

Four new species of *Elatosara* (Ephemeroptera: Caenidae) from Myanmar and the Philippines

Author: Malzacher, Peter

Source: Integrative Systematics: Stuttgart Contributions to Natural History, 6(2) : 45-54

Published By: Stuttgart State Museum of Natural History

URL: <https://doi.org/10.18476/2023.456049>

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

RESEARCH ARTICLE

Four new species of *Elatosara* (Ephemeroptera: Caenidae) from Myanmar and the Philippines

PETER MALZACHER

Abstract

Four new species of *Elatosara* are described based on nymphal material: *Elatosara bamar* **sp. n.** and *Elatosara erikseni* **sp. n.** from Myanmar, and *Elatosara tagalog* **sp. n.** and *Elatosara konstantini* **sp. n.** from the Philippines. Moreover, *Elatosara phanomensis* Malzacher, 2020, *Caenis kareniae* Malzacher, 2020, *C. picea* Kimmins, 1947 and *C. ulmeriana* Malzacher, 2015 are newly recorded from Myanmar.

Key words: Clypeocaeninae, South-East Asia, square-gill mayflies, taxonomy.

Zusammenfassung

Die Nymphen von vier neuen *Elatosara*-Arten werden beschrieben, aus Myanmar *Elatosara bamar* **sp. n.** und *Elatosara erikseni* **sp. n.** sowie von den Philippinen *Elatosara tagalog* **sp. n.** und *Elatosara konstantini* **sp. n.** Darüber hinaus konnten *Elatosara phanomensis* Malzacher, 2020 sowie *Caenis kareniae* Malzacher, 2020, *C. picea* Kimmins, 1947 und *C. ulmeriana* Malzacher, 2015 für Myanmar neu nachgewiesen werden.

Introduction

The South-East Asian fauna of square-gill mayflies (Ephemeroptera: Caenidae) is still little known. Only two species of Caenidae were previously known from the Philippines, namely *Caenis annulata* Navás, 1923 and *Caenis philippinensis* Ulmer, 1924 (MALZACHER 2015). Likewise, until recently, only a few mayfly species had been reported from Myanmar, including records of unidentified “*Caenis* sp.” from various rivers in the central regions (KO et al. 2020a, 2020b, 2020c). These unidentified records may represent different species to those already recorded, if not genera, as in the neighbouring areas, namely the Indian subregion and Thailand, a diverse fauna of Caenidae is found (e.g., HUBBARD & PETERS 1978; MALZACHER & SANGPRADUB 2021).

The present study adds to the knowledge of the Oriental Caenidae fauna by describing four new species of *Elatosara* Malzacher, a genus recently described from the Mekong River in eastern Thailand (MALZACHER & SANGPRADUB 2021) and since collected also in Laos (V. VANNACHAK, unpublished). Two of the new species are from Myanmar and the other two are from the Philippines. The new species represent new country records for the genus, whose distribution is confirmed to be wider than initially thought. Also, the new species add to the generic differential diagnosis of *Elatosara* by MALZACHER & SANGPRADUB (2021), which is updated herein.

Material and methods

The material from Myanmar was collected in 2019 in the framework of an investigation of the ecological condition, biodiversity and major environmental challenges of a tropical river network in the Bago District in south-central Myanmar (ERIKSEN et al. 2021).

The investigated material was preserved in 75% ethanol and examined with a Wild M3 binocular microscope. Line drawings were made with the aid of a Zeiss Large camera lucida on a Leitz Laborlux microscope and digitised by using Photo Filtre version 6.5.2. Specimens used for SEM imaging were dehydrated through a stepwise immersion in ethanol and critical point dried. The mounted material was coated with a 20 nm Au layer and examined and imaged with a Zeiss EVO LS 15 scanning electron microscope.

Type specimens and other material are stored at Musée Cantonal de Zoologie, Lausanne, Switzerland.

Systematic account

Genus *Elatosara* Malzacher, 2021

Type species: *Elatosara phanomensis* Malzacher in Malzacher & Sangpradub, 2021.

Amended differential diagnosis

An extension of the generic diagnosis was necessary because some characters differ somewhat in the newly described species, e.g., segments of the maxillary and

labial palps, the row of microtrichia on the ventral side of the operculate gill and the number of pluri-branched filaments on gill III (cf. MALZACHER & SANGPRADUB 2021: 17). *Elatosara* can be characterised and distinguished from all other genera of Caenidae by the following combination of characters:

Male. Short to medium length forceps, apically converging and rounded (Fig. 3g) (MALZACHER & SANGPRADUB 2021, fig. 17b), without longitudinal folds or ridges. No functional unit of forceps and lateral sclerite (see MALZACHER & STANICZEK 2006: 187).

Nymph. Thorax broadened. Head without ocellar tubercles and microscopic pits. Outline of head bulged in lateral view (Fig. 1a–e). Clypeus scarcely protruding anteriorly, with short bristles. Maxillary and labial palps three-segmented, short. Segments 2 and 3 of labial palp subequal in length; both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4f–i) [valid for *Elatosara phanomensis* Malzacher, *E. bamar* sp. n., *E. tagalog* sp. n. and *E. erikseni* sp. n., but not for *E. konstantini* sp. n. (Fig. 4j; see discussion)]. Legs not narrow and slender. Fore tibia and fore tarsus without filtering setae. Mid and hind tibiae ventrally without long bristles. Operculate gill ventrally with an irregular row or band of simple, scale-shaped microtrichia, clusters of spines and single spines, often very small and inconspicuous. Band does not reach hind margin of gill (Figs. 2a–d, 5–7). Number of pluri-branched filaments on gill III(–V) reduced, only 39 filaments with 3 or more branches; about 20–26 one- or two-branched filaments. Lateral spines of abdomen not bent dorsally. Posterior part of sternum IX rounded, more or less triangular not shortened (Figs. 1j, 3g) (MALZACHER & SANGPRADUB 2021, fig. 17a). Abdominal terga VIII–X without a medio-longitudinal ridge.

Elatosara phanomensis Malzacher, 2021

In MALZACHER & SANGPRADUB (2021: 18).

Material examined

Myanmar, Bago reg., Sittaung River, 17.78941N, 96.49021E, 01.03.2017, 7♂ nymphs, 11♀ nymphs. – Myanmar, Bago reg., Sittaung River, 17.86902N, 96.49225E, 09.03.2017, about 40 nymphs. – same locality, 13.03.2018, about 20 nymphs. – Myanmar, Bago reg., Sittaung River, 17.98970N, 96.48161E, 13.03.2018, 2 nymphs. – Myanmar, Bago reg., Irrawaddy River, 17.37319N, 96.29305E, 06.05.2017, 10 nymphs. – Myanmar, Bago reg., Sittaung River, 17.59296N, 96.28410E, 01.03.2018, 5 nymphs. All leg. T. E. ERIKSEN.

Description (nymph)

[Extension of the description in MALZACHER & SANGPRADUB (2021).]

Measurements and colouration. Male, subadult: Body length 2.5 mm, cerci length 1.5 mm. Female, last instar: Body length 2.8 mm. Colouration of cuticle: Head, thorax

and operculate gills brown, abdominal terga with a very variable pattern of pale marks and spots. No visible epidermal pigmentation.

Morphology. Cuticle: most parts with net-meshes; often each mesh with a small denticle or granule; other parts more or less strongly granulated. Variable in different specimens.

Head: Outline of head in lateral view more or less bulged (variable), clypeus slightly protruding (Fig. 1a, b). Genae slightly bulged. Mandibles with a dorsolateral group of moderate to long bristles. Segments 2 and 3 of labial palp subequal in length. Both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4f).

Thorax: Sides of pronotum straight, slightly converging anteriorly, denticulated. Coxal processes sickle-shaped, strongly denticulated, with one or two long bristles or inconspicuous. Forefemur on dorsal side with an irregular and variable transverse row of 5–7 moderate to long, thin bristles. Hind margin of metanotum broadly triangularly protruding posteriorly. Femora marginally with long, thin bristles, slightly shorter on inner margin. Tarsi ventrally each with an inner row of about 5–7 simple bristles of moderate length. Foreclaw moderately curved, mid and hind claws stronger curved, with about 5 strong denticles. Hind claw sometimes additionally with few very short micro-denticles apicad to the stronger ones. Curvature and denticulation variable.

Abdomen: Abdominal segments V–VII with posterolateral processes of moderate length, with about 10 moderate to long bristles. Segments VIII–IX with short posterolateral processes, with 2 short to moderate bristles and margins finely denticulated. Posteromedian process on tergum II long, conical, erect (Fig. 1g, h). Hind margins of terga VII–VIII with 15–20 long bristles, terga IX–X with denticles. Hind part of sternum IX posteriorly protruding to form a triangle, apically broadly rounded. Shagreen not visible.

Operculate gill [Figs. 2a, 7 (frame)] nearly square, posteromedian corner rounded; lateral margin with about 12 thin bristles, anteriorly decreasing in length. Posterolateral corner and adjacent part of hind margin with fine, frayed, short bristles, towards the posteromedian corner with more and more prolonged, thin, simple bristles. On inner margin about 15 short to moderately thin bristles. Y-shaped ridges inconspicuous, posteriorly reduced, marked by long bristles. Microtrichia on ventral side of operculate gill often very small (nearly invisible under the light microscope), forming an irregular row or band, ending in the middle of the hind margin; arrangement very variable [compare Figs. 5–7 and MALZACHER & SANGPRADUB (2021, fig. 19)]. Figure 6 shows the arrangement on the left and right gill of a single specimen. Gill III (first of four respiratory gills) possesses 6–9 filaments each made up of

3–4 branches and about 20–25 filaments with one or two branches. Gill I about half as long as gill II.

***Elatosara bamar* sp. n.**

(Figs. 1c, f, 2b, 4h)

Type material

Holotype ♂ (final instar nymph on microslide): Myanmar, Bago reg., Sittaung River, 17.86902N 96.49225E, 13.03.2018, leg. T. E. ERIKSEN.

Paratypes: Same data as holotype, 4 nymphs.

Other material

Same locality as holotype, 09.03.2017, 2 small nymphs, leg. T. E. ERIKSEN.

Etymology

The species epithet is a noun in apposition and refers to the Bamar people, who live in the western part of Myanmar.

Description (male nymph)

Measurements and colouration. Body length 2.0 mm, cerci length 1.0 mm. Colouration of cuticle: Brown with a large central mark on mesonotum, other parts with small pale spots, legs yellowish white. No epidermal pigmentation visible.

Morphology. Cuticle strongly granulated or denticulated; granules domed, strongly so on wing buds. In several places with finely feathered microtrichia.

Head: Outline of head clearly bulged (Fig. 1c). Genae scarcely bulged. Mandibles dorsolaterally with few mod-

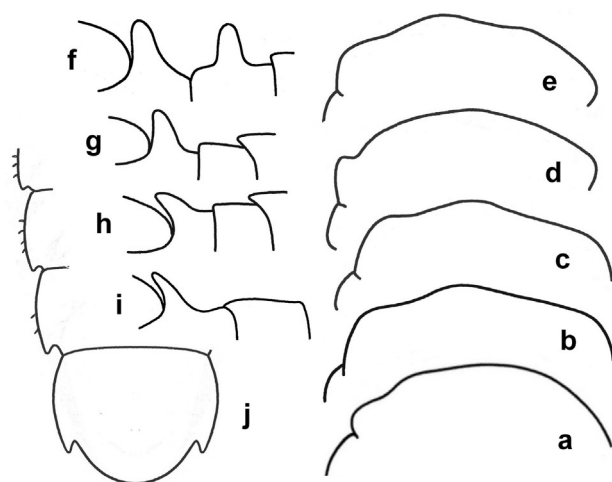


Fig. 1. Genus *Elatosara* Malzacher, nymph; outlines of head in lateral view (a–e), abdominal terga I and II in lateral view (f–i), abdominal segments VI–IX (j). **a, b.** *Elatosara phanomensis* Malzacher, 2021. **c.** *Elatosara bamar* sp. n. **d.** *Elatosara tagalog* sp. n. **e.** *Elatosara konstantini* sp. n. **f.** *Elatosara bamar* sp. n. **g, h.** *Elatosara phanomensis* Malzacher, 2020. **i.** *Elatosara konstantini* sp. n. **j.** *Elatosara tagalog* sp. n.

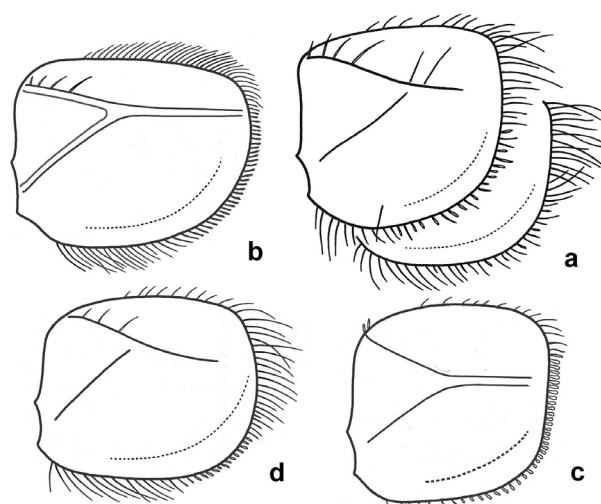


Fig. 2. Genus *Elatosara* Malzacher, nymph; operculate gills. **a.** *Elatosara phanomensis* Malzacher, 2021. **b.** *Elatosara bamar* sp. n. **c.** *Elatosara tagalog* sp. n. **d.** *Elatosara konstantini* sp. n.

erate bristles and a couple of feathered microtrichia. Segments 2 and 3 of labial palp subequal in length. Both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4h).

Thorax: Sides of pronotum straight, parallel or slightly converging anteriorly. Coxal processes sickle-shaped. Forefemur on dorsal side with an oblique transverse row of moderate, blunt bristles. Mid and hind femora with medium-long bristles on hind margin, fore margin with shorter ones and feathered microtrichia. Tibiae marginally with moderate bristles and feathered microtrichia. Tarsi ventrally each with an irregular row of 7–10 simple bristles, apical ones frayed. Claws moderately curved, curvature variable, with about 5–7 denticles.

Abdomen: Posterolateral processes of abdominal segments very short. Margins of median segments with 5–6 bristles of moderate length. Posteromedian process on tergum II voluminous and strongly erect, a similar process medially on tergum I (Fig. 1f). Hind margin of tergum VII with few short to moderate blunt bristles, tergum VIII denticulated with feathered microtrichia, terga IX–X with denticles only. Hind margin of tergites VII and VIII slightly domed. Hind part of sternum IX triangular, posteriorly broadly rounded. Shagreen not visible.

Operculate gill (Fig. 2b) clearly longer than broad, hind and lateral margins continuously curved; margins densely provided with bristles, 80–90 in total. Posterolateral curvature with short, feathered bristles, the remaining ones thin and of moderate length, anterolaterally a little longer. Y-shaped ridges broad and strongly bulged, conspicuously granulated; inner ridge basally with about four strong bristles. Row of microtrichia on ventral side of operculate

gill runs away from the margin and consists of very small microtrichia, nearly invisible under the light microscope. Gill III (first of four respiratory gills) with 3–5 filaments each made up of 3–4 branches and about 20 filaments with one or two branches. Gill I almost half as long as gill II.

***Elatosara erikseni* sp. n.**

(Figs. 3, 4i)

Type material

Holotype (subadult ♂ nymph on microslide): Myanmar, Bago reg., Sittaung River, 17.86902N 96.49225E, 13.03.2018, leg. T. E. ERIKSEN.

Paratypes: Same data as holotype, 4 nymphs.

Other material

Same locality as holotype, 09.03.2017, 1 nymph, leg. T. E. ERIKSEN.

Etymology

Dedicated to T. E. ERIKSEN, the collector of the new species and leader of the ecological investigations in the Bago District.

Description

Male subimago. [The holotype and one paratype are male last instar nymphs; the following subimaginal characters are therefore visible:] Base of antennal flagellum not dilated. Prosternal ridges forming an apically open equilateral triangle. Segments of foretarsus apically not broadened, without small spines. Abdominal segments with short posterolateral processes. Subimaginal genitalia as in Fig. 3g. Penis broad, with short, broadly rounded lobes. Forceps of moderate length, apically converging and rounded.

Nymph. *Measurements and colouration.* Body length 2.0–2.4 mm (male, subadult); 2.5–2.7 mm (female, subadult). Colouration of cuticle: Specimens rather brightly coloured. Frons light yellowish brown. Pronotum with a yellowish brown anteromedian mark and fore and hind margins slightly coloured. Meso- and metanotum of the same colour, mesonotum with several light spots. Other parts yellowish white. No epidermal pigmentation visible.

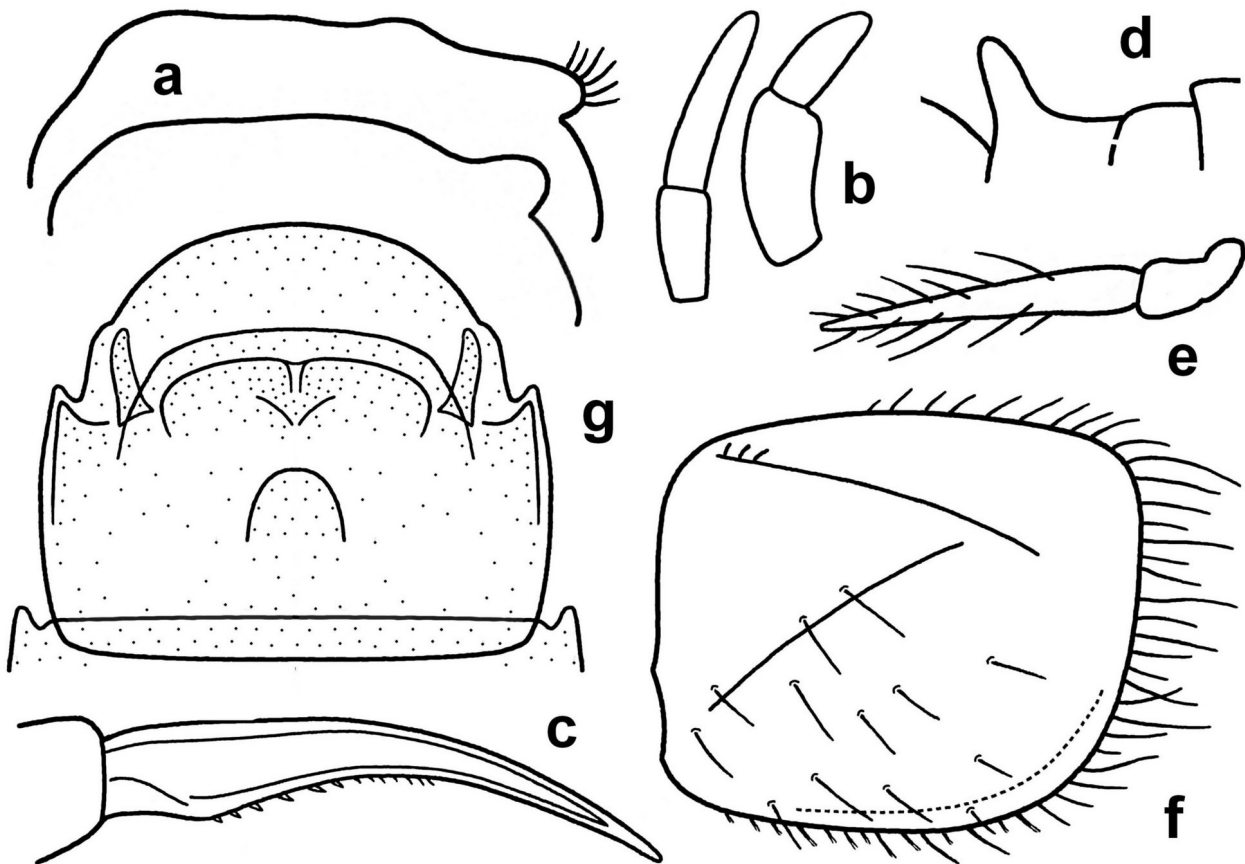


Fig. 3. *Elatosara erikseni* sp. n., nymph. **a.** Outline of head in lateral view. **b.** Second and third segments of maxillary and labial palps. **c.** Hind claw. **d.** Abdominal terga I and II in lateral view. **e.** Gill I. **f.** Operculate gill. **g.** Sternum IX with subimaginal genitalia.

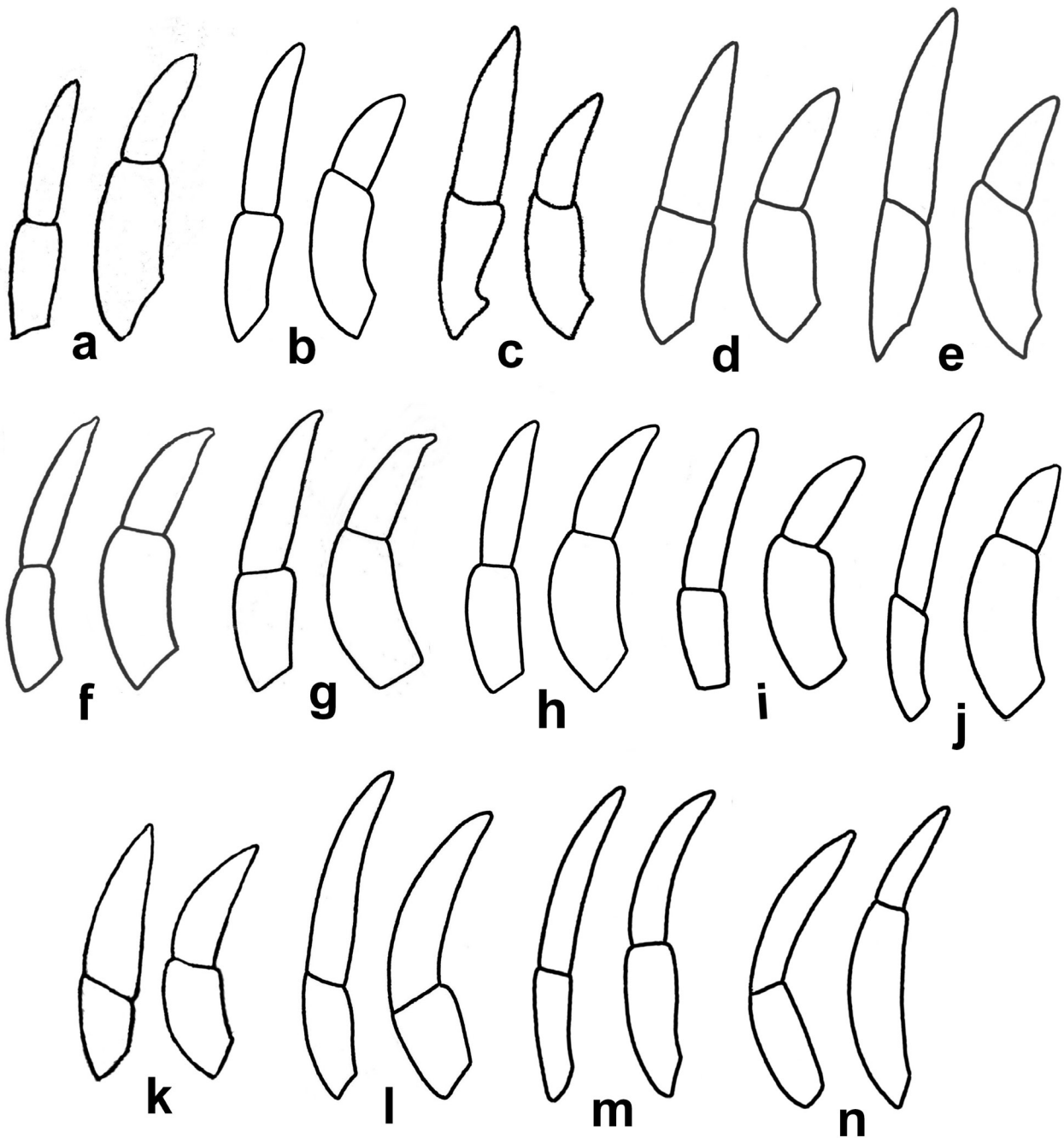


Fig. 4. Second and third segments of maxillary palp (left) and labial palp (right) in nymphal Clypeocaenini (a–l) and outgroup Neophemeridae (m, n). **a.** *Aenigmocaenis morgensterni* Malzacher, 2009. **b.** *Trichocaenis inexperta* Malzacher, 2009. **c.** *Callistellina* Sun & McCafferty sp. **d.** *Mandelara immutata* Malzacher, 2016. **e.** *Papuaenis balkei* Malzacher, 2016. **f.** *Elatosara phanomensis* Malzacher, 2021. **g.** *Elatosara tagalog* sp. n. **h.** *Elatosara bamar* sp. n. **i.** *Elatosara erikseni* sp. n. **j.** *Elatosara konstantini* sp. n. **k.** *Provonshara spinifera* Malzacher, 2014. **l.** *Amercaenis ridens* Provonsha, 1986. **m.** *Neophemera maxima* (Joly, 1871). **n.** *Potamanthellus edmundsi* Bae, 1998.

Morphology. Cuticle inconspicuously denticulated.

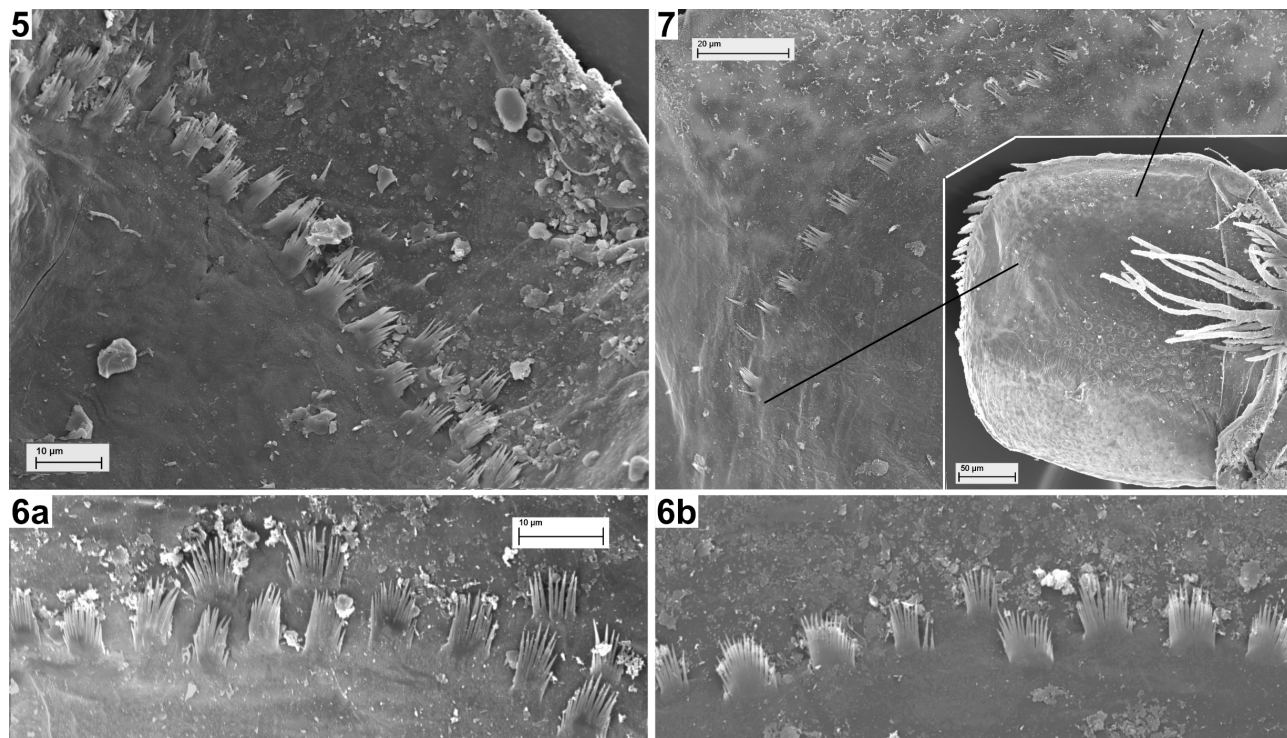
Head: Outline of head in lateral view bulged as in Fig. 3a; clypeus clearly protruded, translucent, with numerous strong bristles, often bifid or tufted. Genae slightly bulged. Anteriomedian indentation of labrum very shallow; its foremargin and anterior epipharynx with blunt bristles, often with single or multiple knobs. Mandibles dorsolaterally with few short and thin bristles; both incisivi narrow, with two or three denticles. Segments 2 and 3 of labial palp subequal in length. Both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4i).

Thorax: Sides of pronotum weakly convex, slightly converging anteriorly, with about 10 strong, acute bristles; few bristles also on the adjacent surface. Coxal processes inconspicuous, with one or two long, thin bristles. Femora marginally with long acute bristles, single bristles also on dorsal surface. Forefemur without a transverse row of bristles. Tarsi ventrally each with an inner row of about 5–7 short, simple bristles. Claws thin and elongate, with 5–6 small denticles in basal part. Hind claw additionally with few inconspicuous microdenticles, apically adjacent (Fig. 3c).

Abdomen: Length of posterolateral processes of abdominal segments short (middle segments) to very short (posterior segments). Margins of the median segments

(IV–VII) with 6–8 strong, acute, slightly bent bristles, segment VIII with three shorter bristles and segment IX with only one bristle or no bristles. Hind margin of tergum II with a cone-shaped, erect median process; tergum I without such a process (Fig. 3d). Hind margins of terga VII–VIII with long acute bristles, on terga IX–X with very small denticles (IX) or granules (X), often nearly invisible. Hind part of sternum IX moderately protruding, semicircularly bulged (Fig. 3g), without any shagreen; hind margin with very short, often bifid or tufted bristles.

Operculate gill (Fig. 3f) nearly square, lateral hind corner slightly protruding posteriorly; with moderate to long, thin bristles on hind margin and few shorter ones on posterior half of inner margin; lateral margin with very short, often bifid or tufted bristles, with more or less long bristles in between. Y-shaped ridges well developed, the inner one basally with few very short, blunt bristles. Ventral side of operculate gill with a very inconspicuous row of small, simple, scale-shaped microtrichia, clusters of spines and single spines. The row runs close to the lateral margin of the gill. Gill III (first of four respiratory gills) with 6–8 filaments each made up of 3–4 branches and about 26 filaments with one or two branches. Gill II 2.3 times as long as gill I, the latter basally broadened and apically pointed (Fig. 3e).



Figs. 5–7. *Elatosara phanomensis* Malzacher, 2021, nymph; microtrichia on operculate gills of three different specimens in ventral view, showing their variation. **5.** Specimen 1, similar to the holotype. **6.** Specimen 2, right (a) and left (b) side. **7.** Specimen 3, with very short row of microtrichia.

***Elatosara tagalog* sp. n.**

(Figs. 1d, j, 2c, 4g)

Type material

Holotype (subadult ♂ nymph on microslide): Philippines, Luzon, Maria Aurora prov., Wenceslao, Bingwangan River, 15°45'48"N 121°25'21"E, 60m, 05.02.1998, leg. J. M. GARCES.

Etymology

The species epithet is a noun in apposition and refers to the Philippine Tagalog people, who live on the islands of Luzon and Mindoro.

Description (male nymph)

Measurements and colouration. Subadult: Body length 2.3 mm, cerci length 1.0 mm. Colouration of cuticle: Frons and parts of vertex brownish. Pro- and mesonotum as well as abdominal terga and posterolateral part of operculate gill strongly brown; two large pale marks on inner margin of wing buds. Each half of abdominal sternites with a large brown spot, increasing in intensity posteriorly. No epidermal pigments visible.

Morphology. Cuticle more or less strongly granulated, without any setation.

Head: Clypeus in lateral view slightly protruding, similar to a turned-up nose (Fig. 1d). Genae moderately bulged. Mandibles with a dorsolateral group of short to moderate bristles. Segments 2 and 3 of labial palp subequal in length. Both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4g).

Thorax: Sides of pronotum straight, parallel, denticulated. Coxal processes sickle-shaped, inconspicuous. Forefemur on dorsal side with an oblique transverse row of about 5 inner and 3 outer, moderate to long, thin bristles apically scarcely frayed. Femora marginally with moderate to long, thin bristles slightly shorter on inner margin. Tarsi ventrally each with an inner row of about 5–6 short, simple bristles, those on hind tarsus finely frayed. Claws moderately curved, with about 5 small denticles.

Abdomen: Posterolateral processes of abdominal segments very short, slightly increasing in length posteriorly, with few very short bristles (Fig. 1j). Margins of segments VIII–IX scarcely denticulated. Posteromedian process on tergum II forming a flat, equilateral triangle. Hind margins of terga VII–IX denticulated, terga VII and VIII with few, very short bristles. Hind part of sternum IX semicircular, without bristles (Fig. 1j). Shagreen not visible.

Operculate gill (Fig. 2c) nearly square; margins provided with very short bristles, slightly spatulate laterally. Bristles on hind margin broader and close-fitting, finely frayed. Few longer bristles on posteromedian corner, on inner margin about 10 thin and short bristles. Y-shaped ridges reduced. Very small microtrichia on ventral side of operculate gill (nearly invisible under the light microscope), forming a shortened irregular row. Gill III (first of four respiratory gills) with about 6 filaments each made

up of 3–5 branches and about 20 filaments with one or two branches. Gill I just over half as long as gill II.

***Elatosara konstantini* sp. n.**

(Figs. 1e, i, 2d, 4j)

Type material

Holotype (subadult ♂ nymph on microslide): Philippines, Oriental Mindoro prov., Roxas, Brgy. San Vicente, Taugad River, 12°37'18"N 121°22'58"E, 140 m a.s.l., 2017/2018, leg. MENDOZA.

Paratype: 1 subadult female nymph, same data as holotype.

Etymology

The species is dedicated to my grandchild Konstantin.

Description (nymph)

Measurements and colouration. Female, subadult: Body length 2.7 mm. Colouration of cuticle: Brown, with pale spot on frons and a few pale dashes on mesonotum. Abdominal terga and legs yellowish white. Epidermal pigmentation: Traces of pigments between lateral ocelli and two paramedian spots on pronotum.

Morphology. Cuticle denticulated, with very small, shield-shaped microtrichia nearly invisible under the light microscope.

Head: Outline of head in lateral view more or less bulged as in Fig. 1e. Genae clearly bulged. Mandibles with a dorsolateral group of moderate to long bristles. Segment 3 of labial palp nearly two times as long as segment 2. Both segments together clearly shorter than segments 2 and 3 of maxillary palp (Fig. 4j).

Thorax: Sides of pronotum straight, denticulated, clearly diverging anteriorly; forecorner rounded with three short, blunt bristles. Sides of mesonotum anterolaterally moderately bulged. Coxal processes sickle-shaped. Forefemur on dorsal side with a regular and straight transverse row of about 5–6 inner and 3 outer, moderate, broadly spatulate and apically slightly frayed bristles; both groups clearly separated, and bristles within each group very densely arranged. Similar bristles, but slightly longer, on margin, apicad to transverse row. Mid and hind femora on hind margin with long, acute bristles in basal part, becoming shorter and blunt apically. Tarsi ventrally each with an inner row of about 7 short, simple bristles, hind tarsus additionally with a short outer row of 3 unipinnate, frayed bristles. Claws moderately curved, with about 5 small denticles.

Abdomen: Posterolateral processes of abdominal segments short to moderate, slightly longer on segment IX. Margins with 7–8 bristles, long and thin on segments IV and V, posteriorly decreasing in length, becoming more and more spatulate. Hind margin of tergum II strongly denticulated, with a median process forming an equilateral triangle, moderately erect in lateral view (Fig. 1i). Hind margins of terga VII–VIII with long acute bristles.

Terga IX–X denticulated, denticles also on hind margin of tergum VIII. Hind part of sternum IX moderately protruding, apically cut or slightly concave. Few very small denticles close to the hind margin as a rest of shagreen.

Operculate gill (Fig. 2d) a little longer than wide; moderate to long, thin bristles on hind margin and basal two thirds of lateral margin. On posterolateral corner with short or very short, spatulate and finely frayed bristles, few thin and short bristles on inner margin. Y-shaped ridges well developed. Small microtrichia on ventral side of operculate gill forming a slightly irregular row, in its middle part far away from margin. Gill III (first of four respiratory gills) with about 30 filaments, five of which made up of 3–4 branches and about 25 of which with one or two branches. Gill I a little more than half as long as gill II.

Caenis picea Kimmins, 1947

KIMMINS (1947: 99); MALZACHER (2015: 38); MALZACHER & SANGPRADUB (2021: 12).

Material examined

Myanmar, Bago reg., Sittaung River, 17.46536N 96.44641E, 07.03.2017, 1 nymph. – Myanmar, Bago reg., Sittaung River, 17.50067N, 96.34586E, 27.02.2016, 2 nymphs. All leg. T. E. ERIKSEN.

Remarks

Caenis picea is a species with type 3a forcipes (see MALZACHER 2022), apically with a number of small trichomes extending beyond the apex. The species is closely related to the West Palearctic *Caenis lactea* Burmeister, 1839 and is known so far from India and Thailand; here firstly reported from Myanmar. For a detailed description see MALZACHER (2015: 38) and MALZACHER & SANGPRADUB (2021: 12).

Caenis ulmeriana Malzacher, 2015

MALZACHER (2015: 38); MALZACHER & SANGPRADUB (2021: 8).

Material examined

Myanmar, Bago reg., Sittaung River, 17.962552N 96.749241E, 06.03.2018, 1 nymph. – Myanmar, Bago reg., Sittaung River, 17.722642N 96.618507E, 01.03.2017, 1 nymph. – Myanmar, Bago reg., Sittaung River, 17.789412N 96.490206E, 01.03.2017, 1 nymph. All leg. T. E. ERIKSEN.

[The following specimens belong to the *C. ulmeriana*-group but cannot be clearly determined as *C. ulmeriana*:] Myanmar, Inle reg., Salween River, 20.460119N 96.929139E, 16.11.2017, 2 nymphs. – Myanmar, Bago reg., Sittaung River, 17.86901N 96.492245E, 13.03.2018, 1 nymph. – Myanmar, Bago reg., Sittaung River, 17.989699N 96.481606E, 13.03.2018, 1 nymph. – Philippines, Luzon, Laguna prov., Los Banos, Molawin River, 14°10'05"N 121°11'44"E, 29.09.1998, 1 nymph. All leg. T. E. ERIKSEN.

Remarks

Caenis ulmeriana is a species with type 4T forcipes (see MALZACHER 2022), apically with a tuft of strong spines but without elongated penis lobes and without the dilated base of the antennal flagellum. So far known from Thailand and Sumatra and here firstly reported from Myanmar. For a detailed description see MALZACHER (2015: 33) and MALZACHER & SANGPRADUB (2021: 8).

Key to nymphs of Clypeocaenini

With the additional knowledge of the genus *Elatosara* presented here, the key to the nymphs of Clypeocaenini in MALZACHER & STANICZEK (2016: 50) is modified as follows:

- 8 Head and thoracic nota with ridges and pits with branching setae in them (SUN & MCCAFFERTY 2001, figs. 1, 10; MALZACHER 2009, figs. 9, 10) *Callistellina* Sun & McCafferty
- Head and thoracic nota without ridges and pits 9
- 9 Gill III with only 1–2 filaments with three or more branches. Operculate gill ventrally with a sublateral band of scattered spines and clusters of spines (MALZACHER 2009, fig. 5b, c).... *Trichocaenis* Malzacher
- Gill III with 4–9 filaments with three or more branches. Operculate gill ventrally with a narrow irregular band of simple, scale-shaped microtrichia and clusters of spines (Figs. 5–7) (MALZACHER & SANGPRADUB 2021, fig. 19) *Elatosara* Malzacher

Key to nymphs of *Elatosara*

- 1 Claws narrow and elongate (Fig. 3c). Clypeus clearly protruded, translucent. Row of microtrichia on ventral side of operculate gill running close to the lateral margin of the gill (Fig. 3f) *Elatosara erikseni* sp. n.
- Claws shorter and broadened. Clypeus scarcely protruding anteriorly. Row of microtrichia on ventral side of operculate gill with a clear distance to the lateral margin of the gill (Fig. 2) 2
- 2 Posteromedian process on tergum II voluminous and strongly erect, a similar process medially on tergum I (Fig. 1f). Hind and lateral margins of operculate gill continuously curved; margins densely provided with bristles, 80–90 in total; Y-shaped ridges broad and strongly bulged (Fig. 2b) *Elatosara bamar* sp. n.
- Posteromedian process on tergum II conical, more or less erect, tergum I without a median process (Fig. 1g–i). Operculate gill more or less square; margins with about 45–60 bristles (Fig. 2a, c, d). Y-shaped ridges only slightly bulged 3
- 3 Few very short blunt bristles on lateral margins of abdominal segments (Fig. 1j). Bristles on hind margin of operculate gill very short, blunt or spatulate (Fig. 2c) *Elatosara tagalog* sp. n.
- Bristles on lateral margins of abdominal segments moderate to long, most of them thin and acute. Hind margin of operculate gill with moderate to long, thin and acute bristles (Fig. 2a, d) 4
- 4 Segments 2 and 3 of labial palp subequal in length; both segments together subequal in length to segments 2 and 3 of maxillary palp (Fig. 4f). Hind margins of terga VII–VIII with 15–20 long bristles, terga IX–X with denticles *Elatosara phanomensis* Malzacher

- Segment 2 of labial palp clearly longer than segment 3; both segments together clearly shorter than segments 2 and 3 of maxillary palp (Fig. 4j). Hind margin of tergum VIII with bristles and denticles *Elatosara konstantini* sp. n.

Discussion

The new species of *Elatosara* described here have more pronounced bulges on the outline of the head (Figs. 2b–e) than *Elatosara phanomensis* from Thailand (Fig. 2a) (MALZACHER & SANGPRADUB 2021, fig.17f). Due to the latter apomorphic character and due to the apomorphic reduction in the number of multi-branched gill filaments, the genus *Elatosara* can now be unambiguously assigned to Clypeocaenini, in which both characters are synapomorphic. Moreover, the genus represents a plesiomorphic taxon within Clypeocaenini. The variability of different characters, together with the limited availability of specimens, makes it impossible to consider the establishment of further genera. In *Elatosara erikseni* sp. n., these variable characters are the elongated claws and the protruding, translucent clypeus. In contrast to the remaining species of the genus, the third segment of the labial palp in *Elatosara konstantini* sp. n. is nearly twice as long as segment 2 and both segments together are clearly shorter than segments 2 and 3 of the maxillary palp (Fig. 4j). Such ratios can often be found in Caenini, but not in Clypeocaenini. Nevertheless, the genus definitely belongs to the latter tribe, as it shows the two synapomorphies mentioned above. In any case, the ratios of the labial and maxillary palp in the genus *Elatosara* as described here are plesiomorphic. They are not only present in nearly all Clypeocaenini (Fig. 4a–l) (with the exception of species with continuing apomorphies such as all *Clypeocaenis* Soldán species), but also in Neophemeridae (Fig. 4m, n), the sister group of Caenidae.

Acknowledgements

My special thanks go to MICHEL SARTORI (Musée Cantonal de Zoologie, Lausanne) for loaning me the material for investigation, as well as to CRISTINA GASCÓ MARTÍN (State Museum of Natural History Stuttgart, SMNS) for taking the SEMs. I am also indebted to ARNOLD H. STANICZEK (SMNS) and an anonymous reviewer for their helpful comments, and to DANIEL WHITMORE (SMNS) for his thorough editing.

References

ERIKSEN, T. E., FRIBERG, N., BRITAIN, J. E., SØLI, G., BALLOT, A., ÅRSTEIN-ERIKSEN, E., ADLER BLAKSETH, H. & VEITEBERG

- BRAATEN, F. (2021): Ecological condition, biodiversity and major environmental challenges in a tropical river network in the Bago District in South-central Myanmar: first insights to the unknown. – *Limnologica* **86**: 125835. <https://doi.org/10.1016/j.limno.2020.125835>
- HUBBARD, M. D. & PETERS, W. L. (1978): A catalogue of the Ephemeroptera of the Indian Subregion. – *Oriental Insects*. Supplement **9**: 1–43. <https://doi.org/10.1080/00305316.1978.11745231>
- KIMMINS, D. E. (1947): New species of Indian Ephemeroptera. – *Proceedings of the Royal Entomological Society of London. Series B, Taxonomy* **16**: 92–100. <https://doi.org/10.1111/j.1365-3113.1947.tb00865.x>
- KO, N. T., SUTER, P., CONALLIN, J., RUTTEN, M. & BOGAARD, T. (2020a): The urgent need for river health biomonitoring tools for large tropical rivers in developing countries: Preliminary development of a river health monitoring tool for Myanmar Rivers. – *Water* **12**: 1408. <https://doi.org/10.3390/w12051408>
- KO, N. T., SUTER, P., CONALLIN, J., RUTTEN, M. & BOGAARD, T. (2020b): Aquatic macroinvertebrate indicators in the Zawygyi irrigation channels and a river in the central dry zone of Myanmar. – *Sustainability* **12**: 8788. <https://doi.org/10.3390/su12218788>
- KO, N. T., SUTER, P., CONALLIN, J., RUTTEN, M. & BOGAARD, T. (2020c): Aquatic macroinvertebrate community changes downstream of the hydropower generating dams in Myanmar–Potential negative impacts from increased power generation. – *Frontiers in Water* **2**: 573643. <https://doi.org/10.3389/frwa.2020.573643>
- MALZACHER, P. (2009): New larvae of Caeninae from Madagascar (Ephemeroptera: Caenidae). – *Stuttgarter Beiträge zur Naturkunde A. Neue Serie* **2**: 177–194.
- MALZACHER, P. (2015): Revision of the Oriental species of the genus *Caenis* Stephens (Insecta: Ephemeroptera: Caenidae). – *Stuttgarter Beiträge zur Naturkunde A. Neue Serie* **8**: 27–47.
- MALZACHER, P. (2022): Trait evolution of the male genitalia in the speciose genus *Caenis*, with emphasis on forcipes structure (Insecta: Ephemeroptera: Caenidae). – *Integrative Systematics* **5** (1): 1–16. <https://doi.org/10.18476/2022.253690>
- MALZACHER, P. & SANGPRADUB, N. (2021): New mayfly species of *Caenis* and *Kalimaenis* from Thailand and descriptions of two new genera of the subfamily Caeninae (Ephemeroptera: Caenidae). – *Integrative Systematics* **3**: 1–33. <https://doi.org/10.18476/insy.v03.a1>
- MALZACHER, P. & STANICZEK, A. H. (2006): Revision of the Madecocercinae (Ephemeroptera: Caenidae). – *Aquatic Insects* **28** (3): 165–193. <https://doi.org/10.1080/01650420601065403>
- MALZACHER, P. & STANICZEK, A. H. (2016): Two new genera of Caeninae (Ephemeroptera: Caenidae), with a cladistic analysis of the tribe Clypeocaenini. – *Stuttgarter Beiträge zur Naturkunde A. Neue Serie* **9**: 41–62. <https://doi.org/10.18476/sbna.v9.a4>
- SUN, L. & MCCAFFERTY, W. P. (2001): *Callistina panda*, a striking new genus and species of Caeninae (Insecta: Ephemeroptera: Caenidae) from Madagascar. – *Bulletin de la Société d'Histoire Naturelle de Toulouse* **137**: 7–15.

Author's address:

Friedrich-Ebert-Straße 63, 71638 Ludwigsburg, Germany;
e-mail: malzacher.lb@t-online.de

ZooBank registration: <https://zoobank.org/References/595B7213-B4BB-4F6B-88B6-7F47C594E64A>

Manuscript received: 25.I.2023; accepted: 02.XII.2023.