

**REVISIONARY CONTRIBUTIONS TO THE GENUS *TORLEYA*
(EPHEMEROPTERA: EPHEMERELLIDAE)**

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Abstract.—*Torleya* larvae are distinguished from other Ephemerellidae by characteristics associated with the legs, gills, and abdominal terga, and male adults are distinguished by genitalia. We recognize eight valid *Torleya* species from the Palearctic and Oriental Regions. Seven of these eight species are known as larvae and adults; only the adults of *T. lutosa* Kang and Yang are not known. We include new synonyms for *T. major* (Klapálek, 1905) (= *T. nazarita* Alba-Tercedor and Derka, 2003, new synonym) and *T. nepalica* Allen and Edmunds, 1963 (= *T. glareosa* Kang and Yang, 1995, new synonym; = *Serratella tumiforceps* Zhou and Su, 1997, new synonym; = *T. arenosa* Tong and Dudgeon, 2000, new synonym). Larvae of *T. grandipennis* Zhou, Su, and Gui are described for the first time and have maxillae with or without minute palps, paired large spines on abdominal terga, and enlarged posterolateral projections on abdominal segments 3–9 or 4–9. The first description of the larva of *T. japonica* (Gose) is given and shows them to be distinguished by mouthparts and abdominal armature. *Torleya naga* Jacobus and McCafferty new species, is described from larvae, eggs, and a male adult; it is known from Malaysia, Thailand, and Vietnam. The male adult is distinguished by genitalia, caudal filaments, and abdominal color. Larvae are distinguished by having rows of spatulate setae on the head and numerous setae on the abdominal sterna. Eggs of *T. naga* are distinguished by having relatively thin reticulations.

Torleya Lestage, 1917 (Ephemeroptera: Ephemerellidae) (sensu Allen, 1980) is a Palearctic and Oriental genus of the subfamily Ephemerellinae (McCafferty and Wang, 2000). *Torleya* larvae inhabit silty and sandy substrates in submontane lotic systems (Lestage, 1917; Kazlauskas, 1963; Sander, 1981; Soldán, 1982; Alba-Tercedor, 1990; Tong and Dudgeon, 2000). All larvae have semi-operculate dorsal lamellae of gills 3, bifurcate ventral lamellae of gills 6, paired or absent abdominal tergal spines, and claws with at least a basal set of denticles. Most species have additional subdistal claw denticles, although they may be worn or broken, and for some species, they are minute. Also, most species have the body relatively densely covered with hairlike setae. Male adults have dorsal projections on the penes lobes, which are best seen in lateral view. Most species have genital forceps segment 2 expanded or apparently bent distally and segment 3 elongate. Studemann et al. (1992) distinguished *Torleya* female adults from those of some other European Ephemerellinae by the ratio of the length of the head to width of the thorax: it is less than 0.2 for *Torleya* and greater than 0.3 for *Ephemerella* Walsh and *Serratella* Edmunds. The eggs of several *Torleya* species have been detailed by Degrange (1960), Kang and Yang (1995), Studemann et al. (1995), and Studemann and Landolt (1997). A new species described below has eggs with distinctively thin reticulations (Fig. 5), but *Torleya* eggs usually have the chorion with broader reticulations.

Each valid *Torleya* species is treated here alphabetically. Formal descriptions are provided for new species and first descriptions of life stages. Statements of diagnostic characteristics are

provided for each species, and morphological variability is documented. Phylogenetics and identification will be treated in the near future (Jacobus and McCafferty, in preparation).

The following abbreviations are used for specimens: L = larvae, E = exuviae, S = subimagos, A = adults, M = male, F = female. Material examined is deposited in the Bernice P. Bishop Museum, Honolulu, Hawai'i, USA (BPBM); Chiang Mai University, Thailand (CMUT); National Insect Collection, Department of Agriculture, Bangkok, Thailand (EMBT); Florida A & M University, Tallahassee, Florida, USA (FAMU); Iowa State University, Ames, Iowa, USA (ISUI); Musée de zoologie, Lausanne, Switzerland (MZL); Nanjing Normal University Mayfly Research Collection, Nanjing, P. R. China (NNMRC); Purdue University Entomological Research Collection, West Lafayette, Indiana, USA (PERC); Royal Forestry Department, Thailand (RFDT); Royal Ontario Museum, Toronto, Ontario, Canada (ROME); Wilbur R. Enns Entomology Museum, University of Missouri, Columbia, Missouri, USA (UMRM); and Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia (ZIN).

SPECIES ACCOUNTS

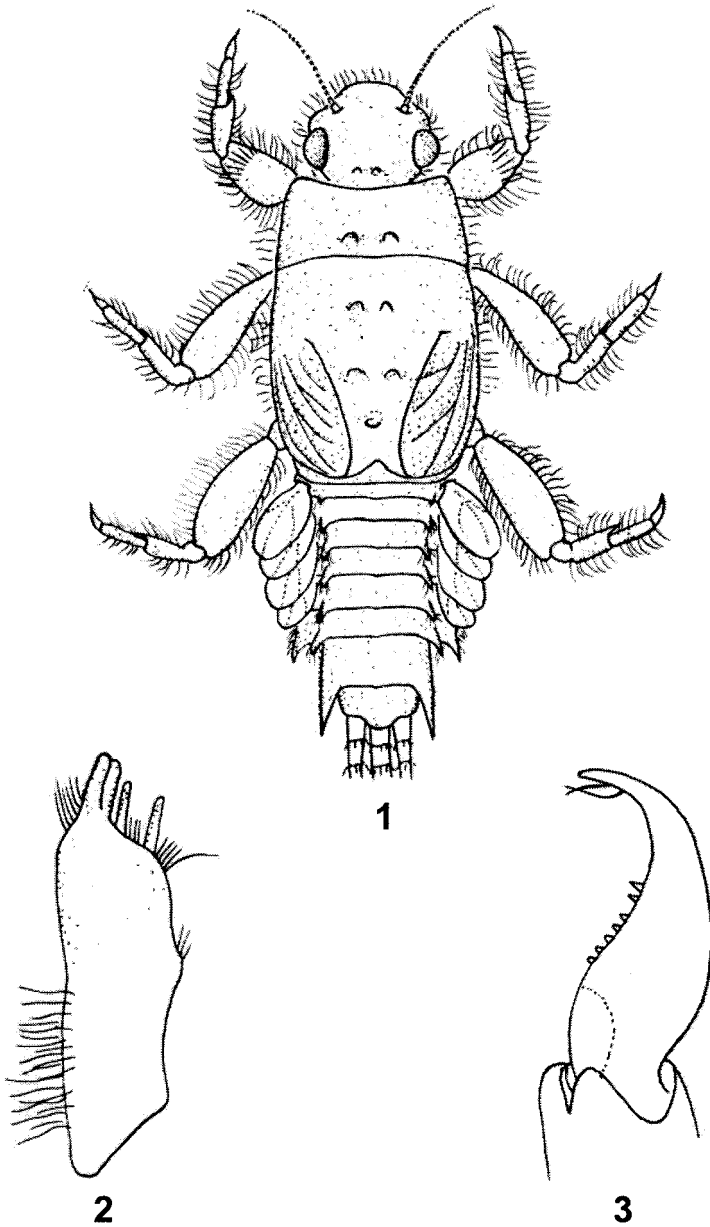
Torleya grandipennis Zhou, Su and Gui

Figs. 1–4, 10, 14

Torleya grandipennis Zhou, Su and Gui, 2000: 312

Description. Mature larva (Figs. 1, 4). Length: body 4.5–7.0 mm; caudal filaments 3.2–4.5 mm. General dorsal color gray to light brown, with variable brown and black markings; ventral color gray to brown. Body and legs with long hairlike setae and brown excrescences.

Head: Head with oblique black streaks lateral to each compound eye. Antenna set in large depression anterior to compound eye; scape and pedicel light brown; flagellar segments pale, with whorl of hairlike setae distally on each segment; hairlike setae length approximately one-third length of respective segment. Vertex with pair of blunt, suboccipital spines and several small excrescences; second pair of blunt spines sometimes present anterior to suboccipital pair. Patch of long, hairlike setae present below compound eye. Frons with row of setae along anterior margin. Clypeus with anterior row of short, hairlike setae. Gena blunt, slightly projected laterally. Labrum dark brown, with black lateral margins; anterior margin densely covered with setae; dorsal surface with transverse row of long setae. Mandibles with long, thick hairlike setae on lateral margin; dorsal surface with short, thick hairlike setae. Maxilla (Figs. 2, 10) with or without minute, single-segmented palp; stipe with dense patch of setae on exterior margin (Fig. 2). Labium densely covered with long, thick, hairlike setae ventrally; palp segment 3 relatively narrow, approximately one-half length segment 2. Thorax: Not a light brown with variable brown to dark brown markings; sterna brown. Pro- and mesonota each with up to seven variably developed blunt dorsal protuberances; wingpad base dark brown; long, hairlike setae present laterally on wingpads. Legs light brown with smoky longitudinal streaks, sparsely covered with fine, hairlike setae. Femora with hairlike setae on dorsal margins; forefemur broad, with variable transverse row of setae medially, length nearly subequal to combined length of foretibia and foretarsus. Tibiae with bristlelike setae on lateral margins. Tarsi with ventral row of six to eight bristlelike setae. Claws (Fig. 3) with two to seven denticles and subdistal setae. Mid- and hindlegs similar to forelegs but without transverse row of setae on femur. Abdomen: Dorsal lamella of gills 3 operculate, pale to dark brown, sometimes with brown, medial, longitudinal stripe and pair of brown, oblique stripes;



Figs. 1-3. *Torleya grandipennis* larva (China variant). Fig. 1. Habitus, dorsal view. Fig. 2. Maxilla. Fig. 3. Claw.

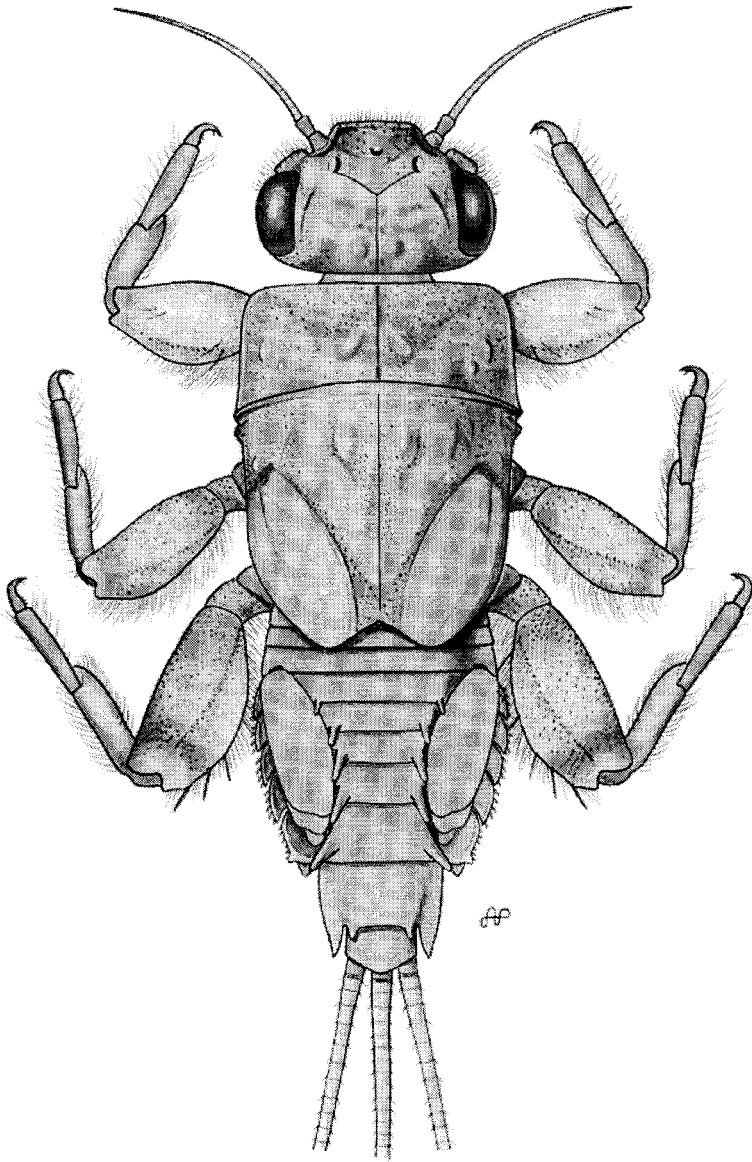


Fig. 4. *Torleya grandipennis*, larval habitus (Vietnam variant 1), dorsal view.

dorsal lamellae of middle gills each with lateral lobe proximally. Terga uniform light brown, with faint brown medial line; terga 4 and 5 sometimes paler; anterior terga sometimes with long, fine, hairlike setae; terga 3-8, 4-8, or 5-8 posterior margins with obliquely projecting, paired, prominent, blunt, compressed, dorsal spines close to inner margin of operculate gills 3;

terga 9 and 10 (Figs. 1, 4, 14) with prominent, paired, submedian spines present or absent. Tergal spines progressively larger posteriorly up to segment 8 and covered with short, blunt setae. Terga 3–9 or 4–9 with prominent posterolateral projections; projections 3–8 or 4–8 flattened and produced dorsolaterally, with long, thin, spatulate setae on outer margins; projections on tergum 9 longest, extending beyond posterior margin of tergum 10. Sterna with faint brown submedial and sublateral maculae, and with few setae. Caudal filaments pale, with whorls of short, fine, hairlike setae and minute spinelike setae at apex of each segment.

Diagnosis. *Torleya grandipennis* larvae are distinguished from other *Torleya* species by the relatively large, blunt, paired spines on the posterior margins of abdominal terga that are close to the inner margin of the operculate gills.

Male adults of *T. grandipennis* are distinguished from all other *Torleya* by having very broad penes and genital forceps, genital forceps segment 2 with a distal bend, and forceps segment 3 very elongate (Zhou et al., 2000: fig. 5).

Larval variability. Notably, the larvae from Vietnam have a vestigial palp on the maxilla (Fig. 10), but larvae we examined from China and Thailand do not have such a palp (Fig. 2). Allen and Edmunds (1963a) described variation in the presence or absence of the maxillary palp for a Nearctic ephemereid species, *Serratella teresa* (Traver).

Further morphological variation includes the variable distribution of minute excrescences on the body surface and variable dorsal dark markings. The relative development of each of the dorsal protuberances on the thoracic nota varies. The pronotum usually has one or two pairs of protuberances that are more prominent than the rest, and the mesonotum usually has two or three pairs of protuberances that are more prominent. The largest of these protuberances usually occurs on the pronotum. The total number of denticles on the claws varies from two to seven, and sometimes two sets of denticles are present (a basal set and a more distal set). A transverse band of setae usually is present on the forefemora (Fig. 1), but sometimes only one or two setae are present (Fig. 4). The anterior abdominal terga sometimes have long, fine, hairlike setae. Paired dorsal spines are present at least on abdominal terga 5–8, and sometimes on terga 3, 4, 9, and/or 10 (Figs. 1, 4, 14). Abdominal posterolateral projections are present on segments 3–9 or 4–9. The dorsal lamellae of gills 3 vary in color from pale (Fig. 1) to dark brown (Fig. 4), and if they are dark brown, the medial and lateral stripes (e.g., Fig. 1) often are difficult to see.

Distribution. East Oriental (southern mainland China, Thailand, Vietnam).

Material examined. CHINA, **Guizhou:** Wangmo Co., Sanglang village, 16-IX-2000, CF Zhou, CR Li, 18 L (NNMRC); Huishui Co., Baijin village, 11-IX-2000, CF Zhou, CR Li, 1 FA, 3 MA, 12 L (NNMRC). **Hunan:** Hongjiang city, Hongjiang R, 16-VI-1986, SS Shen, J Zhang, 1MA (*T. grandipennis* holotype), 3MA (*T. grandipennis* paratypes) (NNMRC); same locale and collectors, 20-VII-1985, 1 MA (NNMRC). **Yunnan:** Jingdong Co., Juhe R, 15-IV-2001, CF Zhou, 2 L (NNMRC). THAILAND, **Lampang:** Chae Son National Park, Namtok Chae Som, 650 m elev., 18°50'N, 99°28'E, 25-X-2002, Chiang Mai University team, 6L (CMUT, EMBT, ISUI, PERC, RFD); **Mae Hong Son:** Namtok Mae Surin National Park, Mae Nam Pai, 19°21'N, 97°59'E, 19-III-2002, GW Courtney, 4L (ISUI, PERC). VIETNAM, **Loa Cai:** Sapa Muong Hoa Ho R, 5/12-V-1995, D Currie, B Hubley, ROM956005, 1L (ROME). **Nghê An:** Khe Moi R, ca. 25 km SW of Con Công, Khe Moi River Forestry Camp, tropical forest edge, 18°56'N, 104°49'E, 308 m elev, 3-VI-1995, B Hubley, ROM956164, 1FL (maxilla and eggs on slide) (ROME); trib of Khe Moi R, ca. 25 km SW of Công, Khe Moi River Forestry Camp, near "Ophiophagus" field, tropical forest edge, 18°56'N, 104°49'E, 308 m elev, 9-VI-1995, B Hubley, ROM956188, 1L (ROME).

Torleya japonica (Gose)

Fig. 9

Ephemerella (*Torleya*) *japonica* Gose, 1980: 286

Torleya japonica (Gose, 1980) Gose, 1985: 25

Description. Mature larva. Length: body 3.8–6.2 mm; caudal filaments 2.0–3.5 mm. General dorsal color light brown with variable brown markings; ventral color pale; body and legs covered with long, hairlike setae.

Head: Color light brown with variable pale markings; frons and antennal pit area diffuse brown. Antennal scape and pedicel light brown; flagellar segments pale with fine, hairlike setae at apex of each segment; hairlike setae nearly half length of respective segment. Vertex with scattered small, spatulate setae. Suboccipital spines absent. Frons with patch of long hairlike setae. Clypeus with scattered fine setae. Labrum brown with dark brown margins; dorsal surface with cilia-like setae. Mandible external margin with cilia-like setae. Maxilla (Fig. 9) with few distal hairlike setae; palp absent; spinous processes hooked distally. Labium with cilia-like setae on ventral surface; palp segment 3 approximately one-half length segment 2. Thorax: Nota brown with variable pale and dark brown markings, covered with long, hairlike setae; sterna pale. Thoracic dorsal protuberances absent. Pronotum pale medially, darker laterally, with pale anterolateral and posterolateral corners. Mesonotum brown with medial pale spot on anterior margin, flanked by two dark brown spots laterally, pale between forewingpads. Legs mostly pale with smoky brown. Femora light brown with pale medial and distal spots; forefemur with submedial transverse row of long hairlike setae. Tibiae pale, ringed with light brown medially and distally. Tarsi pale, ringed with brown distally. Claws with two to four basal denticles, one to four subdistal denticles, and with subdistal setae. Abdomen: Dorsal lamella gills 3 operculate, without apical notch, pale with brown trilobed pattern. Terga 1–3 and 6–9 brown; tergum 4 brown or pale; terga 5 and 10 pale. Terga 4–9 with sharp, stout setae on outer margins (setae progressively shorter posteriorly on segments 7–9); terga 4–7 posterior margins with short, flat, very sharp, paired dorsal spines and bristlelike setae close to inner margin of gill lamellae; terga 8 and 9 with bristlelike setae and no spines close to inner margin of gill lamellae; tergum 8 with prominent, erect, long, hairlike setae along posterior margin; tergum 10 with no spines and no bristlelike setae. Segments 4–9 with posterolateral projections; projections 4–8 flattened and produced slightly dorsolaterally; segment 9 with lateral margins subparallel, and with posterolateral projections sharp, extending well beyond tergum 10. Sterna with few faint brown sublateral maculae, with few setae. Caudal filaments pale with brown bands; whorls of fine hairlike setae at apex of each segment; middle segments with hairlike setae length subequal to that of respective segment; hairlike setae perpendicular to longitudinal plane of filament.

Diagnosis. Larvae have maxillae (Fig. 9) that do not have palps. The paired, dorsal abdominal spines of the larva are flattened and situated more laterally than those of *T. mikhailli* Tiunova, the other eastern Palearctic species that lacks maxillary palps. The flattened dorsal abdominal spines of *T. japonica* have setae that are long and bristlelike, rather than spatulate, and abdominal tergum 8 has long, dorsally projecting, hairlike setae on the posterior margin. The hooked spinous processes of the maxilla (Fig. 9) may be unique within Ephemerellinae.

Male adults have genitalia superficially similar in shape to those of *T. naga*, n. sp., and both species have sublateral gonopores. *Torleya japonica* male adults are distinguished from all other *Torleya* species by the penes lobes (Ishiwata, 1987: fig. 1), each of which has a very sharp tip and a pronounced dorsal projection. Forceps segment 2 has a slight distal expansion.

Discussion. Gose (1980: fig. 1, 1985: fig. 95) and Ishiwata (1987: fig. 7) provided figures of the larva, but they did not give descriptions. Our description is based on material from Kyoto Prefecture, Japan. Gose's (1962) "sp. ED" is equivalent to *T. japonica* (Ishiwata, 2001).

The function of the peculiar spinous processes on the maxilla of *T. japonica* is unknown. McShaffrey and McCafferty (1990: fig. 5) showed that *Ephemerella needhami* McDunnough (Ephemerellidae: Ephemerellinae) uses spinous processes to dislodge food material prior to consumption. We assume the spinous processes of *T. japonica* are used for some specialized feeding behavior.

Distribution. East Palearctic (Japan).

Yang et al. (1990) included *T. japonica* in a listing of species from a stream in Taiwan. However, subsequent studies by Kang and Yang (1995), Ishiwata (2001), and Soldán and Yang (2003) did not include reports of *T. japonica* from Taiwan, and we have not seen material from Taiwan. The listing by Yang et al. (1990) probably is based on a misidentification.

Material examined. JAPAN, **Kyoto Pref.:** Oe Town, Habi, Yura Stream, 6-IX-1998, 3L (PERC); same locale, but III-1997, 4L (PERC); same locale, but 31-III-1998, 2L (maxilla on slide) (PERC); same locale, but 22-IV-1998, 2L (PERC); Oe Town, Kawahigashi, Yura Stream, 26-IV-1999, 2L (PERC).

Torleya lutosa Kang and Yang

Torleya lutosa Kang and Yang, 1995: 109

Diagnosis. Larvae have a slightly developed frontal shelf, maxillae without palps, and caudal filaments that are approximately one-fourth the length of the body. In contrast to *T. naga*, n. sp. (see below), which shares these characteristics, *T. lutosa* does not have prominent rows of spatulate setae on the anterior region of the head, nor does it have a ridge between the antennal bases. Additionally, the eggs of *T. lutosa* have much broader reticulations (Kang and Yang, 1995: figs. 22–25) than *T. naga* (see below).

Larval variability. We did not find the distinctive "bubble setae" described by Kang and Yang (1995: fig. 7i) on the paratype we examined.

Discussion. None of the alate stages have been described.

Distribution. East Oriental (Taiwan).

Material examined. CHINA, **Taiwan:** Nantou Hsien, Shuili, 290 m elev, 1991-11-18(A), SC Kang, 1L (*T. lutosa* paratype) (MZL).

Torleya major (Klapálek)

Ephemerella major Klapálek, 1905: 75

Torleya major (Klapálek, 1905) Ulmer, 1928: 142

Torleya belgica Lestage, 1917: 366 (syn. by Landa, 1969)

Torleya nazarita Alba-Tercedor and Derka, 2003, **new synonym**

Diagnosis. Larvae have maxillae with relatively well-developed palps. In contrast to other such *Torleya*, the abdominal terga do not have paired spines, and the subdistal denticles of the claw are minute (Alba-Tercedor and Sanchez-Ortega, 1982: figs. 2b, c, d). Short setae are present on the abdominal terga, close to the inner margin of the operculate gills.

Male adults have genital forceps segment 2 with a distal expansion, and each penes lobe has a prominent, elongate, obliquely oriented dorsal protuberance (see e.g., Landa, 1969: fig. 4ma; Studemann et al., 1992: figs. 331, 335; Zhou et al., 2000: fig. 6). Female adults have relatively

long posterolateral projections on segments 8 and 9 and have an elongate abdominal sternum 9 (Lestage, 1925b: figs. 6–7). In general, characters associated with female adults probably are limited in their diagnostic value and thereby should be used with caution.

Larval variability. Alba-Tercedor and Derka (2003) reported variability in the length of labial palp segment 3 (compare, e.g., Landa, 1969: fig. 4ma; Gaino and Spano, 1975: fig. 1a; Belfiore, 1983: fig. 43f) and the number of lobules on the ventral lamellae of the gills (see also Thibault, 1971). This latter character had been used as diagnostic by Mikulski (1938). We examined series of specimens from the Czech Republic and Germany and found further variation in morphological characters that have been used for species diagnoses. The length of the maxillary palp varies from nearly subequal to the width of the maxilla at the point of attachment to approximately half that width. The relative length of the maxillary palp has been shown to be variable for several species of Ephemerellinae. For example, Allen and Edmunds (1963a: figs. 43–46, 47a, b) documented such variation for *S. teresa* and *S. velmae* (Allen and Edmunds). The brown, usually trilobed, pattern on the dorsal lamellae of the gills (see e.g., Belfiore, 1983: figs. 43a–c) varies within single populations and sometimes varies between the right and left lamellae of individuals. The extent of the colored patterning on the lamellae varies, and each lobe of the pattern varies in width. Certain populations have purple pigmentation present at the distal margin of the dorsal lamellae. This pigmentation is distinct from the brown trilobed patterning, although the two may overlap. All gill pigmentation is subject to fading with the passage of time. The shape of the lateral margin of abdominal segment 8 grades between, and includes, the shapes attributed to *T. major* (Lestage, 1917: fig. 35d; Lestage, 1925a: fig. 14d; Belfiore, 1983: fig. 43e; Alba-Tercedor and Derka, 2003: fig. 14) and *T. nazarita* (Alba-Tercedor and Derka, 2003: fig. 9).

Adult variability. A short series of reared adults from far western Germany showed a gradation in the shape of the mesoscutellar hind projection. The shapes graded between, and included, the shapes associated with *T. major* and *T. nazarita* (see Alba-Tercedor and Derka, 2003: figs. 34–39). The penes of the males we examined were relatively similar to one another. These penes have the straighter lateral profile associated with *T. nazarita* (Alba-Tercedor and Derka, 2003: fig. 27) and the wide, slightly incised apical space between the lobes associated with *T. major* (Alba-Tercedor and Derka, 2003: figs. 23–26). Ulmer (1928: figs. 1–5) showed additional variability in *T. major* penes shape.

Discussion. Alba-Tercedor and Derka (2003) distinguished *T. nazarita* larvae from *T. major* based on the shape of abdominal segment 8, the coloration of the gill lamellae, the total length of the maxillary palp, the relative length of maxillary palp segment 3, and the setation of maxillary palp segment 3. Male adults were distinguished by the shape and length of the mesoscutellar hind projection and the shape of the penes.

Central European *Torleya* adults and larvae have considerable morphological variability, detailed above. In light of this variability, the only ostensibly consistent differences between Spanish and central European populations of *Torleya* are the shorter length of maxillary palp segment 1 and the longer subapical seta on maxillary palp segment 3 found on larvae from Spain. However, Alba-Tercedor and Derka (2003: figs. 3–6) indicated slight variability even in these structures. Therefore, we consider the species from Spain and the species from central Europe to be the same.

Torleya major is a common species with larvae that have a wide ecological valency and considerable resistance to pollution (Landa and Soldán, 1985; Vidinova and Russev, 1997). Landa and Soldán (1985) noted, however, that in certain microhabitats, *T. major* larvae had been replaced by *Caenis* Stephens (Ephemeroptera: Caenidae) larvae, and Dolisy and Dohet

(2003) indicated that *T. major* inhabits high-order streams characterized by low mineralization. The life cycle of *T. major* has been well documented by Zelinka (1951), Pleskot and Pomeisl (1952), Pleskot (1961), Petr (1961), Landa (1968), Rosillon (1986), and Vidinova and Russev (1997). Landa et al. (1982) detailed aspects of the internal anatomy, and details of the eggs have been provided by Degrange (1960), Studemann et al. (1995), and Studemann and Landolt (1997). *Torleya major* (= *T. belgica*, = *T. nazarita*) is the only *Torleya* species (sensu Allen, 1980) that has been reported from Europe (e.g., Jacob, 1993; Thomas et al., 1999).

Distribution. West Palearctic (continental Europe).

Material examined. CZECH REPUBLIC: Middle Bohemia, Brook, 8-V-1947, 28L (some mouthparts dissected) (PERC). GERMANY: Stream Fulda, D-36110 Schlitz/Pfordt, 16-IV-2002, R Lieske, 10L (some gills removed) (PERC); Simmerbach (a confluence of the Nahe River, a left hand tributary of the River Rhine), 3-V-2003 (reared to 18-V-2003), A Haybach, 3MA, 2FA, 5SE (PERC). Country uncertain: "Ombrat. Rausa," 2-V-1946, G Demoulin, 4L (PERC).

Torleya mikhaili Tiunova

Torleya mikhaili Tiunova, 1995: 52

Diagnosis. *Torleya mikhaili* larvae are most similar to those of the Oriental species *T. nepalica* Allen and Edmunds. *Torleya mikhaili* is distinguished from *T. nepalica* by having the stout setae on the legs bristlelike, rather than spatulate. Each of the abdominal spines has one to three short, blunt setae and one or two long, bristlelike setae. The lateral margins of abdominal segment 8 are nearly parallel. *Torleya mikhaili* is distinguished from *T. japonica*, the other eastern Palearctic species that lacks maxillary palps, by having abdominal spines that are dorsally projected and situated submedially (between the gill lamellae) on the hind margins of the middle abdominal terga. In contrast, the abdominal spines of *T. japonica* are relatively flat and situated closer to the inner margins of the gill lamellae. Furthermore, *T. mikhaili* is differentiated from *T. japonica* by having the posterior margin of abdominal tergum 8 without long setae that project dorsally.

Male adults are distinguished from other eastern Palearctic *Torleya* species by genital forceps segment 3 being relatively short (length approximately 1.5 times the width). Genital forceps segment 2 is slightly expanded distally. In contrast to *T. padunica* Kazlauskas, the penes have ventral spinelike setae that are minute (Tiunova, 1995: fig. 2).

Larval variability. Paired spines are present on abdominal terga 3, 4, or 5 through 7, 8, or 9. Each of these spines has one, two, or three short, blunt setae, and each spine on at least segments 4–7 has one or two long, bristlelike setae also. These setae are present even if spines are not present on a certain segment.

Discussion. Tiunova (1995: fig. 1) illustrated the larva of *T. mikhaili* with abdominal segment 8 lateral margins round. Specimens collected by Tiunova (see Material examined), however, have the lateral margins of abdominal segment 8 straight and nearly parallel. The genitalia of a male adult associated with these larvae differed from the illustration provided by Tiunova (1995: fig. 2) in that forceps segment 2 had the distal expansion typical of *Torleya* species.

Larvae from northeastern China that we tentatively identify as *T. mikhaili* differ in several additional respects from the figure of *T. mikhaili* given by Tiunova (1995: fig. 1): the dorsal abdominal spines are larger; a pair of long hairlike setae is present on the occiput where blunt spines appear in other *Torleya* species; and the pronotum has two pairs of short, blunt, dorsal protuberances, each with scattered short, blunt setae. The presence or absence of occipital

setae and pronotal protuberances was not indicated in the original description of *T. mikhaili* (Tiunova, 1995), but comparative specimens from Russia have a very short pair of dorsal projections on the pronotum. Such characters have been shown to be variable in certain other Ephemereinae species (see e.g., Jacobus and McCafferty, 2003a).

Distribution. East Palearctic (northeastern China, Russian Far East).

Material examined. CHINA, **Beijing:** Mi Yun Co., branch of Bai He R, Jing Ling Gu (Fairy Valley) Park, 8-VIII-2002, L Sun, 7L (PERC). RUSSIA, **Primorskiy Krai:** River Ussuri, 1 km lowe Mountain Utyos, 4-VIII-1994, T Tiunova, 2LE, 2SE, 3A (ZIN).

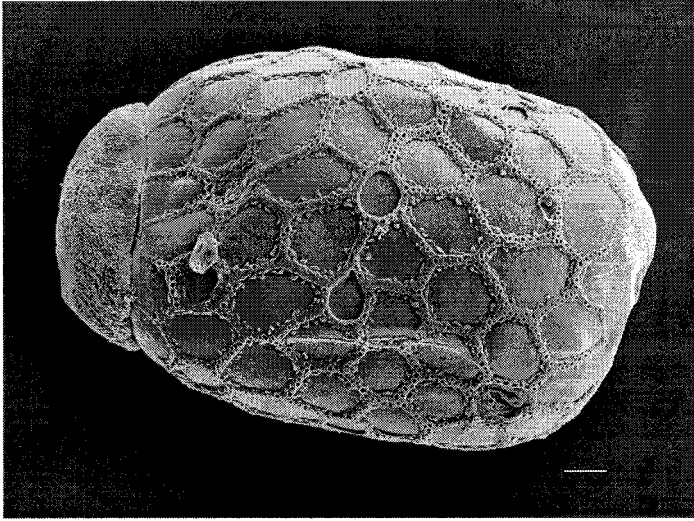
***Torleya naga* Jacobus and McCafferty, new species**

Figs. 5–8, 12, 13

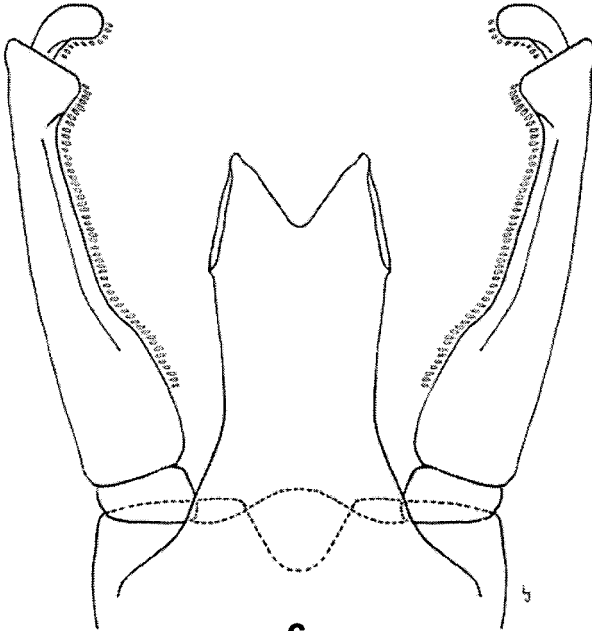
Description. Egg (Fig. 5). One polar cap present. Chorion with reticulations relatively thin and punctulate, and reticulations with small papillae along margins.

Mature larva (Fig. 7). Length: body 4.5–5.0 mm; caudal filaments 1.5–2.0 mm. General dorsal color pale with variable brown and dark brown markings; ventral color mostly pale, abdomen dark brown medially.

Head (Figs. 7, 12): Color pale with tan and brown markings between compound eyes, and with longitudinally paired brown maculae above lateral ocellus. Antennal scape, pedicel, and flagellar segments pale; with whorl of hairlike setae distally on each segment; hairlike setae length minute to approximately one-fifth length of respective segment. Vertex smooth; head tubercles absent. Patch of long, stout, hairlike setae below compound eye; ridge between antenna bases with anteromedially interrupted arc of dorsally projecting, long, spatulate setae. Gena with two or three rows of dorsally projecting, long, spatulate setae. Frontal ridge with anteromedially interrupted row of long, spatulate setae and long, stout, hairlike setae. Clypeus with anterior row of long, spatulate setae and long, stout, hairlike setae. Labrum tan, with dark brown lateral margins; anterior margin somewhat densely covered with fine setae. Mandibles with laterobasal, long, fine, hairlike setae. Maxilla (Fig. 8) without palp. Labial palp segment 3 one-third length segment 2. Thorax: Not a tan with variable light brown markings, few setae present; sterna pale to brown. Thoracic tubercles absent. Pronotum with submedian pair of brown maculae. Mesonotum tan with variable brown markings. Legs pale. Forefemur with distal row of long, stout, spatulate setae; dorsal margin densely covered with long, fine, hairlike setae and long, stout, bristlelike setae, and with scattered stout, spatulate setae; ventral margin with shorter hairlike setae and bristlelike setae. Foretibia ventral margin with long, stout, hairlike setae; dorsal margin with scattered long, fine, hairlike setae. Foretarsus with scattered hairlike setae. Mid- and hindlegs similar to foreleg, but lacking distal band of setae on femur. Claws with two to four basal denticles and palisade of four to eight denticles on outer distolateral margin and one or no denticles on inner distolateral margin, and with subdistal setae present. Abdomen: Dorsal lamella of gills 3 operculate, with shallow apical notch; dorsal and ventral lamellae of alcohol preserved specimens translucent; basal half of anterior dorsal lamellae of gills with faint brown markings; apical half with more variable, faint brown markings. Tergum 2 dark brown; tergum 3 with brown anterior margin; middle terga white; tergum 8 dark brown; terga 9–10 pale. Terga 4–8 with paired oblique rows of long, spatulate setae and fine setae extending from posterior margins; terga 3 and 9 with similar, but shorter, rows of short, spatulate setae and fine setae. Segments 4–9 with posterolateral projections; projections 4–7 flattened and produced dorsolaterally, with long, spatulate setae on outer margins. Segment 8 narrowed posteriorly, with small posterolateral



5



6

Figs. 5–6. *Torleya naga*, n.sp. Fig. 5. Scanning electron micrograph of egg; scale bar = 10 μ . Fig. 6. Male adult genitalia, dorsal view.

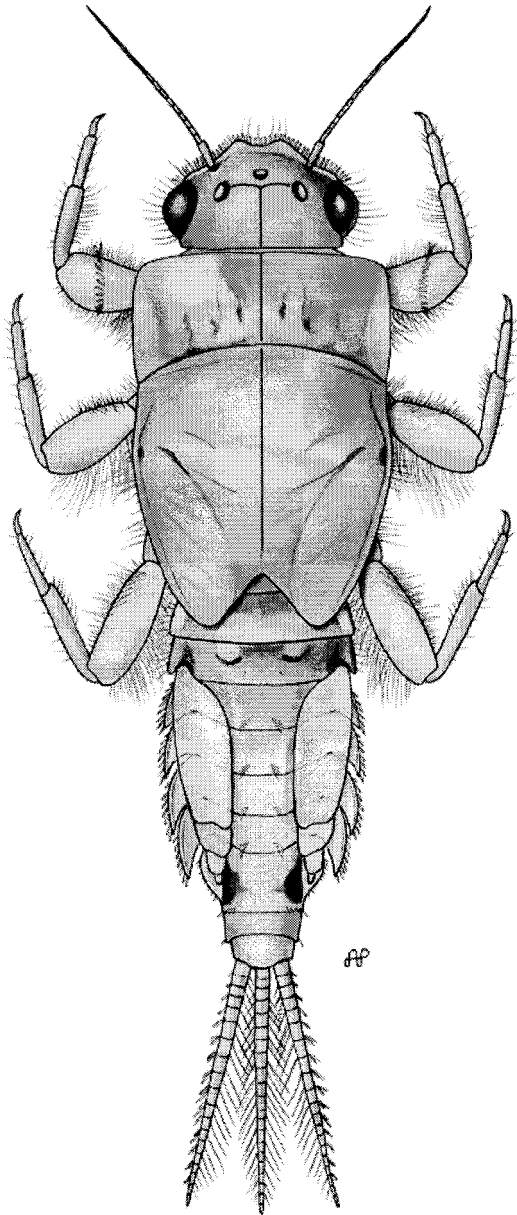


Fig. 7. *Torleya naga*, n.sp., larval habitus, dorsal view.

projections; lateral margin sinuous and with small, stout setae. Segment 9 posterolateral projection with small, stout setae on outer margin and long, spatulate setae on inner margin. Sterna dark brown medially, pale laterally, with many fine setae, variable in length, with long, hairlike setae sublaterally, and sometimes with spatulate setae on posterior margins. Caudal filaments pale to light brown. Setae at apex of each caudal filament segment; setae short and spatulate on outer margins of cerci, long and hairlike on lateral margins of median filament and inner margins of cerci.

Male adult (in alcohol). Length: body 6.5 mm; forewings 5.7 mm; caudal filaments 5.4 mm. Head brown. Antennae with scape and pedicel light brown; flagellar segments dark brown. Ocelli pale; base light brown. Dioptic compound eyes contiguous medially; upper portion pink; lower portion black. Thorax brown; prothorax with variable brown markings; mesothorax with axillary cords 0.1 mm. Wings hyaline with translucent milky tinge along costal margin; stigmatic area clouded with white; costa and subcosta light yellow; longitudinal veins, intercalaries, and crossveins hyaline. Forelegs pale to light brown; length (mm) of segments: femur = 1.0, tibia = 3.0, tarsal segment I = 0.1, tarsal segment II = 0.5, tarsal segment III = 0.25, tarsal segment IV = 0.2, tarsal segment V = 0.15. Mid- and hindlegs pale to light brown. Abdomen basal coloration brown to light brown. Abdominal terga with pale posterior band and thin dark line on posterior margin; terga 1–3, 8 purple-brown; tergum 8 with one pair sublateral, large spots (similar to larva, Fig. 5). Abdominal sterna purple-brown with pale anterior and posterior bands and with two pairs of pale spots. Genitalia (Fig. 6) light brown; forceps pale. Penes lobes divergent; each lobe relatively sharp apically and with sharp dorsal projection at base of gonopore; gonopore directed laterally. Forceps segment 2 expanded distally; forceps segment 3 length approximately 2× width. Cerci and median filament subequal in length, pale, distinctly curled downwards; segments densely covered with relatively long hairlike setae.

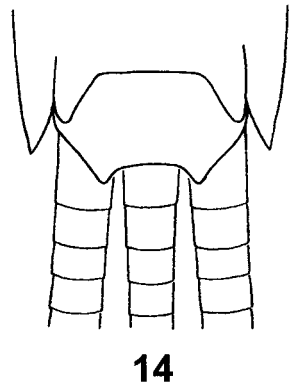
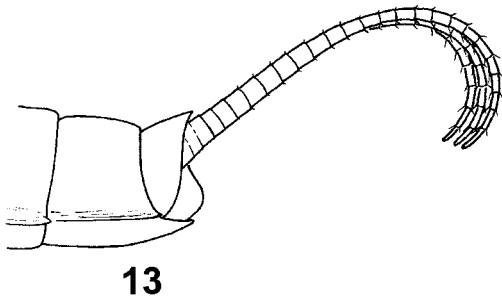
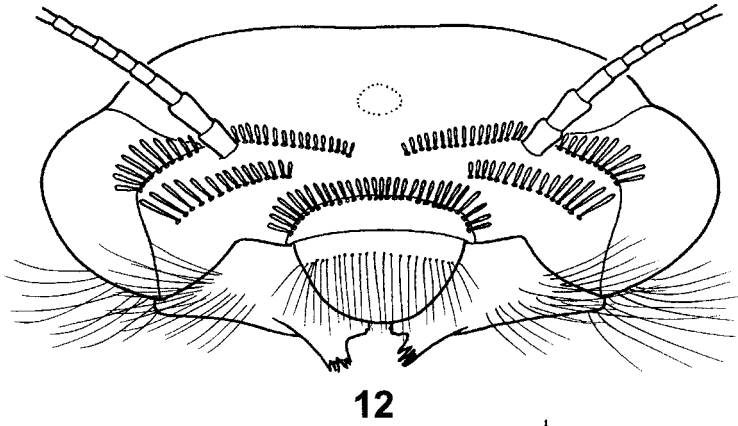
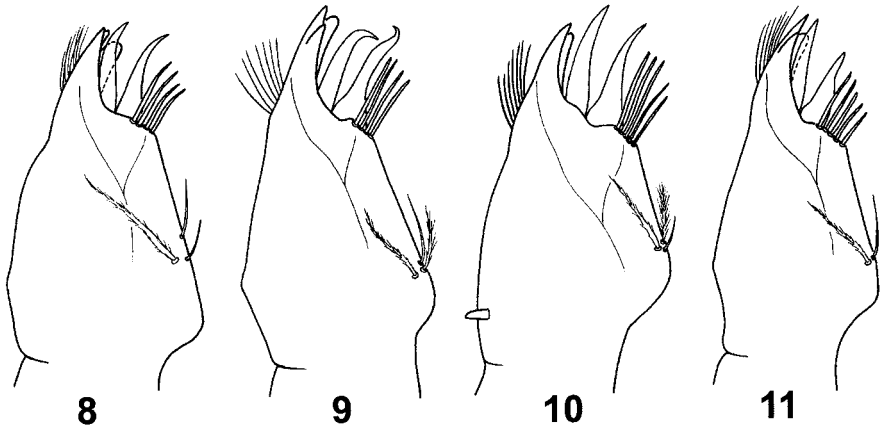
Etymology. Naga is a dragon-like stream guardian from Oriental mythology.

Diagnosis. In contrast to the eggs of other *Torleya* species, *T. naga* has relatively thin reticulations (Fig. 5).

Torleya naga and *T. lutosa* larvae both have a slightly developed frontal shelf and relatively short caudal filaments. *Torleya naga* larvae may be distinguished from *T. lutosa*, and all other *Torleya* species, by the prominent rows of spatulate setae on the anterior region of the head (Fig. 12), the ridge between the antenna bases (Fig. 7), and the generally darker color and relative dense setation of the abdominal sterna. The outer lateral setae on the cerci are spatulate.

The male adult is distinguished from other *Torleya* species by the relatively short and downwardly curled caudal filaments, the relatively sharp and divergent penes lobes, and the purple-brown coloration on the abdominal sterna and on abdominal terga 1–3 and 8.

Larval variability. Variable brown and dark brown markings are present dorsally on the body. The flagellar segments of the antennae have distal hairlike setae that vary in length from minute to approximately one-fifth the length of the respective segment. The anterior of the head always has rows of spatulate setae, but the precise number of setae in these rows varies. The number of denticles on the claws varies from six to thirteen, and an inner distolateral row of marginal denticles may be present or absent. The dorsal lamellae of the gills are variable with respect to the extent of brown markings on them. Abdominal tergum 8 sometimes does not have the large sublateral spots shown in Fig. 7. The abdominal sterna vary in their shade and darkness of brown, and sometimes maculation is not apparent, especially on early instars. The length and density of setae on the abdominal sterna varies, but a field of setae always is present. The color of the caudal filaments ranges from pale to light brown.



Discussion. The caudal filaments of most preserved larvae are fixed in a distinctive downward curl (Fig. 13). We do not know if the caudal filaments appear this way in life, or if the curl is an artifact of fixation. The male adult was collected from the same locale as some of the final instar paratypes, and it shares characters with these larvae, such as the distinctively curled caudal filaments and the abdominal color pattern.

Sites et al. (2001) provided an identification key, diagnosis, and specimen records for Ephemerellidae genera from southern Thailand. The diagnosis and specimen records for the genus *Torleya* are referable to *T. naga*.

The type locale of *T. naga*, the Sungai Gombak, has been considered a typical hill-stream of the central range of Malaya. In a comprehensive study, Bishop (1973) detailed and discussed environmental, biological, and human factors influencing the stream, and he provided inventories and analyses of the algae, vertebrates, and invertebrates. Bishop (1973) reported *T. naga* as “*Ephemerella (Drunella)* sp.A.” The Sungai Gombak has been a valuable source of material for aquatic entomologists, as indicated, for example, by studies of Gerridae (Hemiptera) by Bullock and Furtado (1968), Odonata by Furtado (1969), Baetidae (Ephemeroptera) by Müller-Liebenau (1978a, b, 1980a, b, 1982, 1984), and Heptageniidae (Ephemeroptera) by Braasch and Soldán (1986).

Distribution. Oriental (peninsular Malaysia, Thailand, Vietnam).

Types. Holotype: MALAYSIA, **Selangor:** Gombak R, 6.5 mi N of Kuala Lumpur, nr Bentong Rd, 16-X-1969, JE Bishop, larva (FAMU). Paratypes: MALAYSIA, **Selangor:** Gombak R, 9 mi N of Kuala Lumpur on Bentong Rd, 27-VIII-1969, JE Bishop, 1L (FAMU). THAILAND, **Chiang Mai:** Nam Chai R above hydro station intake at Fang Horticultural Station, 550 m, 15-XI-1985, JT&DA Polhemus, 2L (PERC). **Nakhon Si Thammarat:** stream from Khao Luang NP, under bridge, 12-VII-1997, Sites and Permkam, 8L (UMRM). **Songkhla:** Ton Nga Chang NP, stream at Buddhist temple 6-VII-1997, RW Sites, 5L (some eggs extracted) (UMRM); same locale, 8-I-1995, Sites and Nichols, 2L (UMRM).

Additional Material Examined (not paratypes): MALAYSIA, **Selangor:** Gombak R, 9 mi N of Kuala Lumpur on Bentong Rd, 9-I-1969, JE Bishop, 2L (FAMU, PERC); same data, but 6-II-1969, 1L (FAMU); same data, but 8-III-1969, 1L (FAMU); same data, but 1-V-1969, 1L (FAMU); same data, but 19-V-1969, 4L (parts on slide) (FAMU); same data, but 24-VIII-1969, 1MA (FAMU); Gombak R, 9 mi S of Kuala Lumpur on Bentong Rd, 13-VI-1970, JE Bishop, 4L (FAMU). **Perak:** Sungai Jor, Cameron Highlands Rd, mile 19, 22-IX-1978, GF&CH Edmunds, 1L (mouthparts on slide) (PERC). THAILAND, **Chiang Mai:** Doi Inthanon National Park, Namtok Siriphum, 1,460 m elev., 18°32'N, 98°31'E, 16-X-2002, CMU team, 1L (CMUT). **Mae Hong Son:** Namtok Mae Surin National Park, Nam Mae Surin, above falls, gravel substrate, 18°56'N, 98°04'E, 1,220 m elev., 15-X-2002, CMU team, 17L (CMUT, EMBT, ISUI, RFDT). **Narathiwat:** stream 14km W of Srisakhon, 15-I-1995, Sites and Nichols, 1L (UMRM). **Satun:** Wanpachang District, Ton Bliw, rocky and sandy stream, 9-VII-1997, Sites and Permkam, 1L (UMRM). VIETNAM, **Nghê An:** Khe Moi R, ca.

←

Figs. 8–14. *Torleya* species, structural details. Fig. 8. *Torleya naga* larva, maxilla. Fig. 9. *Torleya japonica* larva, maxilla. Fig. 10. *Torleya grandipennis* larva (Vietnam variant), maxilla. Fig. 11. *Torleya* sp. larva (Tuan Hui, Vietnam), maxilla. Fig. 12. *Torleya naga* larva, head, anterior view. Fig. 13. *Torleya naga* larva, caudal filaments, lateral view. Fig. 14. *Torleya grandipennis* larva (Vietnam variant 2), abdominal tergum 10.

25 km SW of Con Cuông, Khe Moi River Forestry Camp, tropical forest edge, 18°56'N, 104°49'E, 308 m elev, 3-VI-1995, B Hubley, ROM956164, 1L (ROME).

Torleya nepalica (Allen and Edmunds)

Ephemerella (*Torleya*) *nepalica* Allen and Edmunds, 1963b: 20

Ephemerella wahensis Ali, 1971: 359

Ephemerella (*Crinitella*) *wahensis* Ali, 1971; Hubbard and Peters, 1978: 13

Torleya nepalica (Allen and Edmunds, 1963) Allen, 1980: 76

Crinitella wahensis (Ali, 1971) Allen, 1980: 81 (syn. by Jacobus and McCafferty, 2003b)

Torleya glareosa Kang and Yang, 1995: 107, **new synonym**

Serratella tumiforceps Zhou and Su, 1997: 42, **new synonym**

Torleya arenosa Tong and Dudgeon, 2000: 201, **new synonym**

Diagnosis. Larvae have maxillae without palps. *Torleya nepalica* is distinguished from other such species by having variable suboccipital spines, dorsal thoracic projections, spatulate stout setae on the legs, submedian spines on the posterior margins of abdominal terga, and caudal filaments that are more than one-fourth the body length.

Male adults are distinguished from all other *Torleya* by having a combination of a strong distal expansion on genital forceps segment 2 and penes lobes each with a rounded apical margin and a slightly developed dorsal projection that is best seen in lateral view (Zhou and Su, 1997: fig. 5; Zhou et al., 1997: fig. 4; Tong and Dudgeon, 2000: fig. 20). Adults have paired lateral dark patches on the abdominal terga (Tong and Dudgeon, 2000: fig. 23a, b).

Larval Variability. Body size of mature larvae ranges from 3.5–6.0 mm, and body color ranges from pale with brown markings to dark brown with black markings. Suboccipital spines vary in their relative development, and may be present or absent. If absent, tufts of cilia-like or hair-like setae usually are present in their place. Some individuals have spatulate setae scattered on the vertex and frons. Bristle-like setae always are present on the inner margin of the maxilla (similar to Fig. 10), but the number of these setae varies from 1–3. The mandibles have long setae laterally, but the density of these setae varies. Thoracic dorsal protuberances vary in the extent of their development. The length of subdistal denticles of the claws varies among individuals, but probably this is due to deterioration from usage. The abdomens of certain specimens preserved in alcohol are distended, and this distension is apparently an artifact of the fixation process. The dorsal lamellae of gills 3 usually are rounded, but some specimens, especially those from the far eastern part of the species' range, have the distal margin slightly falcate. The coloration of the abdominal terga varies considerably, but usually segment 5 is pale or white. Paired submedian spines are present on the hind margins of abdominal terga 2, 3, or 4 through 6, 7, 8, or 9. The color of the abdominal sterna varies from pale to light brown. A pair of lateral maculae and a pair of submedian maculae usually are present on the abdominal sterna. Robust distal setae on the segments of the caudal filaments vary in the degree of angulation from the longitudinal plane of the filament—in some individuals, these setae are nearly recumbent against the following segment. A submedian dark band may be present or absent on the caudal filaments.

Adult variability. Abdominal coloration often is faded or otherwise obscured in older specimens, especially those preserved in alcohol. Segment 2 of the genital forceps varies slightly in relative thickness.

Discussion. *Torleya tumiforceps* was described based on adult material only (Zhou and Su, 1997). Adults matching *T. tumiforceps* were associated with typical *T. nepalica* larvae from

several locations in China. Kang and Yang (1995) discussed *T. glareosa* in comparison to another Taiwanese species, *T. lutosa*, but they did not mention species described from outside Taiwan. We compared type material of *T. nepalica* and *T. glareosa* and found them to be conspecific. Tong and Dudgeon (2000) distinguished *T. arenosa* from *T. glareosa* (= *T. nepalica*) by having long setae on the mandibles, two pairs of pronotal spines, claws with two sets of denticles, paired spines on abdominal terga 4–7, and paired maculae on abdominal terga 2–8. Based on descriptions (Kang and Yang, 1995; Tong and Dudgeon, 2000) and our examination of type material of both species, we found that *T. arenosa* and *T. glareosa* actually share most of these characters. The only ostensible difference between them is the presence of tergal spines on abdominal segments 3–6 of *T. glareosa* and the presence of such spines on terga 4–7 of *T. arenosa*. This difference is well within the range of variation documented above (under Larval Variability) for the number and placement of these spines. The morphological variability we have discovered in the adults and larvae of *T. nepalica* parallels to a large extent that documented for *Serratella serrata* (Morgan) by Jacobus and McCafferty (2000, 2003a).

Tong and Dudgeon (2000) indicated that “*Ephemerella* T₁” (Dudgeon, 1982; Hubbard, 1986) and “*Ephemerellina* T₁” (Dudgeon, 1990) are referable to *T. nepalica* (= *T. arenosa*). Ishiwata (2001) noted that material reported from the Okinawa islands of Japan by Tanida (1974) as “*Ephemerella* sp.” is referable to *T. nepalica* (= *T. glareosa*). We examined material reported from Thailand as *Serratella* (Sites et al., 2001) that is referable to *T. nepalica*.

Distribution. Oriental (southern mainland China, Hong Kong, Taiwan, India, Japan [Okinawa], Malaysia, Nepal, Pakistan, Thailand, Vietnam).

Material examined. CHINA, **Anhui:** Huoshan Co., Mo-Zi-Tan, VII-1983, XY Wu, CY Su, 2 MA, 2 FA (*S. tumiforceps* paratypes) (NNMRC); Ninguo Co., Hule village, 26-VIII-1998, BX Wang and FR Gui, 1L (NNMRC). **Gansu:** Kangxian Co., Qinghe forest center, 24-VIII-2000, CF Zhou, 2 MA, 2 L (NNMRC). **Guizhou:** Luodian Co., Luokun village, 14-IX-2000, CR Li, CF Zhou, 2 MA, 3 FA, 20 L (NNMRC); Guiding Co., Changming village, 9-IX-2000, CR Li, CF Zhou, 1 MA, 5 FA, 5 L (NNMRC); Huishui Co., Baijing village, 12-IX-2000, CR Li, CF Zhou, 10 MA, 20 FA, 50 L (NNMRC). **Henan:** Jiyuan Co., Huang-Lian-Shu village, 7-IV-2000, HL Yu, 1 MA (NNMRC). **Hong Kong:** Tai Tso Stream, Tai Mo Shan, light trap, 10-IX-1987, D Dudgeon, 1MA (*T. arenosa* paratype) (PERC); Wang Shan Keuk, 21-XI-1996, X Tong, 4L (*T. arenosa* paratypes) (PERC). **Hunan:** Hongjiang city, Hongjiang R, 16-VI-1986, SS Shen, J Zhang, 2 MA (*S. tumiforceps* paratypes) (NNMRC). **Shaanxi:** Liuba Co., Miao-Tai-Zi village, 30-VIII-2000, CF Zhou, 3 MA, 4 FA, 2 L (NNMRC). **Sichuan:** Jiuzhai Co., Shuanghe village, 11-VIII-2000, Q Xie, CF Zhou, 5 MA, 3 FA, 15 L (NNMRC); Jiangjing Co., Simian Mt., 7-VII-1990, LF Yang, JC Morse, 5 MA (*S. tumiforceps* paratypes) (NNMRC). **Taiwan:** Nantou Hsien, Luku, Shanlinsi, 850m elev, 1991-08-22(A), SC Kang, HC Chang, 1L (*T. glareosa* paratype) (MZL). **Yunnan:** Jingdong Co., Juhe R, 11-IV-2001, CF Zhou, 3 FA, 2 MA, 15 L; Jingu Co., 8-IV-2001, CF Zhou, 100L (NNMRC); Jinghong Co., Puwen village, Puwen R, 2-IV-2001, CF Zhou, 2 MA, 4 FA, 20 L (NNMRC). **Zhejiang:** Longquan Co., Lanju, 18-VIII-1994, CF Zhou and CD Zhou, 10 L (NNMRC). INDIA, **Karnataka:** trib R Swarna, Mala Village, Udipi District, KA Subramanian, 1L (PERC). MALAYSIA, **Selangor:** Gombak R, 9 mi N of Kuala Lumpur on Bentong Rd, 29-V-1969, JE Bishop, 1L (FAMU); University of Malaya Studies Center, Gombak R, 16.5 mi N of Kuala Lumpur on Bentong Rd, 14-XI-1968, JE Bishop, 1L (FAMU). NEPAL, Pelung, 5,850 ft elev, 17-IV-1957, EI Coher, 5L (*T. nepalica* holotype and paratypes) (PERC). **Lalitpur:** creek above Godawari, on rd to Phulchowki, 8-VII-1994, GW Courtney, 2L (ISUI). **Sindhupal-**

chok: Chatte Khola at Lamosanga, 11-VII-1994, GW Courtney, 1L (ISUI). PAKISTAN (west), **Hazara Dist.:** Balzkot, mt. stream at ca. 3,400 ft elev, 27-IX-1962, AD Stock, 1L (PERC); THAILAND, **Narathiwat:** stream below Bacho Waterfall, L-78, 15-I-1995, Sites, Nichols, Permkam, 2L (UMRM). **Songkhla:** stream at Buddhist temple, Ton Nga Chang NP, 6-VII-1997, L-127, RW Sites, 1L (UMRM). VIETNAM, **Kon Tum:** 1-4 m trib of Ngoc Mi R, ca. 20 km NE Ngoc Linh, 2° tropical forest, 980 m elev, 15°08'23.5"N, 107°54'40.2"E, 10-IX-1998, B Hubley, DC Currie, M Tseng, ROM982314, 7L (ROME). **Lam Dong:** Dalat, 6 km S, 1,400-1,500 m elev, 9-VI/7-VII-1961, NR Spencer, 1L (BPBM).

Torleya padunica Kazlauskas

Torleya padunica Kazlauskas, 1963: 584

Diagnosis. *Torleya padunica* larvae are distinguished from other *Torleya* larvae by having a palp on the maxilla (Kazlauskas, 1963: fig. 17; Tiunova, 1995: fig. 12), claws with prominent subdistal denticles (Kazlauskas, 1963: fig. 19), and abdominal terga without paired spines (Kazlauskas, 1963: fig. 13).

Male adults are distinguished by their genitalia. Segment 2 of the genital forceps is not expanded distally, and segment 3 is elongate; the penes are relatively rounded apically and have prominent ventral spinelike setae (Tiunova, 1995: fig. 10).

Distribution. East Palearctic (eastern Siberia).

Material examined. RUSSIA, **Primorskiy Krai:** River Narva (=Sidime), 12-VII-1980, V Belov, 1L (dissected mouthparts in microvial) (PERC).

Torleya spp.

Figs. 11, 15

Discussion. We could not identify the following comparative material to the species level with confidence due to damage, deterioration, or lack of sufficient material for ascertaining variation. For example, series of male alates from Taiwan and Fukien, China, are very similar to *T. nepalica*, but they lack abdominal coloration. In contrast, all adults of *T. nepalica* that we examined have lateral dark maculae on the abdomen, as documented by Tong and Dudgeon (2000: fig. 23a, b), although some older specimens might be faded.

A series of three larvae (Fig. 15) from Tuan Hui, Vietnam, were collected together with a larva very similar to *T. nepalica*. The maxillae (Fig. 11) of the larval variants are similar to typical *T. nepalica*, but these three larvae have gills 3 distinctively falcate, the abdominal tergal spines reduced in size, and the lateral margins of the abdomen relatively parallel.

Material examined. CHINA, **Fukien:** Shaowu, Shuipeichieh, 18-IX-1941, 7-X-1941, 8-X-1941, TC Maa, 2MA, 1 pharate MA with associated SE (BPBM). **Taiwan:** Taipei, 13/20-VI-1965, KS Lin, 1MA (genitalia in microvial), 5MS (PERC). VIETNAM, **Tuan Hui:** R. Kinh-Dinh, 16-IV-1982, T Soldán, 4L (parts in microvial) (PERC).

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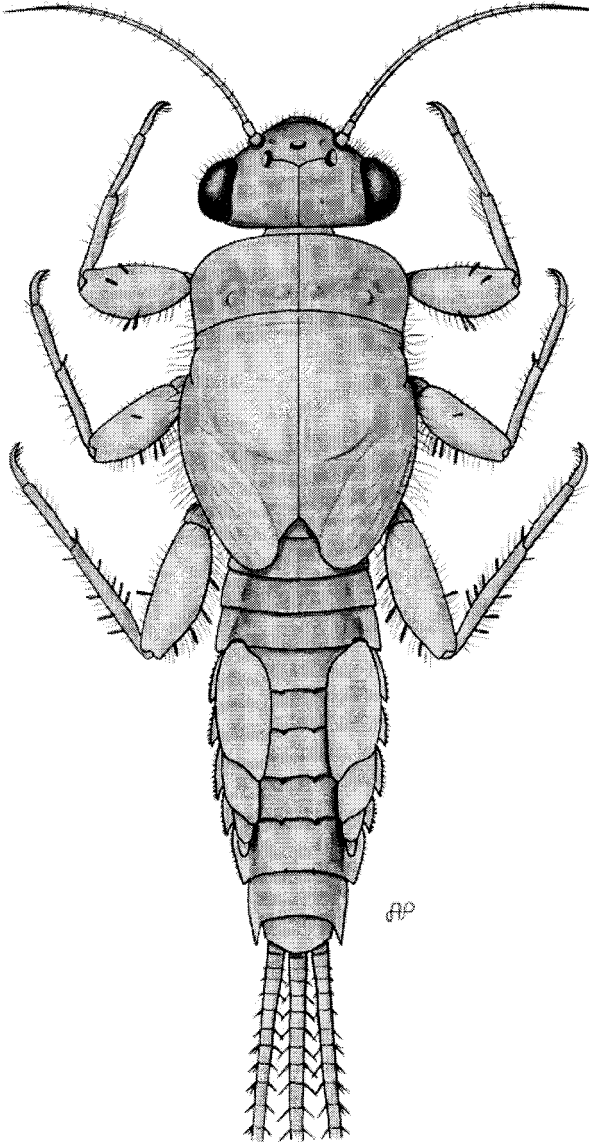


Fig. 15. *Torleya* sp., (Tuan Hui, Vietnam), larval habitus, dorsal view.

Sartori (Lausanne, Switzerland), Kris Simpson (Columbia, Missouri), K. G. Sivaramakrishnan (Madras, India), Bob Sites (Columbia, Missouri), K. A. Subramanian (India), and Xiaoli Tong (Hong Kong, China) loaned or donated material for study. Dan Polhemus (Washington, D. C.) informed us about some important collections, and Tino Gonsalves helped arrange a visit to BPBM. Nikita Kluge examined some specimens, assisted with literature, and critically reviewed the

manuscript. Michel Sartori and Robert Waltz (Indianapolis, Indiana) also critically reviewed the manuscript. Arne Haybach discussed some of the European species. Lu Sun (West Lafayette, Indiana) assisted with Scanning Electron Microscopy and imaging, which was conducted at the Life Science Microscopy Facility, Purdue University. This study was funded in part by USEPA fellowship 91601701-0 to LMJ, and in part “this material is based upon work supported under a National Science Foundation Graduate Research Fellowship” to LMJ.

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