

Mekongellina, a new mayfly genus of the subfamily Brachycercinae (Ephemeroptera: Caenidae) from Thailand

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Abstract

The new genus *Mekongellina* from Thailand with the type species *Mekongellina sangpradubae* is described herein. The genus shows highly modified characters, particularly on head, forelegs and prothorax, together forming a filtering apparatus. It is tentatively attributed to the tribe Brachycercini.

Key words: New genus, *Mekongellina*, Brachycercini, phylogeny, Thailand.

Zusammenfassung

Die neue Gattung *Mekongellina* aus Thailand mit der Typus-Art *Mekongellina sangpradubae* wird beschrieben. Stark abgewandelte Merkmale kennzeichnen die Gattung. Im Bereich Kopf, Vorderbeine und Prothorax ist dadurch ein Filterapparat entstanden. Die Diskussion ergibt eine sehr wahrscheinliche Zugehörigkeit der Gattung zum Tribus Brachycercini.

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1 Introduction

Besides the herein described genus, 7 other genera of Caenidae are known from Thailand. Two of these are attributed to the tribe Caenini, namely *Caenis* Stephens, 1835 with 11 species and *Thainis* Malzacher, 2020 with the two species *T. kalimaenoides* and *T. munensis* (see MALZACHER & SANGPRADUB 2020). Also reported are two genera with one species each of the tribe Clypeocaenini, i.e. *Kalimaenis* Malzacher, 2013 (*Kalimaenis procerata*) and *Elatosara* Malzacher, 2021 (*Elatosara phanomensis*, see MALZACHER & SANGPRADUB 2020). A further genus of this tribe, *Clypeocaenis* Soldán, 1978 is recorded from Vietnam (Soldán 1983) and can also be expected for Thailand. Additionally, two genera of the tribe Caenoculini are present, namely *Caenoculis* Soldán, 1986 (*Caenoculis* c. f. *bishopi*) and *Tigrocercus* Malzacher 2006 (*Tigrocercus dangi*) (MALZACHER & SANGPRADUB 2017). Finally, a genus of the tribe Brachycercini: *Cercobrachys* Soldán 1986 (*Cercobrachys petersorum*) (SUN & McCafferty 2008) is also known.

The new genus and species *Mekongellina* we describe in this contribution has to be assessed to the latter tribe.

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2 Material and methods

The investigated material is preserved in 75% ethanol. Specimens were collected by NARUMON SANGPRADUB within the framework of ecological investigations in the Mekong River, northeast Thailand (GETWONGSA et al. 2010). The holotype is stored in the State Museum of Natural History (SMNS), Stuttgart, Germany, paratypes also in the Applied Taxonomic Research Center, Khon Kaen University, Thailand.

Specimens used for SEM were dehydrated through a step-wise immersion in ethanol and then dried by critical point drying. The mounted material was coated with a 20 nm Au layer, examined and photographed with a Zeiss EVO LS 15 scanning electron microscope. Digital photographs were enhanced by using PhotoFiltre 6.5.2 (<http://www.photofiltre-studio.com>).

3 Systematic account

Genus *Mekongellina* n. gen.

Type species: *Mekongellina sangpradubae* n. sp.

Differential Diagnosis

Mekongellina can be characterised and distinguished from all other genera of Caenidae by the following combination of characters:

Larva: Body elongated, mesonotum broadened (Fig. 1). – Cuticle without shield-shaped microtrichia – Ventral side with bristles of very different length, apically blunt or cut (Figs 10, 11), dorsal side without any setation. – Head without ocellar tubercles and microscopic pits. – Maxillar and labial palps two-segmented (Figs 2b–c, 3). – Glossa reduced, paraglossa laterally elongated (Fig. 2c) – Prosternum strongly protruding anteriorly, provided with very long bristles (Fig. 4). – Forelegs highly modified (Figs 2a, 5–6). – Foreleg provided with long, combed bristles (Figs 6–7). – Tibia and tarsus of mid and hind leg narrow and slender (Fig. 8). – Mid and hind claws straight and narrow (Fig. 9) – Abdominal segments III–VI with posterolateral processes (Fig. 2d), other segments without (Fig. 1). – Lateral processes III–V not bent dorsally, VI moderately curved medially (Fig. 2d). – Operculate gill ventrally without row of microtrichia (Figs 12–13).

Etymology

The genus name refers to Mekong River, locus typicus of *Mekongellina sangpradubae* n. sp.

Mekongellina sangpradubae n. sp. (Figs 1–18)

Material examined

Holotype, ♀ larva (on microslide): MRC 2.4, Thailand, Nakhon Phanom Prov., Mekong River, 01.04.2015. – Paratypes. MRC 1.1, same data as Holotype, 16.04.2013, 1 ♀ larva. – MRC 2.5, same data as Holotype, 1 ♀ larva. – all N. SANGPRADUB leg.

As Mekong River forms the natural border between Thailand and Laos, the genus can also be recorded for the latter country.

Etymology

The species is dedicated to Ms NARUMON SANGPRADUB, who collected extensive material of Caenidae from Thailand, including also the here described specimens. NARUMON SANGPRADUB is also co-author of other papers on this matter (Malzacher & Sangpradub 2020).

Larva

Measurements and colouration

Female larva, subadult, body length 5.0 mm, cerci length 2.5 mm.

Colouration of cuticle white. Epidermal pigmentation: Terga I, II, VII and VIII with pigmented areas as in Fig. 1. Pigmentation can be more or less reduced.

Morphology

Cuticle: Smooth, dorsal side without any setation, ventral side provided with bristles of very different length,

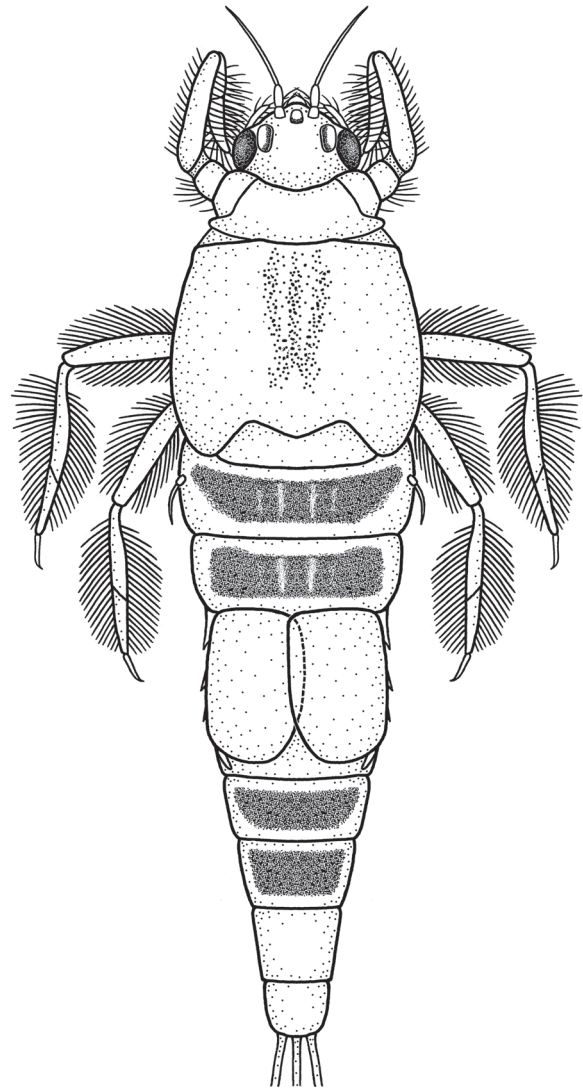


Figure 1. *Mekongellina sangpradubae* n. gen, n. sp., larva, habitus.

apically blunt, often with a slight depression, the longest bristles on thoracal sternites up to 350µm (Fig. 10), on abdominal sternites clearly shorter (Figs 2e, 11).

Habitus: Slender, elongated, mesothorax broadened. Outline of body evenly curved (Fig. 1).

Head (Fig. 1): Circular in dorsal view, genae scarcely bulged. Bases of antennae medially approximated. Lateral ocelli short and broad. Mandibles ventrally with a row of long bristles. Maxillary and labial palps two-segmented, both with a small stepped tip. Segments 2 of labial palp short and broad. Glossa reduced, paraglossa laterally elongated (Figs 2b, c). Maxillae and labium densely provided with long bristles, particularly those on paraglossae are very long (Fig. 3).

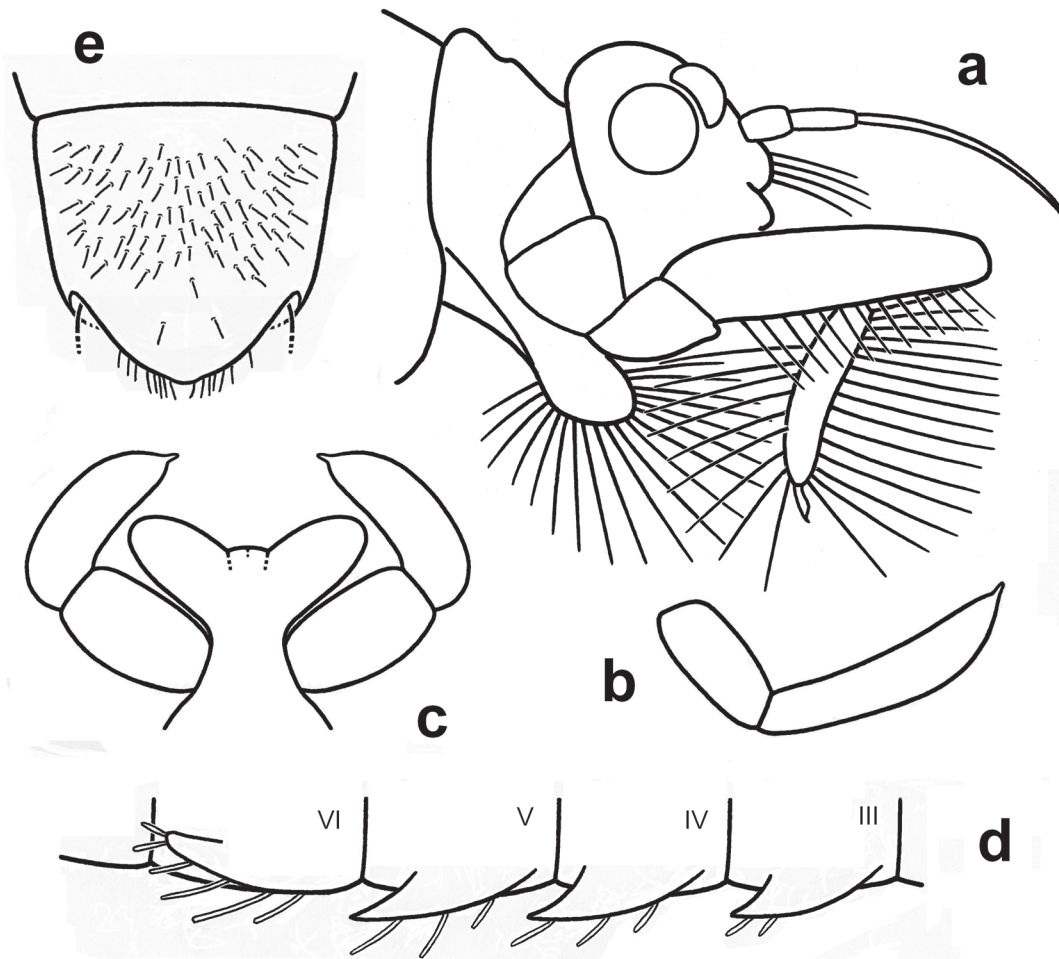
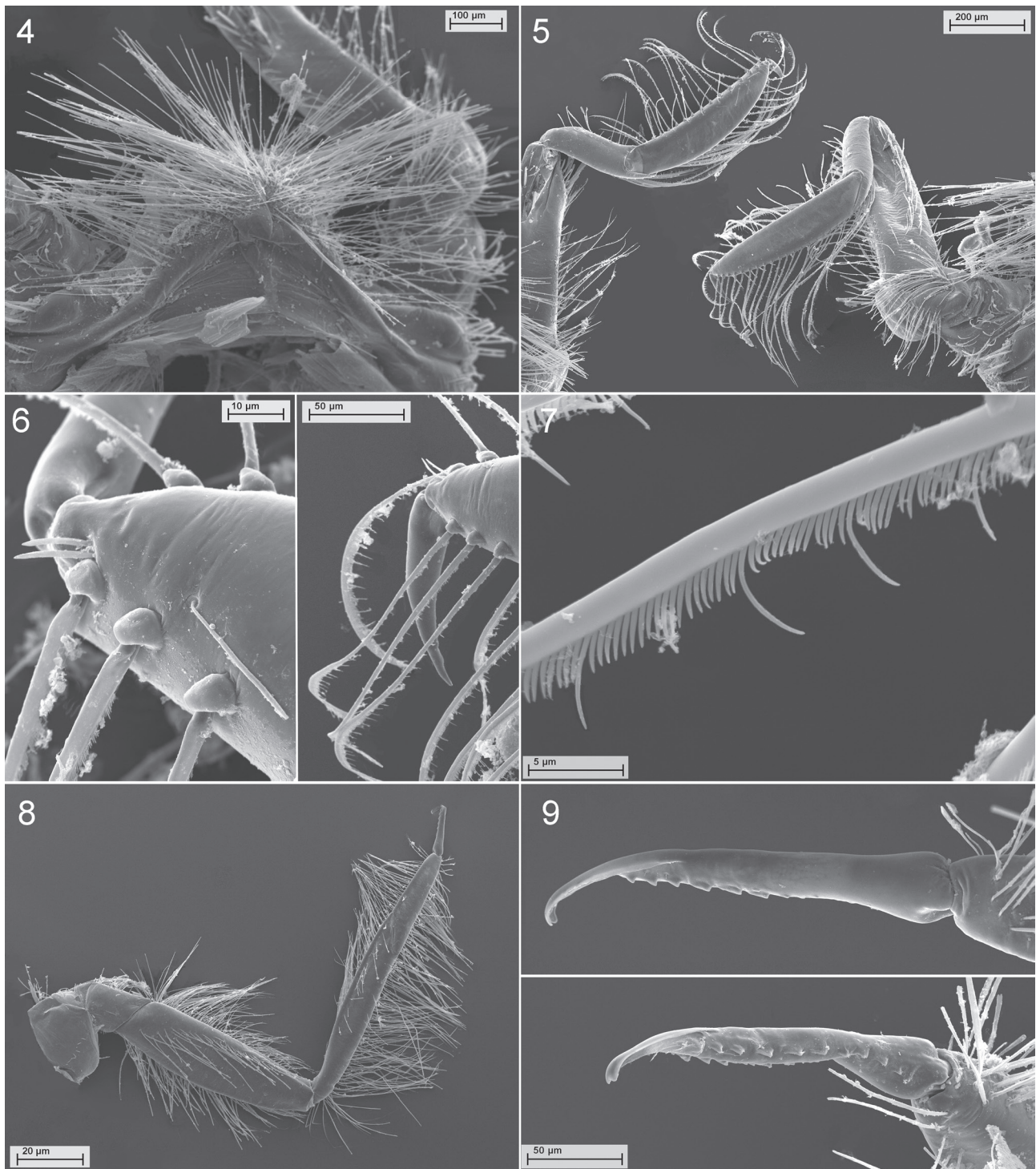


Figure 2. *Mekongellina sangpradubae* n. gen, n. sp., larva. – a. Head and prothorax in lateral view – b. Maxillary palp. – c. Labium (for setation of b and c see Fig. 3). – d. Abdominal segments III–VI, lateral part. – e. Sternite IX.

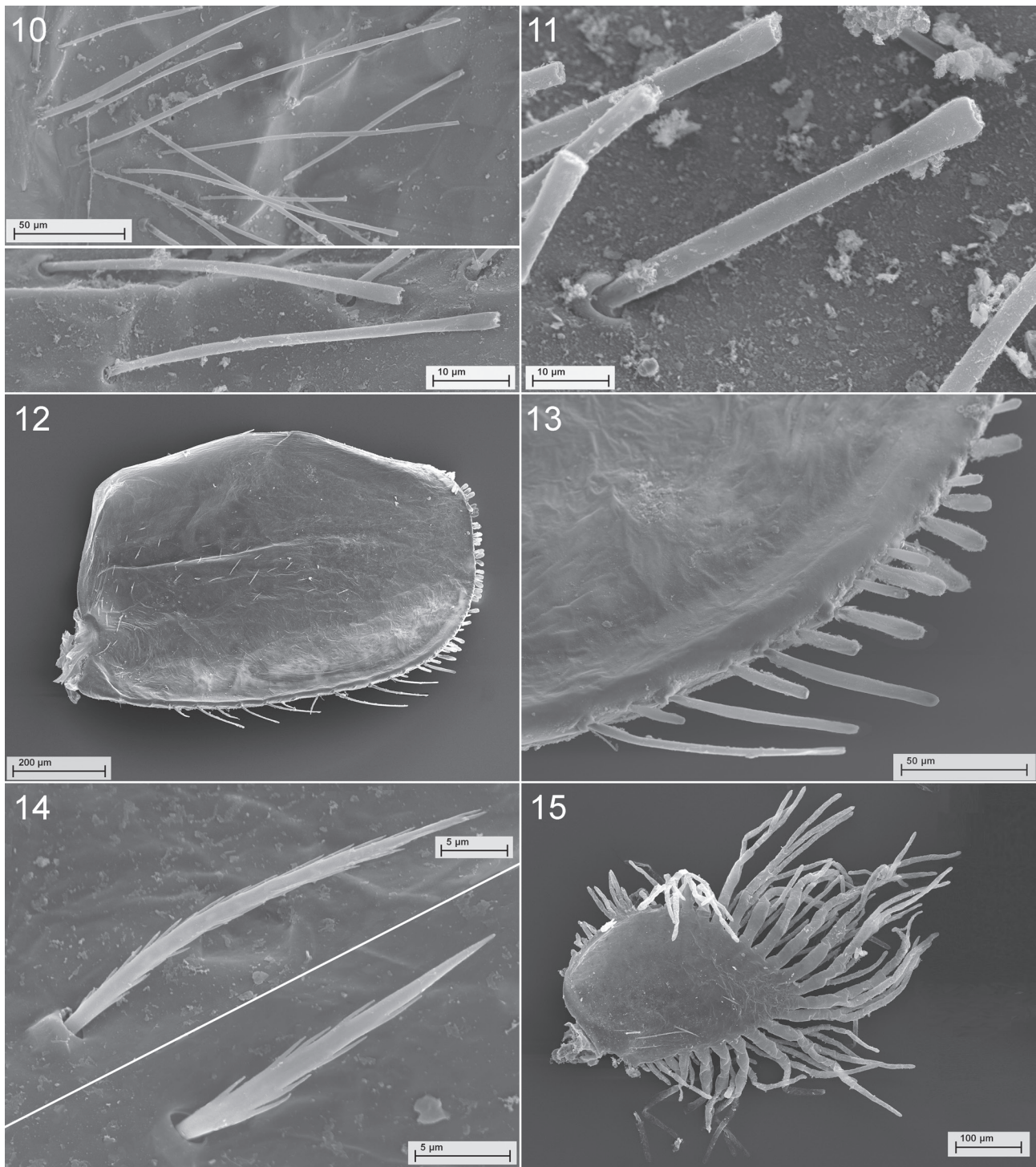
Thorax: Sides of pronotum smooth, strongly converging anteriorly (Fig. 1). Prosternum strongly protruding anteriorly, forming a triangular plate partly overlapping mouthparts; anterior part densely provided with very long arrow-like bristles (Figs 2a, 4). Forelegs highly modified and arranged similar to those in a praying mantis. (Fig. 2a) Tibia shortened (about half as long as femur), tarsus elongated and flattened, more or less sickle-shaped (Fig. 5). Foreclaw reduced in length, slightly bowed and without denticles (Fig. 6, right). Foremargin of femur and fore- and hind margin of tibia with long, modified setae with strongly domed, knob-like bases (Fig. 6, left). These bristles are pectinate with short, densely arranged microtrichia in a lengthwise row; additionally there are single, 2–3 times longer trichomes standing between 8–15 of shorter trichomes (Figs 5–7). Trochanter of foreleg also with very long, simple setae. Mid and hind leg marginally



Figure 3. *Mekongellina sangpradubae* n. gen, n. sp., larva. – Head in ventral view.



Figures 4–9. *Mekongellina sangpradubae* n. gen, n. sp., larva. – 4, prosternum, anterior protrusion. 5, forelegs. 6, foreclaw (right), foretarsus, apical part (left). 7, foreleg, details of combed bristles. 8, mid leg, ventral view. 9, mid claw (above), hind claw (below).



Figures 10–15. *Mekongellina sangpradubae* n. gen. n. sp., larva. – 10, bristles from mesothoracic sternum. 11, bristles from abdominal sternum. 12, operculate gill, ventral side. 13, operculate gill, posterolateral margin, ventral view. 14, operculate gill, bristles from ventral side. 15, gill III.

also provided with very long, simple bristles that are apically blunt, often with a slight depression (Fig. 8). Coxal processes of mid and hind leg inconspicuous. Mid and hind claws thin and straight, with two rows of small, often irregularly and blunt denticles; apically slightly bowed with doubled tip; mid claw a little longer as hind claw (Fig. 9).

Abdomen: Abdominal segments, which are not covered by the operculate gills, are elongated. Segments III-VI with moderate, posterolateral processes with few short or moderately blunt bristles at lateral margins; base of posterolateral processes slightly shifted medially and somewhat separated from the lateral margin of segments (Fig. 2d), basal parts covered by operculate gill so that only tips are visible in dorsal view (Fig. 1); process VI apically rounded and moderately curved medially, laying on dorsal surface of the segment (Figs 1, 2d). Segments I, II, and VII-IX without posterolateral processes. Tergum II without posteromedian process. Setation of abdomen see above under paragraph Cuticle. Sternum IX (Fig. 2e) with broadly rounded hind margin, medially slightly bulged, with a couple of moderate, relatively broad bristles, bristles on ventral surface arranged as in Fig. 2e. Operculate gill (Fig. 12) about one and a half times as long as wide (Fig. 1). Lateral margin with short or moderately thin bristles, hind margin with very short, oval bristles, posteriolateral corner with intermediate stages (Figs. 12, 13) Y-shaped ridges reduced or lacking. Row of microtrichia on ventral side lacking (Figs. 12, 13); basal and median area scattered with few very thin and slightly pinnate bristles (Figs. 12, 14). Gill I about one third as long as gill 2, with few short bristles. Gill III(-V) (Fig. 15) with short filaments, shorter than in most other Caenidae; most of them with 3 or 4 branches; gill corpus with a handful of thin bristles similar to those on ventral side of opercu-

late gill. Cerci relatively short, densely provided with long thin bristles, on lateral sides shorter bristles like those on ventral body side.

Egg

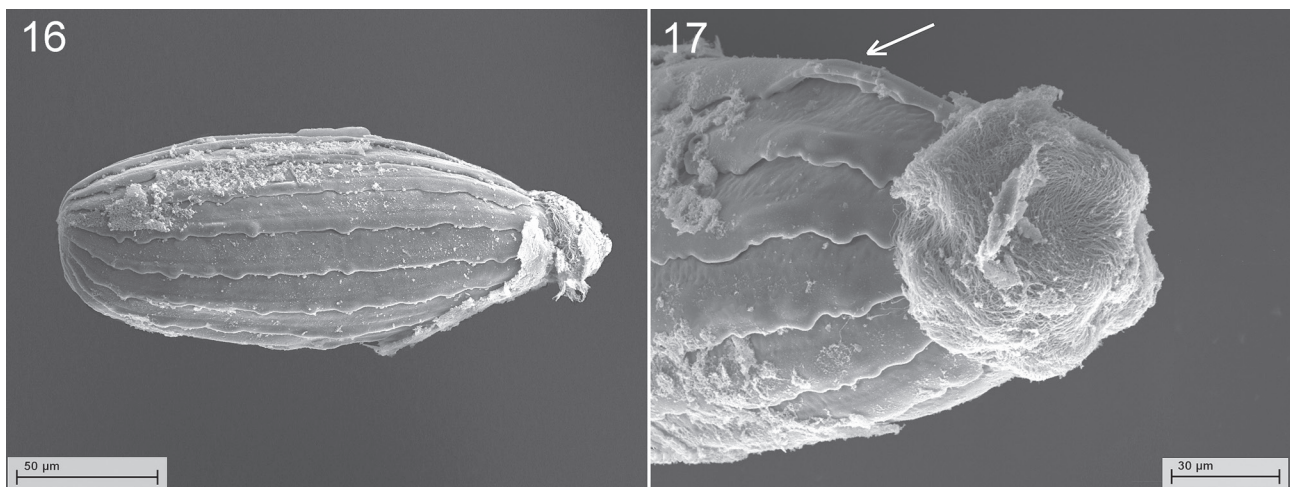
Elongated and elliptical, with single epithema (Fig. 16). Chorion with about 15 longitudinal, wavy-edged costae, each overlapping the base of the adjacent one. The cap-shaped epithema consists of innumerable very fine ravelled threads without any visible end knobs. A structure in the upper costa (Fig. 17, arrow) could be the mouth of a micropyle with associated small sperm-guide.

4 Discussion

The characters discussed below are listed in Table 1 and were used to assess the phylogenetic position within Caenidae as shown in Fig. 18. Synapomorphies of Caenoculini, Brachoculini and Madecocercini are here not charted. For these, compare MALZACHER & STANICZEK 2006 and MALZACHER & SANGPRADUB 2017.

From 5 synapomorphies of Caenidae (characters A-E in Table 1), *Mekongellina* shares two larval ones: Operculate gills medially overlapping (C) and second lamella of operculate gills without filaments (D). A third larval synapomorphy, operculate gill on ventral side with a row or band of submarginal microtrichia (E), is however not present. As imagines are yet unknown, the two male imaginal synapomorphies of Caenidae, styliiger shifted anteriorly and fused together with sternite IX (A), and one-segmented forcipes (B), cannot be verified.

Nevertheless, on the base of the above mentioned larval apomorphies, *Mekongellina* can be assigned to the



Figures 16–17. *Mekongellina sangpradubae* n. gen, n. sp., egg. – 16, total view. 17, epithema and micropyle (? arrow)

Caenidae, the more that in the *Cercobrachys*-group of Brachycercinae (Latineosini and Cercobrachini sensu Sun & McCafferty 2008) a tendency to reduction leads to a nearly total loss of microtrichia on the ventral side of the operculate gill, a development the end of which *Mekongellina* could represent.

The exact phylogenetic position of *Mekongellina* within the family is difficult to assess (compare Fig. 18). The fact that males are unknown makes an unequivocal assignment to one of the two subfamilies Caeninae or Brachycercinae impossible, as all known synapomorphies are based on male morphology. In Brachycercinae these are (1) forcipes with longitudinal grooves or ridges, and (2) genitalia with a functional unit of forceps, forceps muscle and lateral sclerite. In Caeninae, (3) the prosternum with ridges is forming a triangle or trapezoid, and (4) the metanotum has a transverse ridge.

(5) Ocelli with clearly developed tubercles are synapomorphic for Brachoculini + (Niandancini + Brachycercini) (with Brachycercini = Brachycercinae sensu SUN & MCCAFFERTY 2008 sine Caenoculini, see MALZACHER & SANGPRADUB 2017). Such tubercles are not present in Madecocercini or *Mekongellina*. Within Caenoculini, only slightly developed tubercles can be observed in *Caenoculis*; but not in *Tigrocercus*.

(6) Legs elongated and narrow, fore legs shortened. As forelegs in *Mekongellina* are highly modified to form a filtering basket (or filtering apparatus), this character is difficult to interpret in this regard. Mid and hindlegs however are elongated and particularly tibia and tarsus are slender (Fig. 8) with claws straight and nearly parallel-sided (Fig. 9). Some other derived characters, synapomorphic in Brachycercini, can also be found in *Mekongellina*:

Mekongellina shares the (7) two-segmented labial palp with Brachycercini.

A further striking synapomorphy of the tribe Brachycercini is (8) a gill basket formed by abdominal processes III-VI (VII) that are dorsally bent. An even more derived stage can be observed in the *Cercobrachys*-group, where the process of segment VI is bent medially. In *Mekongellina* these lateral processes are not bent dorsally, but their bases are slightly shifted medially, which could be interpreted as a first step in developing a gill basket. In Caeninae and Madecocercini, the bases of lateral processes are integrated in the lateral margin of abdominal segments. The medially bent and apically rounded process VI however has to be assessed as a more derived developmental stage of the gill basket in the *Cercobrachys*-group.

Moreover, (9) the presence of an egg chorion with longitudinal grooves or ridges is exclusively present in most Brachycercini (SUN & MCCAFFERTY 2008), and overlapping costae are characteristic for eggs in the *Cercobrachys*-group (Latineosini and Cercobrachini sensu SUN & MCCAFFERTY 2008). Eggs in Caenoculini and Made-

cocercini show also highly differentiated chorion structures, but each in different ways (MALZACHER & STANICZEK 2006, figs. 14a–f, 15b–d; MALZACHER & SANGPRADUB 2017, figs. 22–24). Together with the presence of a medially bent process VI, the peculiar egg structure would indicate a position within Brachycercini, close to the *Cercobrachys*-group (see also character 10). The lack of ventral

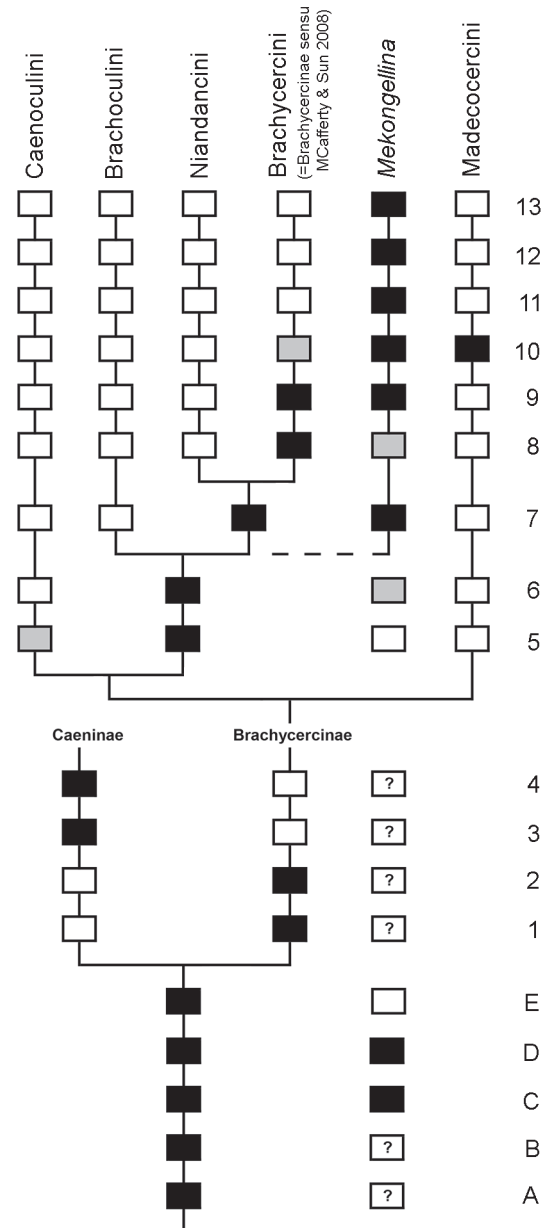


Figure 18. Phylogenetic argumentation scheme illustrating possible phylogenetic positions of *Mekongellina*. White square : plesiomorphic; grey square : intermediate apomorphic; black square : apomorphic character state. Autapomorphies of Caenoculini, Brachoculini, Niandancini, and Madecocercini are not included in the list of characters.

microtrichia on the operculate gill must be interpreted as final stage of a reductive tendency (see above), which would also support this phylogenetic placement.

It is very likely that the morphological modifications in the habitus of *Mekongellina* reflect a change of ecological niche. Larvae of Brachycercini in most cases are inhabitants of muddy substrates. The complex filtering apparatus in *Mekongellina* rather points to an ecological preference of lotic zones. Here, adaptations useful for a life in mud such as (5) ocellar tubercles or (8) a gill basket are no longer necessary and could have been reduced or not yet been developed at all. On the other hand, a (7) shortened foreleg is not helpful for filtering. All these characters different from those in Brachycercini are instead useful for a life in running waters.

However, all autapomorphies of *Mekongellina* reflect this functional change and are connected to the development of a filtering apparatus:

(10) Legs provided with very long bristles. This character can also be observed in some *Cercobrachys* species e. g. in *Cercobrachys pomeiok* and *C. winnebago* (SUN & McCAFFERTY 2008, figs 507, 536) and in Madecocercini (McCAFFERTY & WANG 2000, fig. 4; MALZACHER & STANICZEK 2006, fig. 3). However, within this tribe it is

the only similarity to *Mekongellina* and possibly a parallel development.

(11) Fore legs strongly modified, forming a filtering basket together with

(12) Prosternum protruding anteriorly, covering base of mouthparts, anteriorly provided with very long bristles.

(13) Glossae reduced, paraglossae laterally elongated, forming an enlarged flat structure with very long bristles. Other extremely enlarged flat paraglossae together with reduced glossae can be found in some families of Pannota, e.g. Machadorythidae and Tricorythidae (McCAFFERTY & WANG 2000, figs 79, 87, 94).

5 References

- GETWONGSA, P., HANJAVANIT, C. & SANGPRADUB, N. (2010): Impacts of agricultural land use on stream benthic macroinvertebrates in tributaries of the Mekong River, northeast Thailand. – *Advances in Environmental Sciences – International Journal of the Bioflux Society* 2 (2): 97–112.
- MALZACHER, P. & SANGPRADUB, N. (2017): Revision of the tribe Caenoculini, with description of two new species of *Caenoculis*, and an improved phylogeny of Brachycercinae and Madecocercinae (Insecta: Ephemeroptera: Caenidae). – *Stuttgarter Beiträge zur Naturkunde A, Neue Serie* 10: 1–17.

Table 1. Characters important in assessing the phylogenetic placement of *Mekongellina* (see also Fig. 18). (I) imago, (L) larva, (E) egg.

		Plesiomorphic / apomorphic character states
I	A	Stylicher separated from / fused with sternite IX
I	B	Forcipes at least with two segments / one-segmented
L	C	Operculate gills medially not / overlapping
L	D	Second lamella of operculate gills with / without filaments
L	E	Operculate gill, ventral side without / with submarginal microtrichia
I	1	Forcipes without / with longitudinal grooves or ridges, short and apically broadened or with transverse lamella
I	2	Forceps, forceps muscle and lateral sclerite not / forming a functional unit
I	3	Prosternum without / with ridges forming a triangle or trapezoid
I	4	Metanotum without / with transverse ridge
L	5	Ocelli without or with inconspicuous / with well-developed tubercles
L	6	Forelegs not shortened, legs (particularly femora) broad / forelegs shortened, legs slender
L	7	Labial palp three-segmented / two-segmented
L	8	Abdomen without / with gill basket formed by lateral abdominal spines III-VI (VII) bent dorsally
E	9	Egg, chorion not / with longitudinal grooves or ridges
L	10	Margins of all legs not / densely provided with very long bristles
L	11	Forelegs not / strongly modified
L	12	Prosternum not / protruding anteriorly
L	13	Glossa and paraglossa subequal in length and width / glossa reduced, paraglossa widened

- MALZACHER, P. & SANGPRADUB, N. (2020): *Caenis* species from Thailand and description of two new genera of the subfamily Caeninae (Ephemeroptera: Caenidae). – *Invertebrate Systematics* **3**: 1–33.
- MALZACHER, P. & STANICZEK, A. H. (2006): Revision of the Madecocercinae (Ephemeroptera Caenidae). – *Aquatic Insects* **28**: 165–193.
- MCCAFFERTY, W. P. & WANG, T.-Q. (2000): Phylogenetic Systematics of the major lineages of pannota mayflies (Ephemeroptera.: Pannota). – *Transactions of the American Entomological Society (Philadelphia)* **126**(1): 9–121.
- SOLDÁN, T. (1983): Two new species of *Clypeocaenis* (Ephemeroptera: Caenidae) with a description of adult stage and biology of the genus. – *Acta entomologica bohemoslovaca* **80**: 196–205.
- SOLDÁN, T. (1986): A revision of the Caenidae with ocellar tubercles in the nymphal stage (Ephemeroptera). – *Acta Universitatis Carolinae, Biologica* **1982–1984**: 289–362.
- SUN, L. & MCCAFFERTY, W. P. (2008): Cladistics, classification and identification of the brachycercine mayflies (Insecta: Ephemeroptera: Caenidae), *Zootaxa*, **1801**: 1–239.

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