fine setae densely at apex; posterior margin of femur with long fine setae densely and several stout pinnate clavate setae; median area of femur with loose set of fine setae, stout pinnate clavate setae and small pinnate short oblong setae; tibia slightly longer than femur, with closely set fine setae and loosely set acute setae; tarsus about half the length of tibia; claw with 5-7 denticles, median denticle larger than apical and basal ones. **Middle and hind legs:** same as in fore legs but hind legs larger than middle legs and middle legs larger than fore legs.

Abdomen: terga II-IX each with paired dorsal tubercles, tubercles short and narrowly separated at base on tergum II, longer and gradually more widely separated on terga III-VII, and shorter and more narrowly separated on tergum IV; abdominal segments IV-IX each with posterolateral projections; each lateral margin of terga IV-IX with short blunt setae; each posterior margin of terga VIII, IX with small pinnate oval setae laterally; posterior margin of sternum IX of female truncate or slightly concave, of male with 2 short, blunt processes laterally. **Gills:** present on abdominal segments III-VII, gills III-V alike, oblique oval, gill VI oval; gills III-VI subequal in size, each with irregular pigmented area medially; gill VII very small, pale, oblong. **Caudal filaments:** pale, with 1-2 dark annuluses at base of each filament; slightly shorter than body; each segment especially the median ones with whorled acute and blunt pinnate setae on each articulation; distal half of filaments with long setae on lateral side of each segment.

Eggs: (Fig. 8) general shape pyriform, with a polar cap, composed of dense filaments, terminal of each filament intumescent. Eggs measure about 180 μ in length and 120 μ in width. Chorionic surface with closely set pentagonal or hexagonal ridges except non-polar cap area; the ridges emboss on the chorionic surface slightly, each ridge unit with a small, flat tubercle medially; 2-3 micropylar devices and 3-5 KCTs (knob-terminated coiled threads) visible on equatorial and subequatorial areas. The sperm guides large, oval. The KCTs without surrounding excrescence, the thread surround the knob-terminal.

Holotype: mature female nymph, Sinwuchaio, Haituan, Taitung Hsien, Taiwan, (500 m), 15-XII-1990, S.C.Kang, in collection NCHU.

Paratypes: 6 ♂ (2 mature nymph, 4 immature), 9 ♀ (1 mature, 8 immature), same data as for holotype; 2 ♂, 4 ♀ in collection NCHU; 2 ♂, 3 ♀ in collection NMNS; 2 ♂, 2 ♀ in collection ZML.

Distribution: Taiwan

Remarks: This new species resembles *Acerella commodema* Allen (= *perculata* Allen) but can be differentiated in the nymphs by the following characteristics: (1) in the vertex with only a pair of tubercles; (2) in front view, the margins of gena curved smoothly and margins of *commodema* near rectangular and (3) in the abdominal dorsal tubercles on terga II-IX. In early instar nymphs, the tubercles of vertex, thorax, and abdomen are well developed, and as the nymphs mature these tubercles gradually diminish in size.

***Acerella montana* Kang & Yang n.sp.**

Figs. 2, 9, 10

Mature nymphs: (Fig. 2) body length, female 11.40-13.90mm, male 10.20-12.35mm. General coloration brown to dark brown.

Head: vertex with a pair of tubercles and long fine setae; anterior margin of clypeus with long fine setae; eyes of male divided into 2 portions, upper portion pink, lower black. **Labrum:** anterior margin slightly concave, dorsum with closely set anterior fine pinnate setae and median fine setae except basal third. **Hypopharynx:** superlinguae oval, apical third with closely set acute setae; lingua round, anterior margin slightly convex, dorsum and third of venter with short fine setae densely. **Mandibles:** incisors short and blunt; basal half with numerous pores; lateral half with numerous fine setae medially. **Maxillae:** maxillary palpus 3-segmented, diminish in length, apex of palpus reach to middle of galea-lacinia; venter of galea-lacinia with a large process near apex, the process crenate on mesal margin. **Labium:** paraglossa oval, dorsum with closely set acute setae, venter with loosely set fine setae; glossae oval; labial palpus 3-segmented, segment I as long as segment II, segment III small, about a quarter the length of segment II; dorsum of segment I with numerous pores medially, lateral margins of segments I and II with acute setae; segment III with short blunt setae sparsely.

Thorax: pronotum with 3 tubercles, 1 anteromedially, 2 submedially; mesonotum with 9 tubercles, 2 medially, 2 subanteromedially, 2

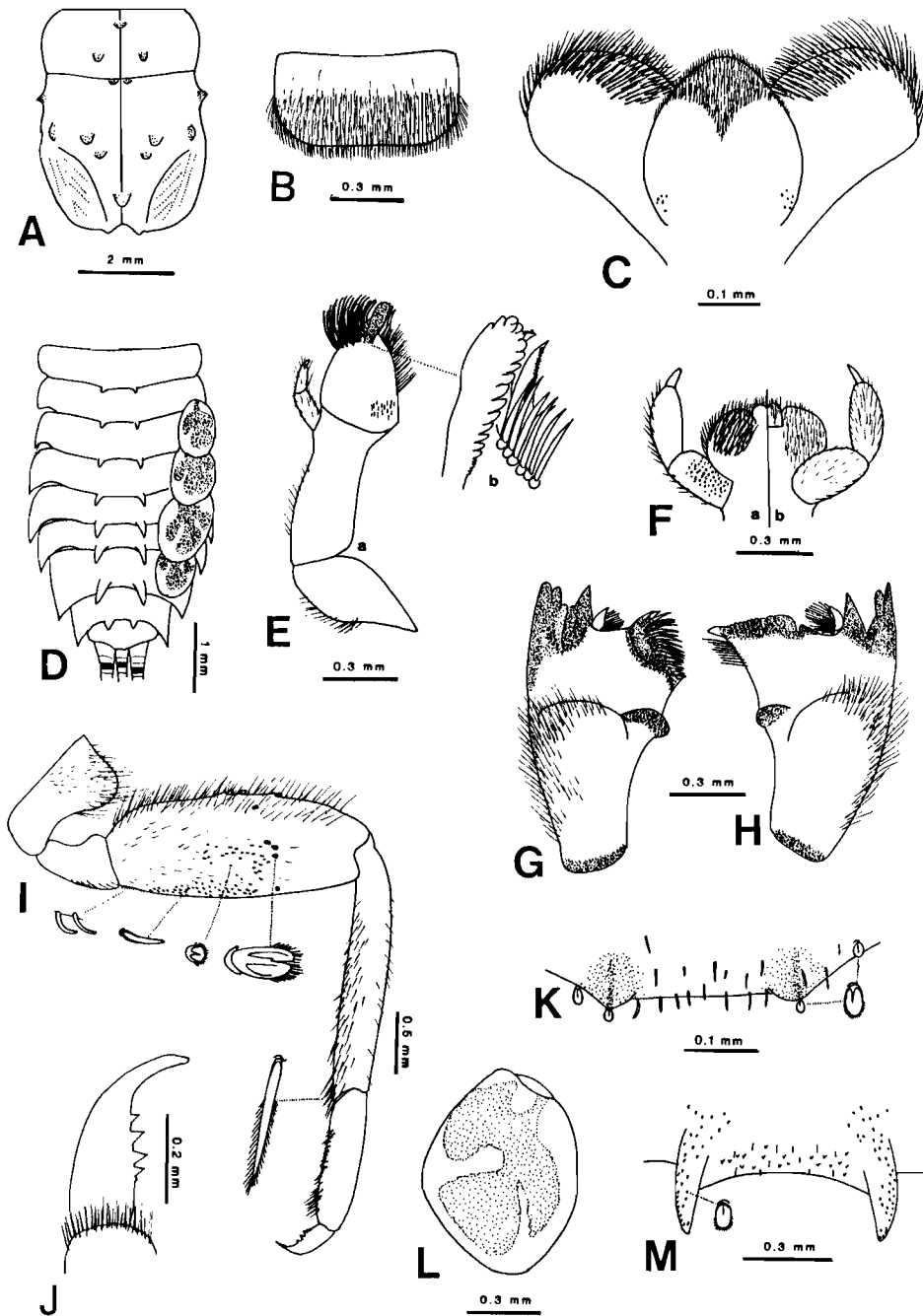


Figure 2. Nymph of *Acerella montana*. A, thorax, dorsal; B, labrum, dorsal; C, hypopharynx, ventral; D, abdomen, female, dorsal; E, a, right maxilla, ventral, b, magnification of apex; F, labium, a, dorsal, b, ventral; G, left mandible, dorsal; H, right mandible, dorsal; I, left fore leg; J, fore claw; K, posteromedian margin of abdominal tergum X; L, gill III; M, posteromedian margin of abdominal tergum VI.

submedially, 2 laterally and 1 subposteromedially; mesonotum with a pair of small processes near anterolateral corner; posterior margin of mesonotum with a cleft. **Fore legs:** coxa with a lobe posteriorly, the lobe with long fine setae densely; posterior margin of femur with long fine setae densely and several stout pinnate clavate setae; median area of femur with loosely set of fine setae, stout pinnate clavate setae and small pinnate short oblong setae; tibia slightly longer than femur, with closely set fine setae and loosely set acute setae; tarsus about half the length of tibia; claw with 5-7 denticles, median denticle larger than apical and basal. **Middle and hind legs:** same as for fore leg but hind leg larger than middle leg and middle leg larger than fore leg.

Abdomen: terga II-IX each with paired dorsal tubercles, tubercles short and narrowly separated at base on tergum II, longer and gradually more widely separated on terga III-VII, except shorter and more narrowly separated on tergum IV; posterior margin of tergum X with a pair of blunt or vague tubercles; abdominal segment III-IX each with posterolateral projections; each lateral margin of terga IV-IX with short blunt setae; each posterior margin of terga VIII, IX with small pinnate oval setae laterally, tergum X with a few small oval pinnate setae; posterior margin of sternum IX of female truncate or slightly concave, of male with 2 short, blunt processes posterolaterally. **Gills:** present on abdominal segments III-VII, gills III-V alike, oblique oval, gill VI oval; gills III-VI subequal in size, with irregular pigmented area medially; gill VII very small, pale, oblong. **Caudal filaments:** pale, with 1-2 dark annuluses at base of each filament; slightly shorter than body; each segment especially the median segments with whorls of acute and blunt pinnate setae on each articulation; distal half of filaments fringe with long setae on lateral side of each segment.

Eggs: (Figs. 9, 10) shape and structure of surface resemble in *Acerella glebosa* n.sp.

Holotype: mature female nymph, Wuling Farm, Hoping, Taichung, Taiwan, (1,620m), 20-I-1987, P. S. Yang & K. J. Huang, in collection NCHU.

Paratypes (mature nymph): 11♂ 12♀, same data as for holotype; 2♂, same locale and collector as for holotype, 29-XII-1986. 5♂ 8♀, in collection NCHU; 3♂ 2♀, in collection NMNS; 3♂ 2♀, in

collection ZML.

Distribution: Taiwan

Remarks: This new species resembles *A. glebosa* n.sp. but can be differentiated in the nymphs by the following characteristics: (1) the palpus of maxilla reduced in length, reaching the middle of galea-lacinia; (2) in the posterior margin of abdominal tergum X with a pair of small, blunt or vague tubercles and a few small oval pinnate setae and (3) in the abdominal tubercles more distinct than in *A. glebosa*.

Genus *Cincticostella* Allen, 1971

Ephemerella nigra-group Imanishi, 1938:33

Ephemerella (Cincticostella) Allen, 1971:513; 1975:16.

Asiatella Tshernova, 1973:368.

Cincticostella Allen, 1980:83; Yoon & Bae, 1988:28.

Type species: *Cincticostella nigra* (Uéno)

The generic characters of nymphs outlined by Allen (1971) are modified as follows.

Mature nymphs: Body flattened ventrally, convex dorsally. Head without tubercles, genae round (Fig. 3A) or truncate (Fig. 4A). Anterior margins of labrum convex (Fig. 4B). Superlinguae of hypopharynx moderate, lingua oval (Fig. 4C). Maxillary palpi well developed (Fig. 3C), vestigial or absent; galea-lacinia without apical canines but with a broad plate on crown (Figs. 3C, 4E). Labial palpus 3-segmented, segments I and II subequal in length and size, much larger than segment III; glossae reduced, (Fig. 4I). Notum without tubercles; anterolateral corners of pronotum produced anteriorly; mesonotum expanded laterally (Fig. 3B). Fore femora with band of transverse setae near middle (Fig. 4J). Claw with serrate denticles (Figs. 3F, 4K). Abdominal terga with paired dorsal tubercles on posterior margins (Figs. 3G, 4F). Gills 5 pairs, present on abdominal segments III-VII, gills III-VI alike, subequal in size and visible distinctly; gill VII small, covered by gill VI. Caudal filaments much shorter than body (Fig. 4F).

***Cincticostella fusca* Kang & Yang n.sp.**

Figs. 3, 14-17

Mature nymphs: (Fig. 3) Large. Body length, female 15.2-17.4mm, male 13.3-15.4mm; cerci length, female 8.8-10.2mm, male 7.4-9.2mm. General

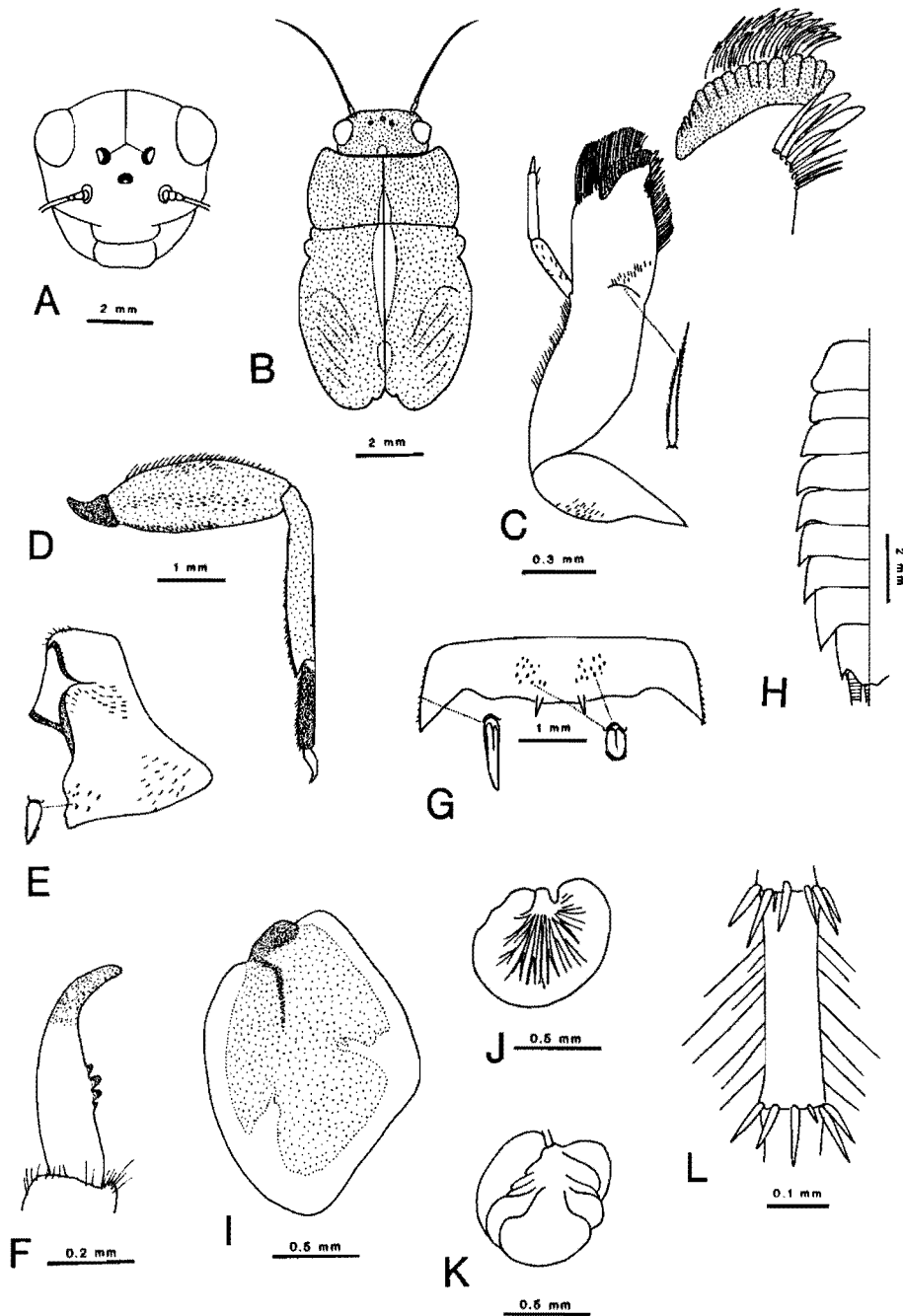


Figure 3. Nymph of *Cincticostella fusca*. A, head, female, anterior view; B, head and thorax, female, dorsal; C, right maxilla, ventral; D, left fore leg, dorsal; E, fore coxa; F, fore claw; G, abdominal tergum VI; H, abdominal sterna, female; I, gill III; J, gill VII, dorsal; K, gill VII, ventral; L, middle segments of caudal filament.

coloration uniform dark brown, usually with a pale discontinuous stripe from head to end of thorax.

Head: dark brown, usually with a pale marking on vertex; eyes of male divided into 2 portions, upper portion small, pink, lower black; gena slightly expansive; clypeus with a row of setae on anterolateral margins. **Labrum:** semicircular, anterior margin thick, slightly concave; dorsum with scattered fine setae. **Hypopharynx:** superlinguae slightly expansive, subquadrate, apical area of venter with closely set of acute fine setae; lingua round. **Mandibles:** incisors short and blunt, inner incisors biforked, left outer incisor four-forked, right outer incisor three-forked. **Maxillae:** apex with 2 large canine teeth and a slightly curved plate, apical margin of plate crenate; a tuft of stout setae at apex; galea-lacinia with several setae near base; lateral margins of stipes and cardo with fine setae; maxillary palpus well developed, 3-segmented; as long as galea-lacinia; segment I very small and short. **Labium:** paraglossae semicircular; apical half of dorsum with closely set acute setae; apical three quarters of venter with loosely set of fine setae; glossae long oval; labial palpus 3-segmented, segments I and II subequal in length, segment III very small, about a fifth as long as segment II; dorsum and venter of segments II and III of labial palpus with acute setae.

Thorax: pronotum uniform dark brown, usually with a medial pale marking, anterolateral corners produced anteriorly; mesonotum with 2 median pale stripes; lateral margins each with a blunt process near anterolateral corner; posterior margin of mesonotum undulate. **Legs:** posterolateral angles of fore and middle coxae each with a acute projection; femora brown; tibiae brown, pale on distal area; tarsi dark brown; fore femur with dorsal setae on median area, posterior and anterior areas; claws pale, apices dark brown, with 3-6 blunt denticles medially.

Abdomen: abdominal segments II-IX each with posterolateral projection, of segment VIII the largest. Posterior margin of terga II-IX each with a pair of acute tubercles; each lateral margin of terga IV-VIII with acute setae, tergum IX with setae posteriorly; each median area of terga II-X with small oval setae. **Gills:** present on terga III-VII, gills III-VI subequal in size; outer lamellae oblique oval, with a three-part pigmentation medially; gill VII small, round. **Caudal filaments:** cerci pale, darkish on distal part; each segment with whorled acute

setae at apex; median segments with long fine setae on lateral margins loosely.

Eggs: (Figs. 14-17) general shape oval, with a polar cap, composed of dense filaments, each filament with intumescent terminal. (Figs. 15, 17). Eggs measure about 155μ in length and 110μ in width. Chorionic surface meshy by irregular, hexagonal ridges except non-polar cap area (Fig. 14), surface of mesh granular, each with 1-5 flat, variety tubercles medially (Fig. 15); 1-2 micropylar devices and 2-6 KCTs visible on equatorial and subequatorial areas. The sperm guides large, round, about 12μ in diameter. The KCTs surround by ringlike excrescence (Fig. 15).

Holotype: mature female nymph, Wuling Farm, Hoping, Taichung, Taiwan, (1,600 m), 13-IV-1986, P. S. Yang & K. J. Huang, in collection NCHU.

Paratypes (mature nymph): 7 ♂ 5 ♀, same data as for holotype; 3 ♂ 4 ♀, same locale and collector, 17-V-1986; 6 ♂ 3 ♀, same locale and collector, 18-V-1986. 10 ♂ 6 ♀, in collection NCHU; 3 ♂ 3 ♀, in collection NMNS; 3 ♂ 3 ♀, in collection ZML.

Distribution: Taiwan

Remarks: This new species resembles *Cincticostella nigra* (Uéno) but can be differentiated in the nymphs by the following characteristics: (1) in the maxillary palpus as long as galea-lacinia; (2) in the dorsal setae of fore femur on median area, anterior and posterior areas, and without subdistal long acute setae; (3) each segment of caudal filaments with whorled acute setae instead of on every other segments for *nigra* and (4) in the body size distinctly larger than in *nigra*.

***Cincticostella colossa* Kang & Yang n.sp.**

Figs. 4, 11-13

Mature female nymphs (Figs. 4): body length 8.0-9.5mm; cerci length 2.1-3.2mm. General coloration dark brown.

Head: dark brown, without tubercles, gena angled, in frontal view anterior margin of head nearly straight. **Labrum:** semicircular, apical half of dorsum with numerous fine pinnate setae. **Hypopharynx:** superlinguae expanded, subquadrate, apical half of venter with closely set acute setae; lingua round, apex of venter and the whole of dorsum covered with short fine setae. **Mandibles:** apical half darkish; incisors short and blunt,

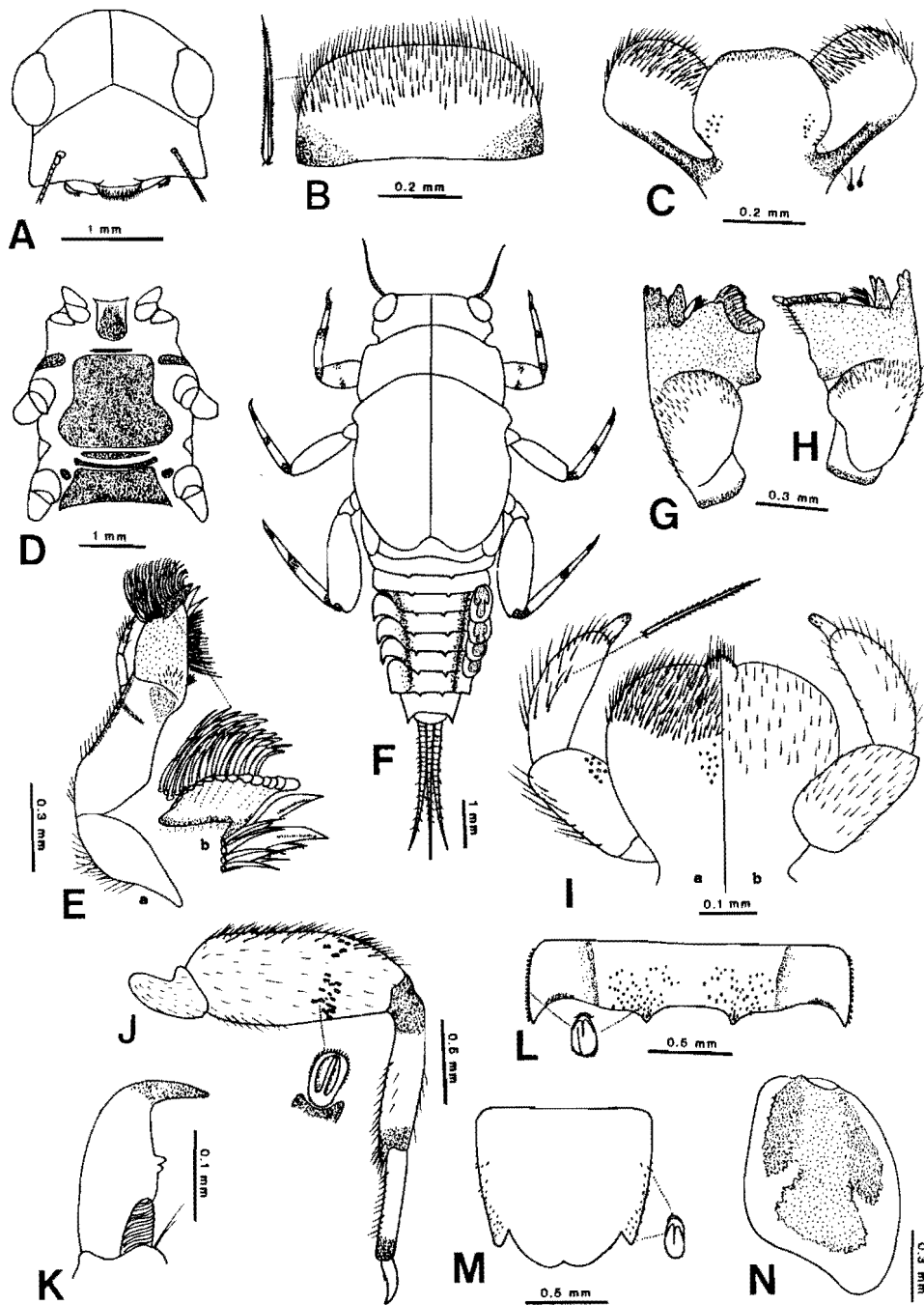


Figure 4. Nymph of *Cincticostella colossa* A, head, female, anterior view; B, labrum; C, hypopharynx, ventral; D, thorax, ventral; E, a, right maxilla, ventral, b, magnification of apex; F, whole view, female; G, left mandible, dorsal; H, right mandible, dorsal; I, labium, a, dorsal, b, ventral; J, left fore leg, dorsal; K, fore claw; L, abdominal tergum VI; M, abdominal sternum IX; N, gill III.

dorsum with numerous fine setae medially. **Maxillae:** apex with 2 large canine teeth and a slightly curved plate, apical margin of plate crenate; a tuft of stout setae at apex; galea-lacinia with several setae near base; lateral margins of stipes and cardo with fine setae; maxillary palpus 3-segmented, about two-thirds as long as galea-lacinia, segment I very small and short. **Labium:** paraglossae of labium nearly confused, round; apical half of dorsum with closely set acute setae; apical half of venter with loosely set of fine setae; glossae fused, round, apex with fine branched setae; labial palpus 3-segmented, segments I and II subequal in length, segment III very small, about a fifth as long as segment II; dorsum of segments II and III of labial palpus each with long branched setae, venter with fine setae.

Thorax: nota uniform dark brown; anterolateral corners of pronotum slightly produced anteriorly; mesonotum slightly ridge medially; sterna of thorax as figured, darkish and with gaps distinctly. **Fore legs:** femur dark brown, dorsum with 2 groups of short pinnate oblong setae; posterior and anteromesal margins of femur with long fine setae; dorsum of trochanter and femur with fine setae loosely; tibia light yellow, darkish at apex and base; tibia shorter than femur; tarsus about half as long as femur, darkish at terminal; apex of claw curved strongly; with 2 blunt denticles medially. **Middle and hind legs:** dorsum of femur with short pinnate oblong setae uniformly except distal third; the others same as in fore leg.

Abdomen: abdominal segments IV-IX each with posterolateral projections. Each posterior margin of terga II-IX with a pair of small, blunt tubercles; each lateral margin and central area of terga II-IX with numerous short pinnate oblong setae; terga III-VIII decline toward laterals suddenly; posterior margin of sternum IX with a shallow emargination. **Gills:** gills present on terga III-VII dorsally, gills III-VI subequal in size, outer lamellae with a three-parted pigmentation medially; gills III-V alike, oblique, gill VI oval; gill VII very small. **caudal filaments:** about 1/4x of body, with short acute or blunt setae on every other articulation.

Mature male nymphs: unknown.

Eggs: (Figs. 11-13) general shape oval, with a polar cap, the polar cap and surface structure resemble *Cincticostella fusca* n.sp. (Fig. 13). Eggs measured about 200 μ in length and 150 μ in width. Chorionic

surface meshy regularly by hexagonal ridges except non-polar cap area (Fig. 11), surface of mesh granular, each with 1-5 blunt tubercles (Fig. 12), polar meshes with more tubercles more than of equatorial meshes; 1-2 microphylar devices and 3-6KCTs visible on equatorial and subequatorial areas. The sperm guides large, stilliform, about 15 μ in length and 9 μ in width. The KCTs with surrounding excrescence (Fig. 12).

Holotype: mature female nymph, Pinghu, Pingchi, Taipei Hsien, Taiwan, (250m), 28-III-1992, S. C. Kang, in collection NCHU.

Paratypes: (mature nymph), 1 φ (dissection), same data as for holotype; 3 φ (2 dissection), Shuicheliao, Sanhsia, Taipei Hsien, Taiwan, (420m), 31-III-1992, S. C. Kang. 2 in collection Nchu; 1 (caudal filaments broken) in collection NMNS; 1 in collection ZML.

Distribution: Taiwan

Remarks: This new species is distinct from other known species of this genus by the head shape, frontal view, gena triangular, anterior lateral angle rectangular. Caudal filaments are very short, about a quarter the length of body. The chorionic structure resembles *Cincticostella fusca* n.sp. but can be differentiated by following characteristics: (1) the ridges discontinuous, with fine gaps; (2) in the center of each 'mesh' with 1-6 blunt tubercles and (3) each KCT surrounded by discontinuous counterscarp-like structure.

***Eburella* Kang & Yang n.gen.**

The genus *Eburella* characterized by the following morphological features:

Mature nymphs: head, thorax without tubercles, processes or spines. Labrum trapezoidal, base slightly wider than apex, anterior margin with a V-shaped emargination medially (Fig. 5G). Superlinguae of hypopharynx expanded, lingua subcordate (Fig. 5C). Outer incisors of mandibles greatly elongated (Figs. 5E, 5F) and extending beyond anterior margin of head (Figs. 5A, 5B). Maxilla without palpus, galea-lacinia without canine teeth on crown (Fig. 5D). Paraglossae of labium subcordate, greatly larger than glossae (Fig. 5H); labial palpus 3-segmented, segments I slightly shorter than segment II, much longer than segment III. Nota without tubercles or process. Claw with

varied size of denticles (Fig. 5J). Abdominal terga and sterna without tubercles or spines; posterior margins of terga with a row of blunt setae (Fig. 5M); posterolateral projections present on abdominal segments IV-IX (Fig. 5N). Gills 5 pairs, present on abdominal segments III-VII, gills III-VI alike, subequal in size and visible distinctly; gill VII small, covered by gill VI. Caudal filaments shorter than body; each articulation with whorled long acute setae, especial on median segments (Fig. 5K).

Type species: Eburella brocha n.sp. (here designated)

Remarks: The nymph of this new genus resembles *Uracanthella* Belov which distributes in Siberia and northeast Asia. Although they are similar in abdominal terga, legs, claws, gills and caudal filaments, they can be differentiated in nymphs by the following characters: (1) labrum trapezoidal instead of semicircle for *Uracanthella*; (2) crown of galea-lacinia without canine teeth instead of with comb-shaped canine teeth for *Uracanthella*; (3) in the outer incisors of mandibles greatly elongated, acute and extending beyond anterior margin of head and (4) paraglossae of labium subcordate instead of oval for *Uracanthella*. This new genus belongs to the tribe Ephemerellini Lamere and subtribe Ephemerellae Allen.

Etymology: *Eburella* feminine, is from the Latin word *ebur* meaning ivory and the Latin diminutive *ella* which conforms to generic names common in the family.

***Eburella brocha* Kang & Yang n.sp.**
Figs. 5, 18, 19

Mature nymphs: (Fig. 5) body length, female 6.10-8.50mm, male 5.19-7.34mm; cerci length, female 3.20-3.80mm, male 2.90-3.50mm. Body dark brown, without tubercles.

Head: dark brown, in young stage with a wide pale transversal band between eyes. **Labrum:** trapezoidal, at base wider than at apex, anterior margin with a V-shaped emargination medially and a semicircular pale marking; dorsum with closely set setae on anterior margin and lateral margins without any setae. **Hypopharynx:** superlinguae expanded, with a row of closely set setae along anterior margin; lingua subcordate, anterior margin slightly concave, apical third of venter with fine short setae. **Mandibles:** outer incisors greatly

elongated, about 2.5x length of inner incisors and extending beyond anterior margin of head, apical half of mesal margin finely serrated; basal half of mesal margin of left outer incisor with 2 blunt processes, right outer incisor with 3 distinct denticles; lateral half of mandibles ridge, lateral margins and apical third of dorsum with long setae. **Maxillae:** articulations of galea, lacinia and cardo distinct, palpus absent, anterior margin convex; mesal and anterior margins of galea with long setae densely; lateral margin of lacinia and posterior margin of cardo with short setae sparsely. **Labium:** paraglossae subcordate, greatly larger than glossae; glossae semicircular; labial palpus 3-segmented, segments I and II subequal in length, about 4.5X length of segment III.

Thorax: nota uniform dark brown; pronotum oblong. **Fore legs:** femur dark brown, with pale markings at apex and on median area; posterior margin of femur with several long blunt pinnate setae; tibia 1.16-12.5x length of femur, pale, apical and basal quarter both with a wide dark brown annulus, lateral margin with long blunt pinnate setae, mesal margin with long blunt pinnate setae and acute setae; tarsus 0.42-0.45x length of femur, darkish medially, with a row of acute setae along mesal margin; claw with 3 distinct denticles, the apical and basal ones larger than medial, basal denticle biforked; basal half of mesal margin of claw with fine setae densely. **Middle legs:** same as in fore leg but tibia only with 3-5 long blunt pinnate setae on lateral margin. **Hind legs:** same as in fore leg but lateral margin of tibia without setae.

Abdomen: dorsum dark brown, tergum V with a pair of pale markings on posterior margin, tergum VIII with a pair of pale marking on anterior margin; venter uniform dark brown, sterna III-IX each with paired pale markings laterally, sterna V-VIII with a longitudinal pale marking medially; abdominal segments IV-IX each with posterolateral projections, of segment IX larger than in other segments; each lateral margin of terga IV-IX with short blunt setae, on tergum IV very sparse; each posterior margin of terga IV-X with short blunt setae sparsely, tergum IV with only 2 setae medially; posterior margin of sternum IX of female convex smoothly, of male slightly undulate, with 2 shallow emarginations medially. **Gills:** gills III-VI alike, gill VII very small; dorsal lamellae of gills III-VI oval, basal half darkish distinctly. **Caudal filaments:** pale, except for the distal 5-7 segments black; each

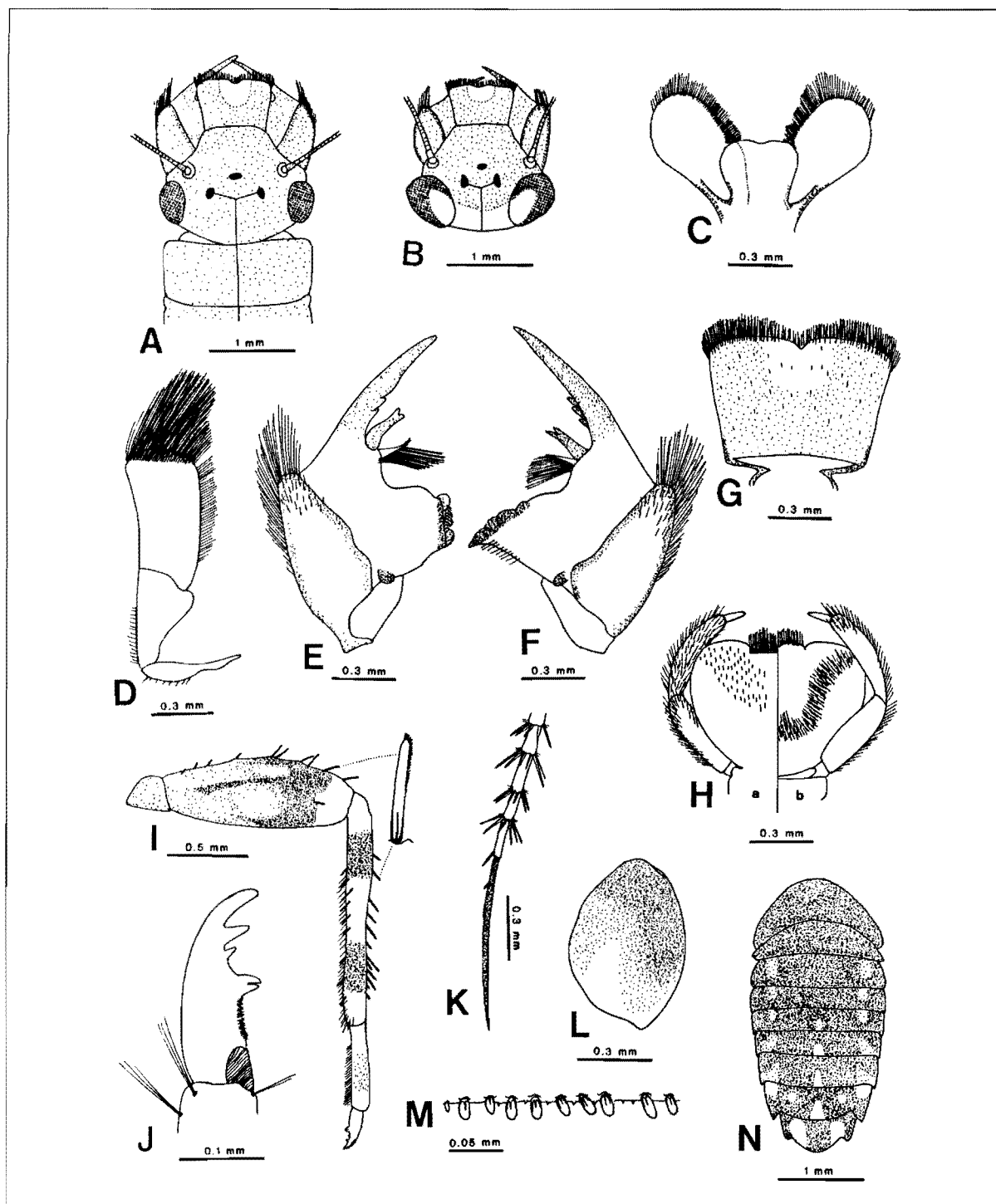


Figure 5. Nymph of *Eburella brocha*, A, head and pronotum, female; B, head, male; C, hypopharynx, ventral; D, right maxilla, ventral; E, left mandible, dorsal; F, right mandible, dorsal; G, labrum, dorsal; H, labium, a, dorsal, b, ventral; I, left hind leg, dorsal; J, fore claw; K, distal part of caudal filament; L, gill III; M, posteromedian margin of abdominal tergum VI; N, abdominal sterna, female.

articulation with whorled long acute setae and a few fine setae except distal black segments; cerci slightly shorter than terminal filaments.

Eggs: (Figs. 18, 19) General shape oval, about 160μ in length and 105μ in width, with a polar cap, the polar cap about 55μ in diameter. chorionic surface meshy with broadly reticular ridges (Fig. 18); the reticular ridges granular, about $5-6\mu$ in width, edges with fine branches (Fig. 19). Each egg with 3-7 visible KCTs on subequatorial areas and with 2-4 visible micropylar devices on equatorial area. Terminal of KCTs long oval (Fig. 19). The sperm guides large, stilliform, about 11μ in width. (Fig. 19).

Holotype: mature female nymph, Kuolai, Pinglin, Taipei Hsien, Taiwan, (315m), 30-III-1992, S. C. Kang, in collection NCHU.

Paratypes: (mature nymph), 7♂ 4♀, same data as for holotype; 1♂ 2♀, Pinglin, Taipei Hsien, Taiwan, (365m), 31-V-1991, S.C. Kang & H.C. Chang; 2♂ 4♀, Wufeng, Hsinchu Hsien, Taiwan, (304m), 24-X-1991, S.C. Kang & H.C. Chang; 3♂ 1♀, Shuicheliao, Sanhsia, Taipei Hsien, (420m), 31-III-1992, S.C. Kang. 7♂ 7♀, in collection NCHU; 3♂ 2♂, in collection NMNS; 3♂ 2♀, in collection ZML.

Distribution: Taiwan

Genus *Torleya* Lestage, 1917

Torleya Lestage, 1917:366.

Type species: *Torleya belgica* Lestage

The nymphs of genus *Torleya* characterized by the following morphological features:

Mature nymphs: Head with tubercles. Anteromedial margin of labrum slightly concave, dorsum with closely set of pinnate setae (Figs. 6D, 7D). Superlinguae of hypopharynx moderate, lingua subquadrate (Figs. 6E, 7E). Maxillary palpi vestigial or absent; galea-lacinia with apical canines (Figs. 6F, 7F). Labial palpus 3-segmented, segments I and II subequal in length and size, much larger than segment III; glossae with moderate size, (Figs. 6C, 7D). Nota with or without tubercles; Fore femora with band of transversely long setae near middle (Figs. 6H, 7H), these setae branched apically. Claw with two kinds of denticles on separate positions, apical denticles acute, basal denticles blunt (Figs. 6I, 7G). Abdominal terga with

paired dorsal tubercles on posterior margins, tubercles with tufty setae (Figs. 6J, 7J). Gills 5 pairs, present on abdominal segments III-VII, gill III large, cover the most part of remainder. Caudal filaments shorter than body, with dark bands and with whorls of long acute setae at apex of each segment (Figs. 6L, 7M).

Torleya glareosa Kang & Yang n.sp.

Figs. 6, 20, 21

Mature nymphs: (Fig. 6) body length, female 4.40-4.95mm, male 4.32-4.76mm. General coloration light yellow to yellowish brown.

Head: yellow, small. Front with several fine clavate setae between eyes. **Labrum:** semicircular, darkish on posterolateral corners; anterior margin with a shallow emargination medially; anterolateral margins each with a row of branched setae; dorsum with numerous pores on central and apical quarter areas. **Hypopharynx:** superlinguae oval, anterior margin with acute setae, posterior margin thick and darkish; lingua quadrate, anterior margin truncate or slightly concave, venter with 2 oblique ridges medially, convergent at base and with some pores near lateral margins, basal half of lateral margins of lingua with a row of fine branched setae; dorsum of lingua covered with fine setae densely. **Mandibles:** incisors short and blunt; lateral margin of left mandible straight; mesal corner of right mandible with some small triangular scales. **Maxillae:** maxillary palpus absent; mesal half of galea darkish, at base with a distinct branched setae, lateral margins of lacinia and cardo with setae sparsely. **Labium:** paraglossa with acute setae on lateral half of dorsum and branched setae on apical half of venter; glossae with branched setae on venter and lateral margin of dorsum; labial palpus 3-segmented, segment I longer than segment II, segment III about half the length of segment II; mesal half of dorsum of segment I with numerous pores, lateral margins of segments I and II with acute setae; segment III with short blunt setae sparsely.

Thorax: nota yellow, darkish on median area and anterior areas of fore wing pads. **Fore legs:** femur light yellow, with a brown, large, oval marking medially, the marking light medially; with a longitudinal row of stout long clavate setae near median area of femur; tibia darkish medially, subequal in length of femur, with a row of acute

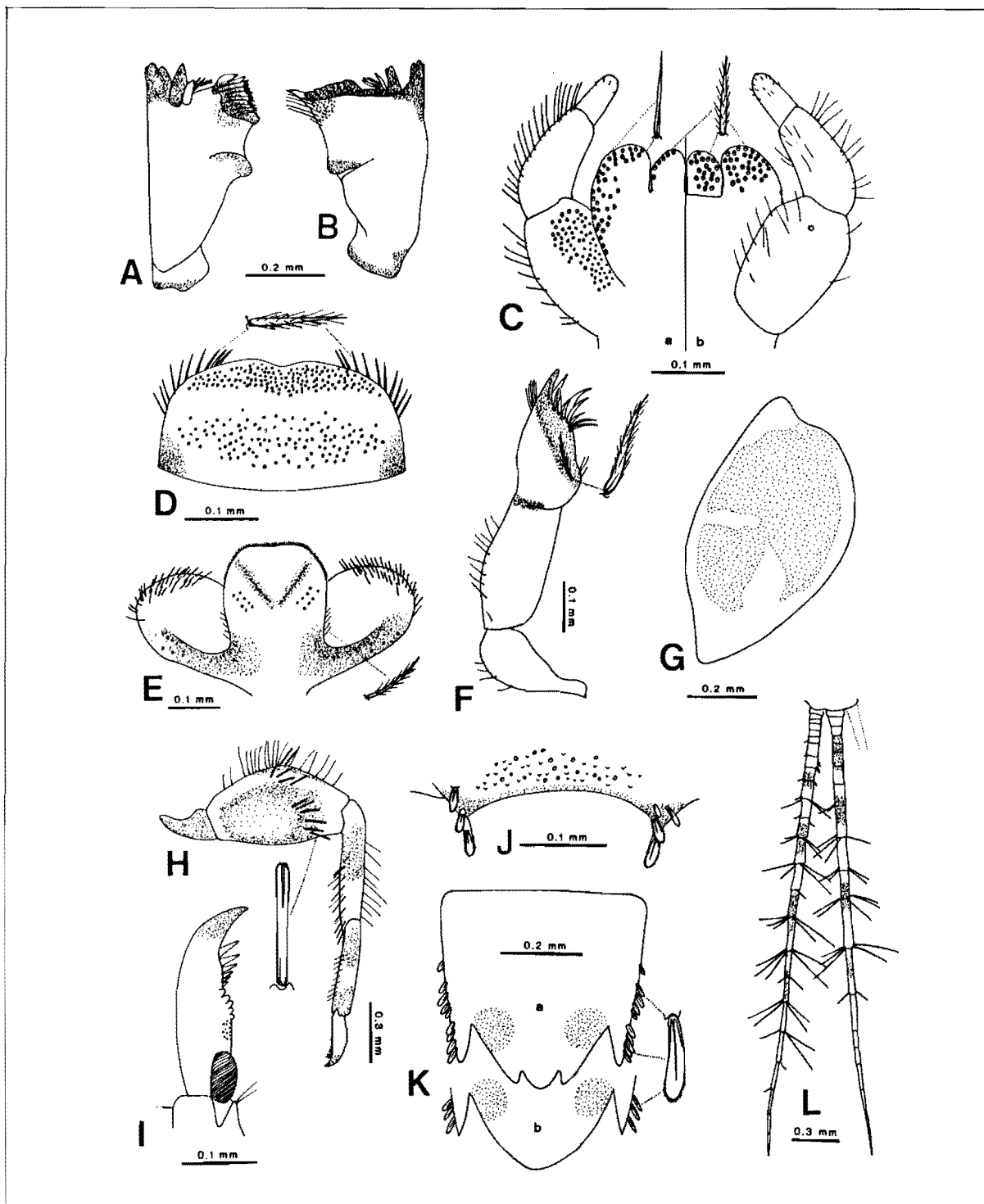


Figure 6. Nymph of *Torleya glareosa*. A, left mandible, dorsal; B, right mandible, dorsal; C, labium, a, dorsal, b, ventral; D, labrum; E, hypopharynx, ventral; F, right maxilla, ventral; G, gill III; H, left fore leg, dorsal; I, fore claw; J, abdominal tergum VI; K, abdominal sternum IX, a, male, b, female; L, caudal filaments.

setae on mesal margin; apical and basal third of tarsus darkish brown, about two-thirds the length of femur, with a row of short acute setae on mesal margin; claw with 2 parts of denticles, the apical part acute and long, with 5-6 denticles, gradually larger apically; the basal part of denticles with 5 small blunt denticles, subequal in size; under the denticles with small triangular scales sparsely. **Middle legs:** femur without stout long clavate setae and with long acute setae, the others same as in fore leg. **Hind legs:** same as in middle leg.

Abdomen: dorsum yellow, sternum IX with a pair of brown round markings near posterior margin; abdominal segments IV-IX each with posterolateral projections, of segments VI and VII larger than in other segments; each lateral margin of abdominal segments IV-IX with short blunt pinnate setae; each posterior margin of terga III-VI with 2 small acute tubercles, terga III and VI vague, the tubercles with several short blunt pinnate setae; posterior margin of tergum IX with 2 short blunt pinnate setae medially; posterior margin of sternum IX of female convex and with fine serrate spines, of male with 2 emarginations medially. **Gills:** present on abdominal segments III-VII, gradually smaller distally; gills IV and V alike, oblong, gills VI, VII small; gill III large, semioperculate, cover the most part of the other gills, only the first three pairs of gills visible. **Caudal filaments:** pale, equal or less than half the body length, with 3-5 brown wide annular pigments; the median half each with whorled long acute setae on each articulation.

Eggs: (Figs. 20, 21) General shape oval, about 150μ in length and 100μ in width, with a polar cap, the polar cap about 65μ in diameter, composed of dense threads, their terminal utriculate and closely band on the edge of polar cap distinctly (same as Fig. 25). Chorionic surface meshy with broadly reticular ridges (Fig. 20); the reticular ridges with numerous fine spurs, about $4-8\mu$ in width (Fig. 21). Each egg with 5-11 visible KCTs on subequatorial areas and with 4-8 visible micropylar devices on equatorial area. Terminal of KCTs long oval (same as Fig. 24). Sperm guides large, stilliform, about 11μ in length and 8μ in width. (Fig. 21).

Holotype: mature female nymph, Shanlinsi, Luku, Nantou Hsien, Taiwan, (850m) 22-VIII-1991, S. C. Kang & H. C. Chang, in collection NCHU.

Paratypes: (mature nymph), 21 ♂ 27 ♀, same data

as for holotype, 11 ♂ 17 ♀, in collection NCHU; 5 ♂ 5 ♀, in collection NMNS; 5 ♂ 5 ♀, in collection ZML.

Other mature nymphal specimens examined: 5 ♂ 8 ♀, Lileng, Hoping, Taichung Hsien, Taiwan, (470m), 20-I-1989, S.C. Kang; 2 ♂ 2 ♀, Kanchiao, Shuangchi, Taipei Hsien, Taiwan, (140m), 30-V-1991, S.C. Kang & H.C. Chang; 2 ♂ 6 ♀, Pingsin, Shuangchi, Taipei Hsien, Taiwan, (365m), 31-V-1991, S.C. Kang & H.C. Chang; 7 ♂ 2 ♀, Shaping, Liukuei, Kaohsiung Hsien, (635m), 19-XII 1991, S. C. Kang.

Distribution: Taiwan

Remarks: This new species resembles *Torleya lutosa* n.sp. but can be differentiated in nymphs by the following characteristics: (1) in the body without bubble-like setae; (2) in the lateral margin of left mandible straight; (3) in the lateral margin of mandible without setae; (4) posterior margins of terga III-VI each with 2 small acute tubercles and (5) caudal filaments equal or less than half the body length, with 3-5 brown wide annular pigments.

***Torleya lutosa* Kang & Yang n.sp.**

Figs. 7, 22-25

Mature nymphs: (Fig. 7) body length, female 4.50-7.1mm, male 4.10-6.25mm. The body light yellow to yellowish brown; dorsum of head, thorax, legs and abdomen with numerous bubble-like setae.

Head: yellow. **Labrum:** semicircular, darkish on posterolateral corners; anterior margin with a shallow emargination medially; dorsum with branched setae on apical quarter and lateral margins; median area with numerous pores and fine setae. **Hypopharynx:** superlinguae oval, anterior margin with acute pinnate setae, posterior margin thick and darkish; lingua subquadrate, anterior margin truncate or slightly convex, venter with 2 oblique ridge medially, convergent at base and with some pores near lateral margins, laterobasal margins of lingua each with a row of branched setae; dorsum and apex of venter of lingua covered with fine branched setae densely. **mandibles:** incisors short and blunt; basal half with numerous pores; lateral half with numerous long acute setae medially. **Maxillae:** maxillary palpus absent; mesal half of galea darkish, with 2-3 distinct branched setae on mesal margin near base; lateral margin with several fine comb-shaped setae apically; lateral

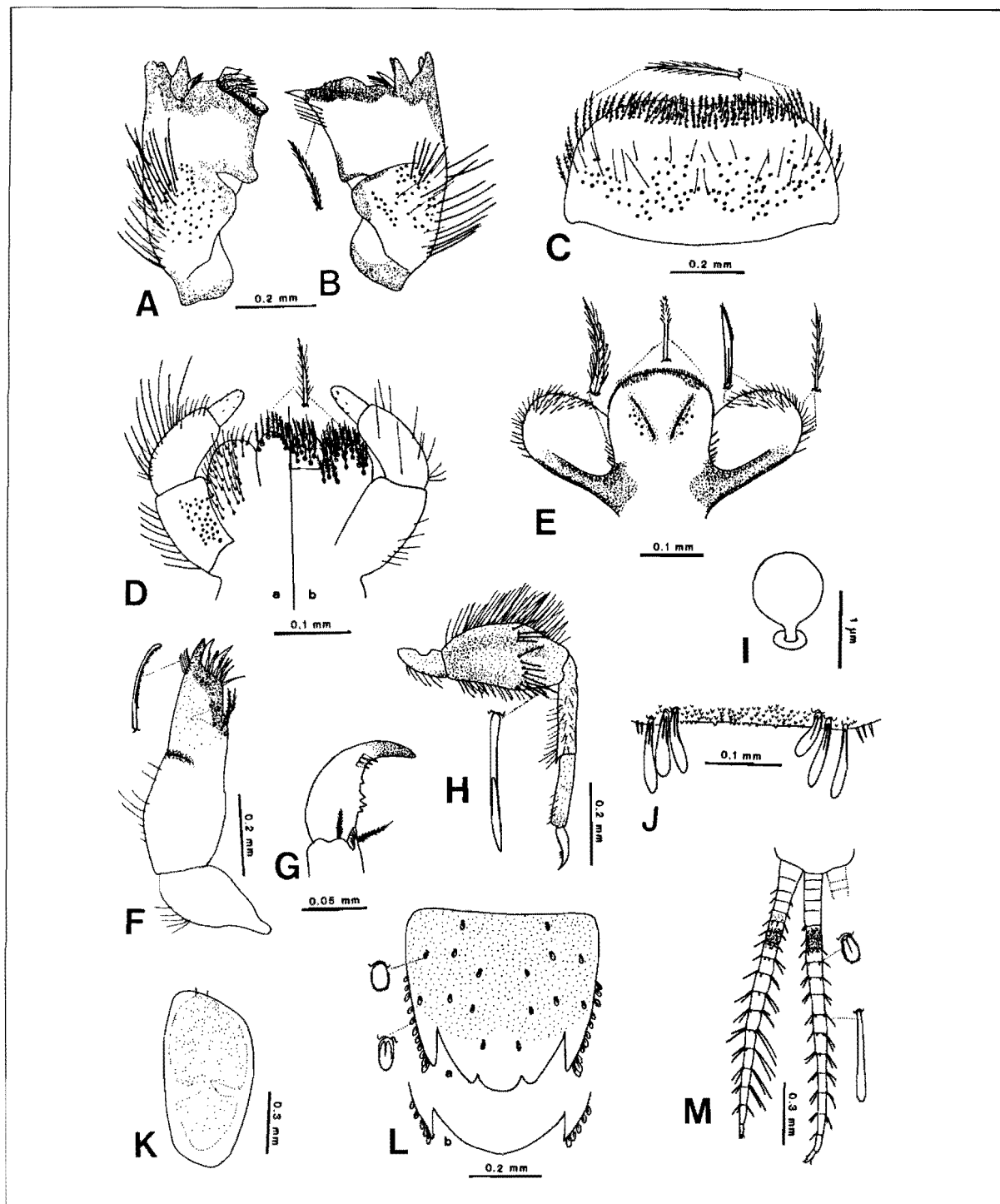
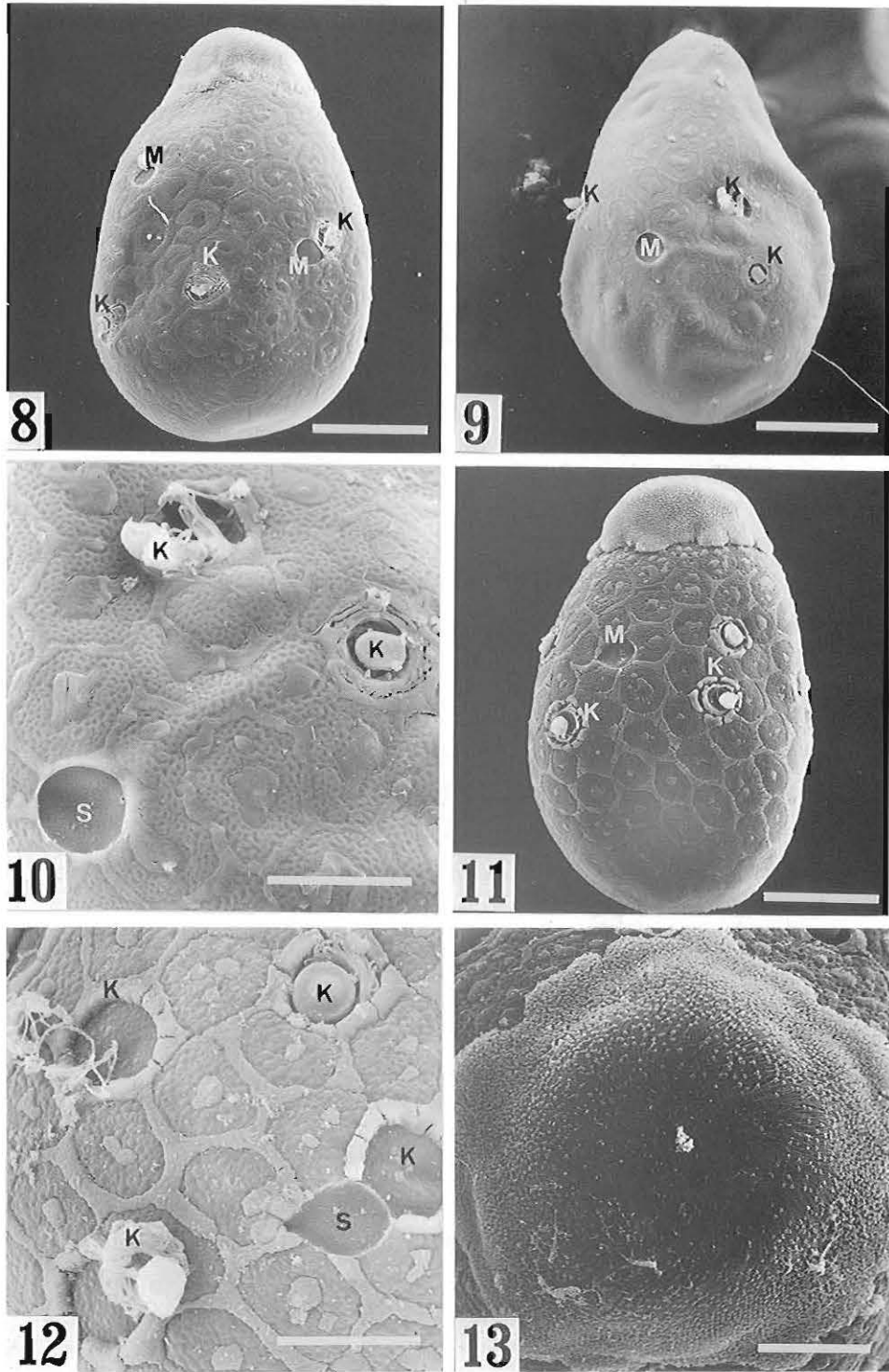
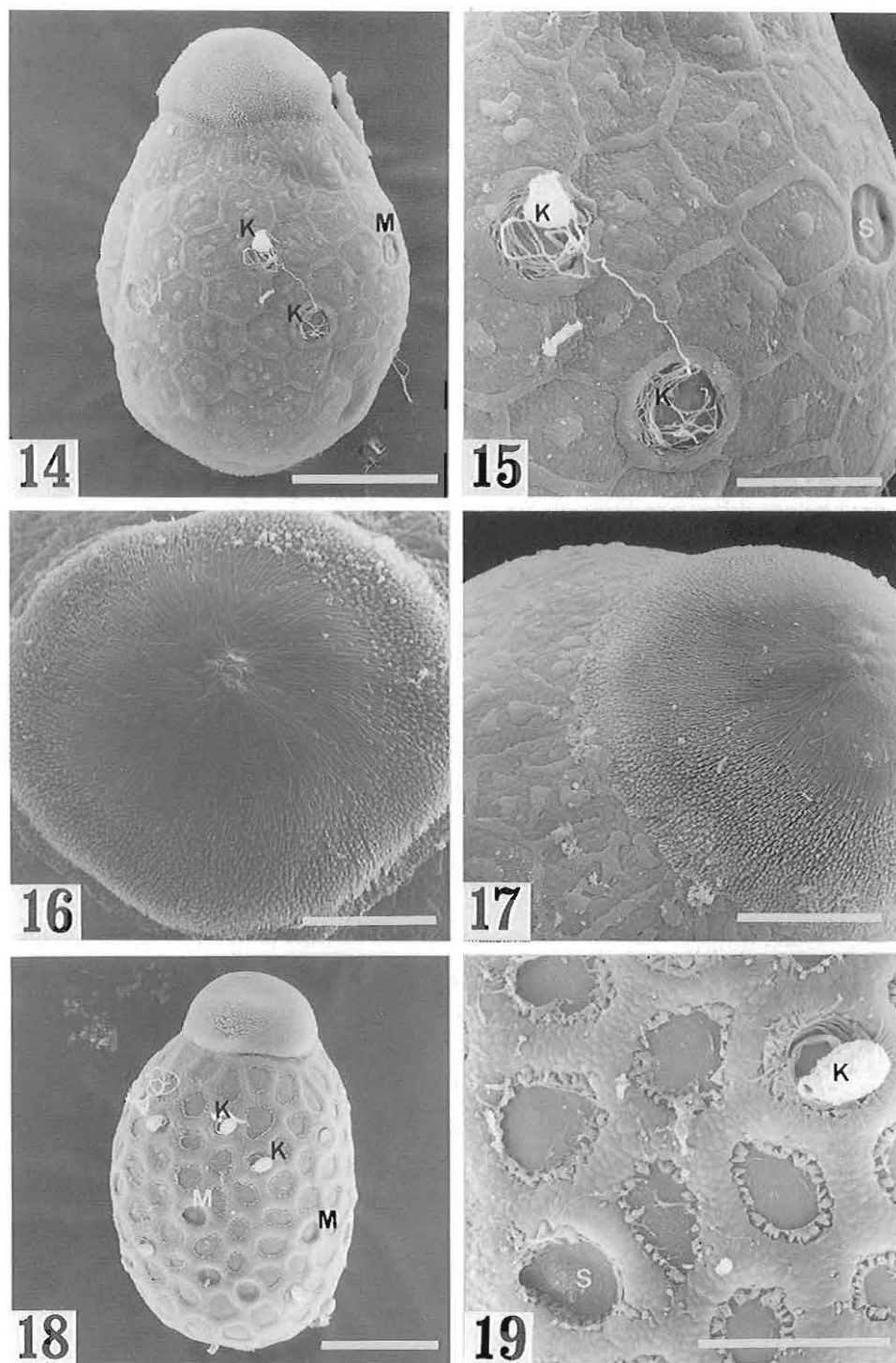


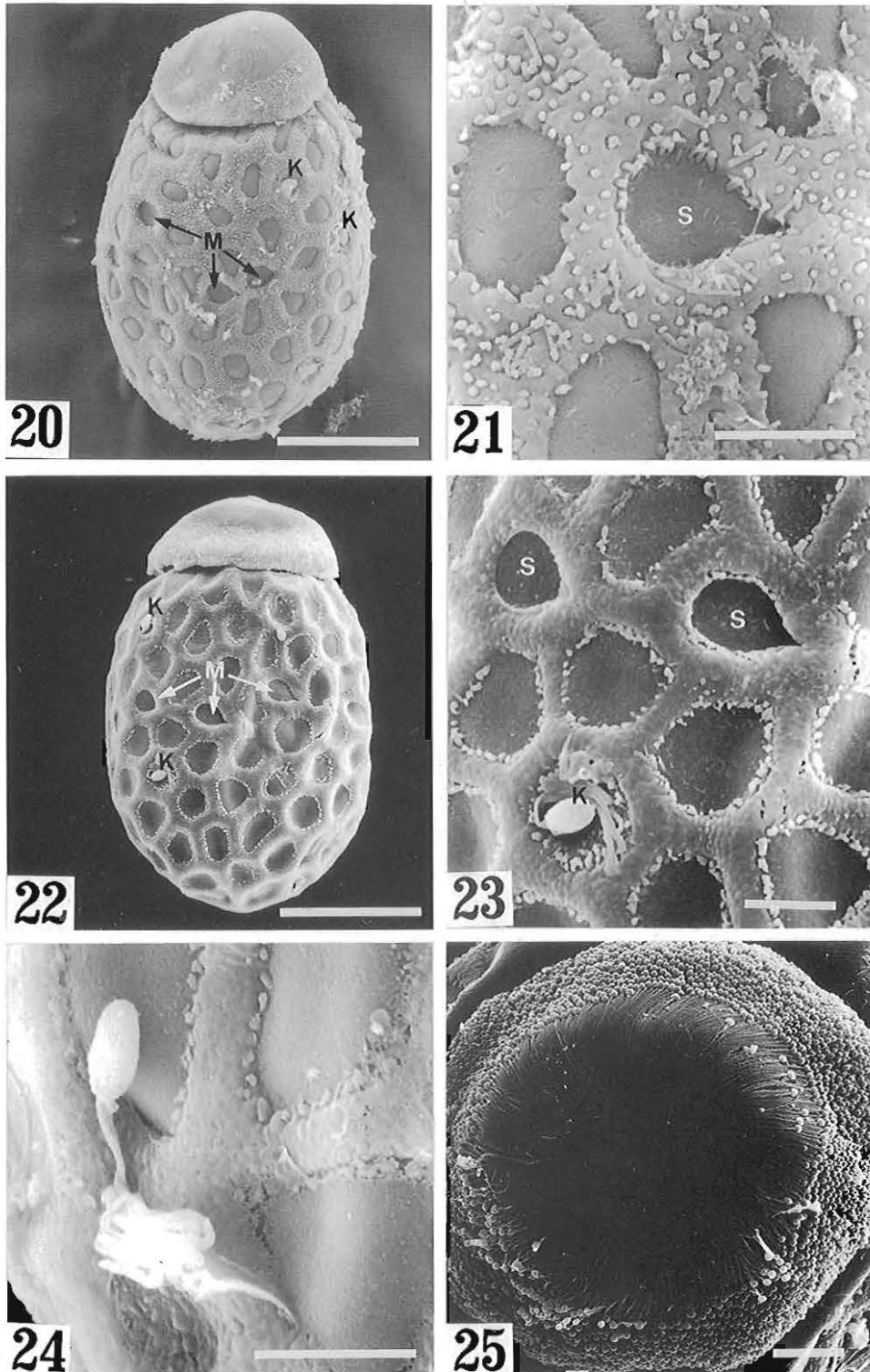
Figure 7. Nymph of *Torleya lutosa*. A, left mandible, dorsal; B, right mandible, dorsal; C, labrum, dorsal; D, labium, a, dorsal, b, ventral; E, hypopharynx, ventral; F, right maxilla, ventral; G, fore claw; H, left fore leg, dorsal; I, bubble like setae of dorsum of body; J, posteromedian margin of abdominal tergum VI; K, gill III; L, abdominal sternum IX, a, male, b, female; M, caudal filaments.



Figures 8-13. Eggs. 8, *Acerella glaebose*; 9-10, *A. montana* (9, general view; 10, magnification); 11-13, *Cincticostella colossa* (11, general view; 12, magnification; 13, polar cap). [K: KCT, knob-terminal coiled threads; M: micropylar device; S: sperm guide; Scales: Figs. 8, 9, 11 - bar = 50 μ ; Figs. 10, 12, 13 - bar = 20 μ]



Figures 14-19. Eggs. 14-17, *Cincticostella fusca* (14, general view; 15, magnification; 16, 17, polar cap); 18-19, *Eburella brocha* (18, general view; 19, magnification). [K: KCT, knob-terminal coiled threads; M: micropylar device; S: sperm guide; Scales: Figs. 14, 18 - bar = 50 μ ; Figs. 15-17, 19 - bar = 20 μ].



Figures 20-25. Eggs. 20-21, *Torleya glareosa* (20, general view; 21, magnification); 22-25, *T. lutosa* (22, general view; 23, magnification; 24, KCT; 25, polar cap). [K: KCT, knob-terminal coiled threads; M: micropylar device; S: sperm guide; Scales: Figs. 20, 22 - bar = 50 μ ; Figs. 21, 23-25 - bar = 10 μ].

margins of lacinia and cardo with setae sparsely. **Labium:** paraglossa with acute setae on lateral half of dorsum and branched setae on apical half of venter; glossae with branched setae on venter and lateral margins of dorsum; labial palpus 3-segmented, segment I longer than segment II, segment III about half the length of segment II; dorsum of segment I with numerous pores medially, lateral margins of segments I and II with acute setae; segment III with short blunt setae sparsely.

Thorax: nota yellow, anterolateral corners of pronotum round, mesonotum darkish on median area and anterior areas of fore wing pads. **Fore legs:** femur light yellow, with a longitudinal row of stout long clavate setae near median area of femur; tibia slightly shorter than femur; tarsus darkish at apex, about half the length of femur, with a row of short acute setae on mesal margin; claw with 2 groups of denticles, the apical group with 3 acute and long denticles; the basal group with 4-5 blunt denticles sparsely. **Middle and hind legs:** femur without longitudinal row of stout long clavate setae near median area, the others same as in fore leg.

Abdomen: dorsum yellow, darkish on abdominal segments II-IV, VIII and IX, with triangular scales on each tergum; venter darkish yellow to dark brown especially on the last 2-3 sterna; abdominal segments IV-IX each with posterolateral projections, of segments VI and VII larger than in other segments; each posterior margins of terga IV-VIII with 2 tufts of clavate setae medially; each lateral margin of terga IV-IX with a row of clavate or oblong setae; lateral area of each sterna with clavate setae, on sterna VIII and IX with oblong setae; posterior margin of tergum IX with 2 short blunt pinnate setae medially; posterior margin of sternum IX of female convex, of male with 2 emarginations medially. **Gills:** present on abdominal segments III-VII, gills IV, V alike, oblong, gills VI, VII small; gill III, large, semioperculate, cover the most part of the other gills, only the first three pairs of gills visible. **Caudal filaments:** pale, about a quarter as long as body, with a brown wide annular pigment near basal third or quarter; each segment especial median segments with whorled long clavate and short pinnate oblong setae on each articulation.

Eggs: (Figs. 22-25) General shape oval, about 150μ in length and 90μ in width, with a polar cap, the polar cap about 60μ in diameter, composed of dense

threads, their terminal utriculate and closely band on the edge of polar cap distinctly (Fig. 25). Chorionic surface meshy with broadly reticular ridges (Fig. 22); the reticular ridges granular, about $3-7\mu$ in width (Fig. 21), edges with fine, short branches. Each egg with 2-8 visible KCTs on subequatorial areas and with 3-7 visible micropylar devices on equatorial area. Terminal of KCTs long oval (Fig. 24). The sperm guides large, stilliform, about 12μ in length and 8μ in width. (Fig. 23).

Holotype: mature female nymph, Wufeng, Hsinchu Hsien, Taiwan (304m), 24-X-1991, S. C. Kang & H. C. Chang, in collection NCHU.

Paratypes: (mature nymph): 3♂ 8♀, same data as holotype; 4♂ 3♀, Sunchit, Tatung, Ilan Hsien, Taiwan, (720m), 30-V-1991, S. C. Kang & H.C. Chang; 8♂ 5♀, Shuili, Nantou Hsien, Taiwan, (290m), 18-XI-1991, S. C. Kang. 7♂ 9♀, in collection NCHU; 4♂ 4♀, in collection NMNS; 4♂ 4♀, in collection ZML.

Other mature nymphal specimens examined: 3♂ 6♀, Lileng, Hoping, Taichung Hsien, Taiwan, (470m), 20-I-1989, S. C. Kang; 5♂ 5♀, Hsincheng, Hualien Hsien, Taiwan, (90m), 1-IV-1990, S. C. Kang; 4♂ 5♀, Laochichaun, Shoufeng, Hualien Hsien, Taiwan, (85m), 3-IV-1991, S. C. Kang; 1♂ 3♀, Tsaotun, Kuohsing, Nantou Hsien, Taiwan, (190m), 20-VIII-1991, H. C. Chang; 5♂ 7♀, Wufeng, Hsinchu Hsien, Taiwan, (304m), 24-X-1991, S. C. Kang & H.C. Chang; 2♂ 2♀, Kuohsing, Nantou Hsien, Taiwan, (285m), 22-XI-1991, S. C. Kang; 5♂ 1♀, Peikang, Kuohsing, Nantou Hsien, Taiwan, (310m), 22-XI-1991, S. C. Kang; 2♂ 1♀, Shanping, Liukuei, Kaohsiung Hsien, Taiwan, (515m), 19-XII-1991, S. C. Kang.

Distribution: Taiwan

Remarks: This new species resembles *Torleya nepalica* Allen & Edmunds but can be differentiated in the nymphs by the following characteristics: (1) in the head without small paired tubercles of vertex; (2) in the fore femur with a longitudinal row of stout long clavate setae near middle; (3) in the dorsum of head, thorax, legs and abdomen with numerous bubble-like setae and (4) in the claw with 2 groups of denticles, the apical group with 3 acute and long denticles; the basal group with 4-5 blunt denticles sparsely. The egg resembles that of *Eburella brocha*

n.sp. but somewhat differ from the of *T. glareosa* n.sp. The reticular ridge of *T. lutosa* is granular (Fig. 23) instead of with numerous spurs for *T. glareosa* (Fig. 21).

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台灣的小蜉蝣科(昆蟲綱，蜉蝣目)

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摘 要

本文共述分布於台灣的小蜉蝣科種類，共計一屬七新種，分別爲：*Acerella glebosa* n. sp., *A. montana* n. sp., *Cincticostella fusca* n. sp., *C. colossa* n. sp., *Eburella brocha* n. gen, n. sp., *Torleya glareosa* n. sp.及*T. lutosa* n. sp.。種類的判別均根據稚蟲特徵，各種的卵均經用掃描式電子顯微鏡觀察與描述。文中附屬及種的檢索表。

關鍵詞：蜉蝣目，小蜉蝣科，*Acerella*, *Cincticostella*, *Torleya*, *Eburella*,台灣