

# Revision of the Oriental species of the genus *Caenis* Stephens (Insecta: Ephemeroptera: Caenidae)

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## Abstract

29 described species of *Caenis* Stephens, 1835 are known from the Oriental Region. In this contribution, eight of these species are revised, five of them are declared as ‘species inquirenda’. Seven new species of *Caenis* are described herein: *Caenis nigropunctatula* n. sp. (Sumatra, Java, Thailand), *C. ranauensis* n. sp. (Sumatra), *C. ulmeriana* n. sp. (Sumatra, Java, Thailand), *C. maratha* n. sp. (India), *C. guttata* n. sp. (Thailand), *C. gephyria* n. sp. (Thailand), and *C. incurva* n. sp. (India). A key is provided for 14 species that can be differentiated by modern diagnostic criteria.

**Key words:** *Caenis*, revision, new species, Oriental Region.

## Zusammenfassung

Aus der Orientalischen Region sind 29 beschriebene Arten von *Caenis* Stephens, 1835 bekannt. In diesem Beitrag werden acht davon revidiert und fünf als ‘species inquirenda’ eingestuft. Sieben neue Arten der Gattung *Caenis* werden beschrieben: *Caenis nigropunctatula* n. sp. (Sumatra, Java, Thailand), *C. ranauensis* n. sp. (Sumatra), *C. ulmeriana* n. sp. (Sumatra, Java, Thailand), *C. maratha* n. sp. (Indien), *C. guttata* n. sp. (Thailand), *C. gephyria* n. sp. (Thailand) und *C. incurva* n. sp. (Indien). Für 14 Arten, die nach modernen diagnostischen Kriterien unterschieden werden können, wird ein Bestimmungsschlüssel erstellt.

## Contents

1	Introduction .....	27
2	Material and methods .....	28
3	Systematic account .....	28
4	Key to males of Oriental <i>Caenis</i> .....	45
5	Conclusions .....	46
6	References .....	46

## 1 Introduction

The following described species of *Caenis* are known from the Oriental Region: *Caenis perpusilla* Walker, 1853, *C. nigropunctata* Klapálek, 1905, *C. annulata* Navás, 1923, *C. pumila* Navás, 1923, *C. philippinensis* Ulmer, 1924, *C. nigrostriata* Navás, 1932, *C. srinagari* Traver, 1939, *C. picea* Kimmins, 1947, *C. piscina* Kimmins, 1947, *C. demoulini* van Bruggen, 1954, *C. dangi* Soldán, 1986, *C. kimminsis* Ali, 1967, *C. argillosa* Kang & Yang, 1994, *C. bella* Kang & Yang, 1994, *C. corniga* Kang & Yang, 1994, *C. corpulenta* Kang & Yang, 1994, *C. granifera* Kang & Yang, 1994, *C. montana* Kang & Yang, 1994, *C. nitida* Kang & Yang, 1994, *C. yangi* Kang & Yang, 1996, *C. aspera* Tong & Dudgeon, 2002, *C. bicornis* Tong & Dudgeon, 2002, *C. lubrica* Tong & Dudgeon, 2002, *C. pycnacantha* Jia, Qin, Ju & Zhou, 2010, *C. abdita* Malzacher, 2013, *C. bidigitata* Malzacher, 2013, *C. fregatula* Malzacher, 2013, *C. sebastiani* Malzacher, 2013, and *C. unidigitata* Malzacher, 2013.

The descriptions of nearly all Oriental *Caenis* species published during the 20<sup>th</sup> century are insufficient and

useless for an exact determination. Nonetheless a lot of records from this period were earlier determined as *C. perpusilla* and *C. nigropunctata*. At present it seems to be impossible to clarify at least some of these records.

The present paper gives an overview of the Oriental *Caenis* species that can be described (or redescribed) by providing modern diagnostic characters. Types and/or other material were available to me from the following species: *Caenis perpusilla*, *C. nigropunctata*, *C. philippinensis*, *C. annulata*, *C. pumila*, *C. nigrostriata*, *C. picea*, and *C. piscina*. These taxa are revised in the present paper and their taxonomic status is clarified. Additionally the following seven new species are described: *Caenis nigropunctatula* n. sp., *C. ranauensis* n. sp., *C. ulmeriana* n. sp., *C. maratha* n. sp., *C. guttata* n. sp., *C. gephyria* n. sp., and *C. incurva* n. sp.

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(Lunz), MICHEL SARTORI (Lausanne), OLAGUER ESCOLÁ (Barcelona) and BENJAMIN PRICE (London) for material and the loan of type specimens. Thanks are extended to SUSANNE LEIDENROTH (Staatliches Museum für Naturkunde Stuttgart) for taking SEMs and CARLOS MONJE (Staatliches Museum für Naturkunde Stuttgart) for his efforts in genetic barcoding. ARNOLD STANICZEK (Stuttgart) and MICHEL SARTORI (Lausanne) kindly read the manuscript and provided valuable suggestions.

## 2 Material and methods

The initial impetus for this paper was the examination of the large *Caenis* collection in the Zoologisches Museum, Hamburg that not only contains the types of *C. nigropunctata*, but also additional material of *Caenis* from the ULMER collection, all identified as *C. nigropunctata* by ULMER. Additionally, I could study samples of Oriental *Caenis* located in my own collection and material I recently received from the Musée Cantonal de Zoologie, Lausanne. Also available were some types of species described by LONGINOS NAVÁS, deposited in the Museo de Zoología de Ayuntamiento, Barcelona, and types of *C. perpusilla*, *C. picea* and *C. piscina* from the Natural History Museum, London.

The types of the herein described species *Caenis nigropunctatula* n. sp., *C. ranauensis* n. sp., and *C. ulmeriana* n. sp. are deposited in the Zoologisches Museum, Hamburg, of *C. guttata* n. sp. and *C. gephyria* n. sp. in the Musée Cantonal de Zoologie, Lausanne and of *C. maratha* n. sp. and *C. incurva* n. sp. in the Natural History Museum, London. A few paratypes of the first three species are also preserved in the author's collection.

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 EVOLS 15 scanning electron microscope. Digital photographs were enhanced by using Photofiltre 6.5.2 (<http://www.photofiltre-studio.com>).

The attempt to clarify the taxonomic status of *C. nigropunctata* by extracting and identifying its COI sequence out of dried historical type material unfortunately yielded no results, probably due to DNA degradation over the ages.

## 3 Systematic account

### *Caenis nigropunctata* Klapálek, 1905

KLAPÁLEK (1905: 104); ULMER (1924: 46); ULMER (1939: 520, 635).

#### Material examined

Syntypes: 20 ♀♀, Java, Buitenzorg, 24.II.–12.III.1904, K. KRAEPELIN leg.

All type specimens of *Caenis nigropunctata* described by Klapálek (1905) are females in dried condition. An identification on the base of modern differential-diagnostic features is therefore impossible.

The redescription of *Caenis nigropunctata* by ULMER (1939) is based on an extensive material mainly collected in the year 1929. The investigation of this material revealed that it contains three *Caenis* species that are described below. As the attempt to identify one of these species as *C.*

*nigropunctata* by COI comparison was not successful, *C. nigropunctata* is declared as 'species inquirenda'.

### *Caenis nigropunctatula* n. sp.

(Figs. 1a–l, 2a–e, 4l, 8–15)

Holotype ♂ (on microslide): R26, Sumatra, Ranau, 28.I.1929, A. THIENEMANN leg.

Paratypes: same data as holotype, 56 ♂♂, 26 ♀♀.

Other material: R18a, Sumatra, Ranau, 28.I.1929, A. THIENEMANN leg., 20 larvae. – R4c, Sumatra, Ranau, 21.I.1929, A. THIENEMANN leg., 2 larvae. – Sumatra, Balige, lake Toba, 3.IV.1929, A. THIENEMANN leg., 25 ♂♂. – FT15, Sumatra, Pangururan, lake Toba, 12.IV.1929, 1 ♂. – F32a, Sumatra, Fort de Kock, 13.III.1929, several ♂♂. – Sumatra, Kalung (Kamang), XII.1913, several ♂♂. – Java, Buitenzorg (Bogor), 13.III.1921, 11 ♂♂. – Thailand, Ayutthaya, 100°34'E, 14°25'N, 3.IV.1989, H. MALICKY leg., 11 ♂♂, 4 ♀♀. – Thailand, Nan, 24.–26.XI.2001, R. GRIMM leg., 22 ♂♂.

#### Etymology

As most of the specimens of the ULMER material (originally attributed to *C. nigropunctata*) belong to this species and because the name *C. nigropunctata* is widely distributed in literature, I chose the only slightly changed species epithet *C. nigropunctatula*.

#### Description

##### Male imago

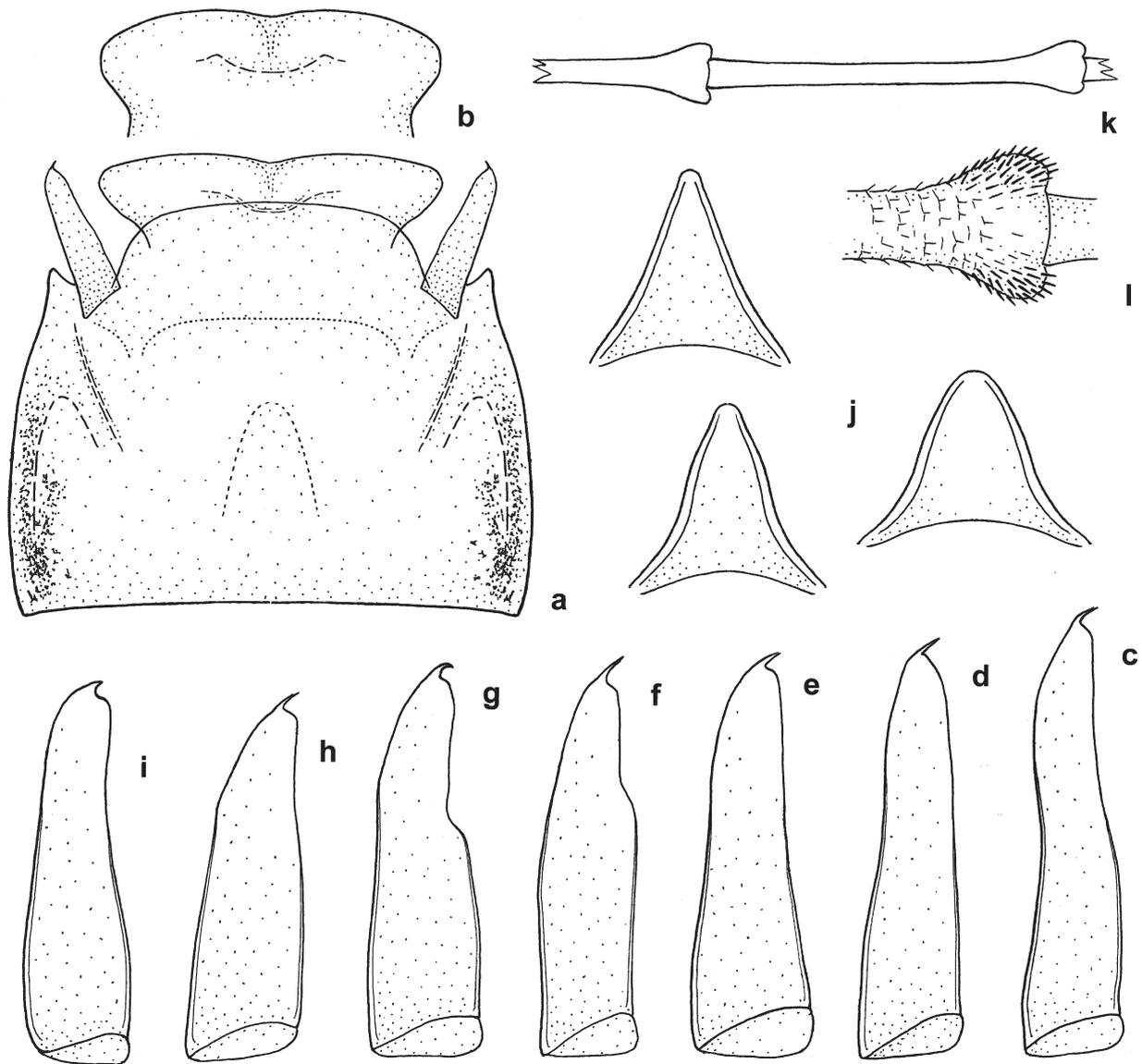
##### Measurements, ratios and colouration

Body length: 2.6–3.3 mm; wing length: 2.2–2.5 mm; length of fore leg: 2.1–2.6 mm. Head ratios (see Fig. 4k): c : a = 2.4–2.8, a : b = 0.9–1.1; ratio of fore femur : fore tibia = 0.52–0.64; ratio of fore tibia : fore tarsus = 1.15–1.26 (Buitenzorg), 1.29–1.34 (Ranau), 1.13–1.35 (Thailand); ratio of fore leg : hind leg = 1.73–1.85 (Buitenzorg), 1.83–1.90 (Ranau), 1.46–1.69 (Thailand); ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 3.9–4.6 (Buitenzorg), 2.9–3.8 (Ranau, Thailand) : 2.0–2.8 (Buitenzorg, Ranau), 1.7–2.0 (Thailand) : 1.7–2.2 (Buitenzorg, Ranau), 1.5–1.8 (Thailand) : 1.5–1.7 (Buitenzorg), 1.1–1.4 (Ranau, Thailand); ratio of body length : length of cercus : length of terminal filament = 1 : 2.5–2.7 : 3.5–3.8; ratio terminal filum : cercus = 1.3–1.4.

Colouration and pigmentation of the ULMER material is not preserved. The Thailand material is coloured as follows:

Colouration of cuticle: Thorax brownish; other parts yellowish to white.

Epidermal pigmentation: Vertex with two more or less intense grey transverse bands. Pronotum laterally shaded, with two paramedian black spots. Sutures of mesonotum more or less greyish. Abdominal terga I–II with lateral spots, III–VI (VII) with relatively narrow transverse



**Fig. 1.** *Caenis nigropunctatula* n. sp., ♂. – a, b. Genitalia. c–i. Different shape of forcipes. j. Prosternal triangle. k. Tarsomeres 2 and 3 of fore tarsus. l. Fore tarsus, detail: apical end of tarsomere 2.

bands, (VII) VIII–X diffusely shaded or white. Blackish paratergal spots. Coxae often with grey spots and surrounding dashes. Base of mouthparts and lateral parts of ventral head greyish. Femora with intense preapical dashes.

#### Morphology

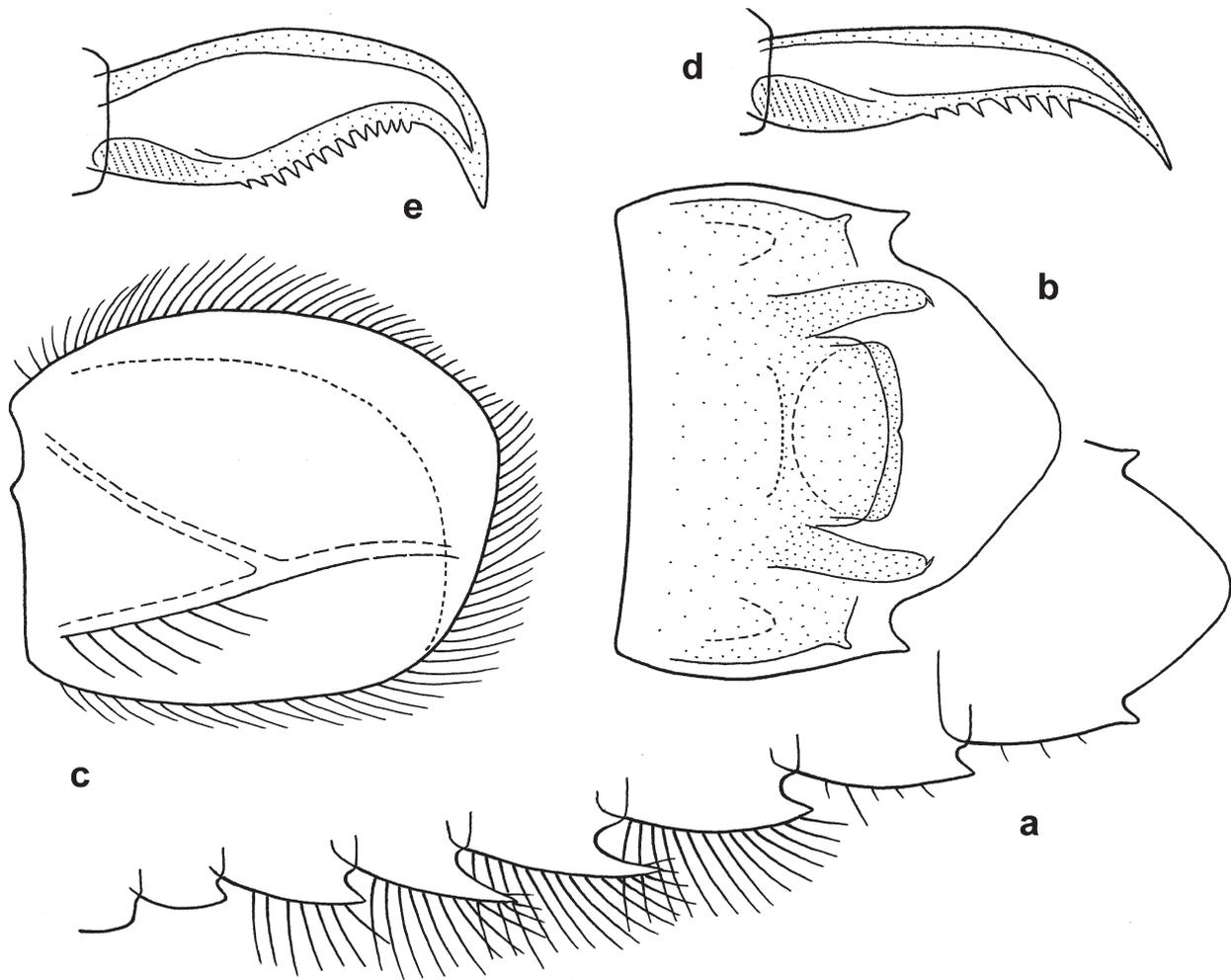
**Head** (Fig. 4l): Fore margin between lateral and frontal ocelli straight. Eyes and lateral ocelli large. Distance between inner margins of lateral ocelli relatively short. Base of antennal flagellum not dilated.

**Thorax:** Prosternal ridges strong, forming an isosceles triangle, sides more or less S-shaped; without trans-

verse strip (Fig. 1j). Tarsomeres 2–4 of fore tarsus apically broadened (Fig. 1k); broadenings equipped with small strong spines (Fig. 1l).

**Abdomen:** Lateral filaments of abdominal segments short or (Thailand specimens) moderate. Without finger-like process on tergum II.

**Genitalia and sternum IX** as in Figs. 1a, b. Penis broad, with rounded lobes of moderate length, hind margin sometimes with a more or less pronounced medial incision. Styliger sclerite broad with short apophyses. Forcipes relatively short, slightly narrowed to the tip, with a short spine, more or less bent medially, sometimes 2–3 spines which are nearly totally fused together (Figs. 1c–i).



**Fig. 2.** *Caenis nigropunctatula* n. sp., larva. – a. Outline of abdomen with marginal setation. b. Sternum IX, ♂, with subimaginal genitalia. c. Operculate gill, general view. d. Claw of fore leg. e. Claw of hind leg.

### Female imago

#### Measurements and colouration

Body length: 4.5–5.2 mm; wing length: 2.7–3.8 mm.

Colouration and pigmentation similar to the males, bands on abdominal terga a little broader and stronger.

Morphology not different from males.

### Egg

Chorion finely pored. Micropyle very short, triangular, about as long as diameter of sperm-guide (Fig. 8). Two flat epithemata of coiled-rope-type (Figs. 8–11). Epithemata of a modified *C. perpusilla* subtype (compare MALZACHER 2011: figs. 13, 34, 35 and MALZACHER 2013: figs. 18–20), with 6–8 threads emerging from the poles (Figs. 9, 10,

11). Threads are forming loops by turning about (Figs. 9, 10). About 5 terminal knobs give end to about 3–7 threads (Fig. 9).

This subtype of epithemata was described for the first time by SMITH 1935 (fig. 34) for the eggs of *Caenis perpusilla*. In the present paper this species is regarded as ‘species inquirenda’ (see below). Nevertheless I will maintain the name for the described epithema subtype.

### Larva

The assignment to the males is based on a larva with visible subimaginal genitalia, showing short forcipes with a small apical spine. The herein described larva is not identical with any of the larvae described by KANG & YANG (1994) from Taiwan, the imagines of which are unknown.

#### Measurements and colouration

Male larva, last instar body length 3.5 mm, length of cerci 2.5 mm; female larva of last instar, body length 5.0 mm, length of cerci 3.5 mm.

Colouration and pigmentation of the ULMER material is not preserved.

#### Morphology

Cuticle smooth, with numerous, very different bristles or microtrichia: bifurcated with two or more branches on margins of femora (Fig. 13), tongue-shaped on dorsal side of femora and on abdominal terga VIII–X (Fig. 12), and shield-shaped on head, pro- and mesonotum and operculate gills (Fig. 14). There are also intermediate stages between these forms.

Head: Genae not bulging out. Pedicle with about 10 strong bristles. Labrum with broadly rounded corners and a shallow indentation. Mandibles with a group of long, bent setae on lateral margin. Second segment of labial palp about as long as the third (along the centre-line); outer margin with about 6–8 very long bristles. Sides of postmentum posteriorly diverging.

Thorax: Sides of pronotum straight or slightly concave, more or less diverging anteriorly. Coxal processes inconspicuous, forming small ridges. There is no transverse row of bristles on dorsal side of fore femur, only an irregular longitudinal row of a few bristles, sometimes even only one or two bristles present. Fore tarsus ventrally with an irregular row of pinnate bristles, often simple at the base of the row. Mid and hind tarsus ventrally with two irregular rows or a band of numerous pinnate bristles. Ventral sides of all tibiae also covered with a great number of those pinnate bristles. Claws with a row of strong denticles, fore claw relatively slender (Fig. 2d), mid and hind claws broad and stocky, with strongly bent apical third; hind claw with homodont dentition (Fig. 2e).

Abdomen: Abdominal segments with posterolateral processes of different length; segments V and VI long, VII–IX shorter and broader. Segments IV–VII with long, bent bristles, segments VIII and IX only with a few short ones. Sides of segment IX often slightly S-shaped (Fig. 2a). Posteriomedian process of tergum II short, broadly triangular with rounded tip. Hind margins of terga VII and VIII with long bristles, of terga IX and X with denticles. Hind margin of sternum IX posteriorly protruding, forming a triangular plate with rounded tip (Figs. 2a, b); dorsal side without shagreen. Margins of operculate gills densely provided with long, often frayed bristles, a few short bifurcate ones on posterolateral corner. Y-shaped ridges well developed, median ridge slightly keeled, its basal half with 6–8 bristles similar to that from lateral margin. Ventral row of microtrichia and lateral margin posteriorly diverging, reaching posterior-median corner of gill (Fig. 2c). Microtrichia very elongated (Fig. 15), shorter on the ends of the

row (Fig. 15, small frame). A couple of spatulate pinnate bristles basally on ventral side. Gill I two-thirds as long as gill II, with only a few, relatively short bristles.

#### Differential diagnosis

*Caenis nigropunctatula* can be distinguished from all other *Caenis* species by the following combination of characters: Male imago: Forcipes slightly narrowed to the tip, with a short spine, more or less bent medially, sometimes 2–3 spines which are nearly totally fused together. Tarsomeres 2–4 of fore tarsus apically broadened; broadenings with small strong spines, not tongue-shaped. Ratio of fore femur : fore tibia = more than 0.46. Ratio of fore leg : hind leg = less than 1.90. Penis broad, with rounded lobes of moderate length. Styli sclerite with short apophyses.

Larva: Second segment of labial palp about as long as the third. Sides of pronotum straight or slightly concave, more or less converging anteriorly. Bristles on fore femur in a longitudinal row or band, no transverse row. Tarsi and tibiae ventrally with a great number of long, pinnate bristles. Abdominal segments IV–VII laterally with long bristles, other segments with a few very short and thin bristles or without any bristles. Hind margin of sternum IX posteriorly protruding, forming a triangular plate with rounded tip. Ventral row of microtrichia and lateral margin posteriorly diverging, the row reaching the posteromedian corner.

#### Remarks

*Caenis nigropunctatula* seems to be a species with characters broadly varying in different populations and geographical races, such as length ratios of fore femur to fore tibia and fore leg to hind leg. The male genitalia, however, are very similar. Therefore it is not possible to divide the complex into different species by morphological characters.

#### *Caenis ranauensis* n. sp.

(Figs. 3a–k)

**Holotype** ♂ (on microslide): R9, Sumatra, lake Ranau, southern shore, 23.I.1929, A. THIENEMANN leg.

**Paratypes**: same data as holotype, several hundred ♂♂.

**Other material**: FZ, Bali, Munduk, 12.VI.1929, H. J. FEUERBORN leg., 1 ♂.

#### Etymology

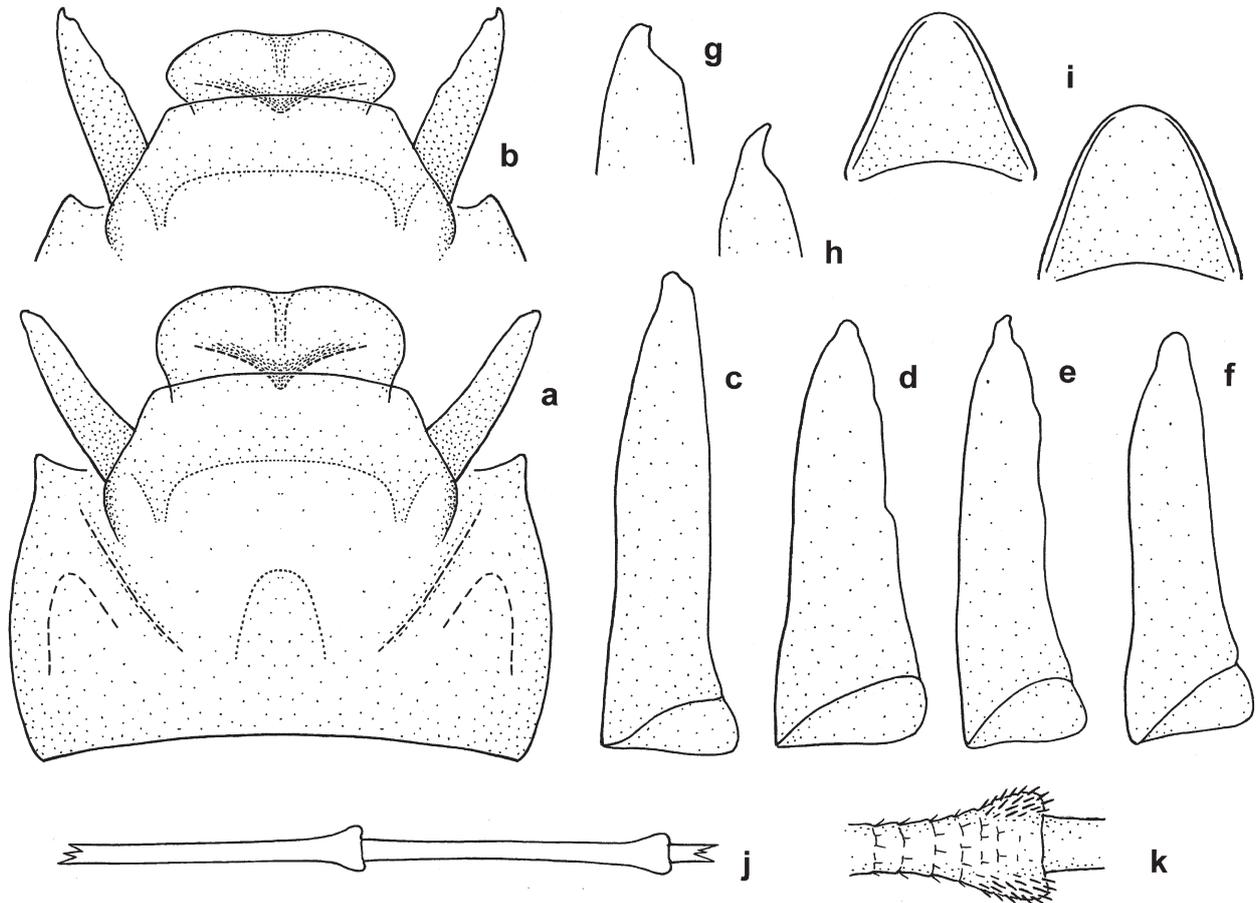
The name refers to lake Ranau. Its southern shore is the locus typicus of the new species.

#### Description

##### Male imago

##### Measurements, ratios and colouration

Body length: 2.7–3.0 mm; wing length: 2.0–2.3 mm; length of fore leg: 2.3–2.5 mm. Head ratios (see Fig. 4k):



**Fig. 3.** *Caenis ranauensis* n. sp., ♂. – a, b. Genitalia. c–h. Different shape of forcipes. i. Prosternal triangle. j. Tarsomeres 2 and 3 of fore tarsus. k. Fore tarsus, detail: apical end of tarsomere 2.

c : a = 1.8–2.0, a : b = 1.4–1.5; ratio of fore femur : fore tibia = 0.46–0.50; ratio of fore tibia : fore tarsus = 1.27–1.33; ratio of fore leg : hind leg = 2.03–2.15; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 3.7–4.4 : 1.8–2.5 : 1.3–1.7 : 1.3–1.4; ratio of body length : length of cercus : length of terminal filament = 1 : 3.3–3.4 : 3.7–4.1; ratio terminal filum : cercus = 1.2.

Colouration and pigmentation is not preserved.

#### Morphology

**Head:** Fore margin between lateral and frontal ocelli slightly bowed. Eyes and lateral ocelli clearly smaller as in *C. nigropunctatula*. Distance between inner margins of lateral ocelli relatively long. Base of antennal flagellum not dilated.

**Thorax:** Prosternal triangle broad, with slightly convex sides and broadly rounded tip. Without transverse strip (Fig. 3i). Tarsomeres 2–4 of fore tarsus apically broadened; broadenings equipped with small strong spines (Figs. 3j, k).

**Abdomen:** Lateral filaments of abdominal segments short. Without finger-like process on tergum II.

**Genitalia and sternum IX** as in Figs. 3a, b. Penis not as broad as in *C. nigropunctatula*, lobes short or very short broadly rounded, posteroventrally with a broadly V-shaped, brownish sclerite. Styliger sclerite broad, with moderate apophyses. Shape of forcipes variable, more or less narrowed to the tip, apex rounded, often with short bumps or projections of different shape (Figs. 3c–h).

Female imago and larva unknown.

#### Differential diagnosis

*Caenis ranauensis* can be distinguished from all other *Caenis* species by the following combination of characters:

**Male imago:** Forcipes slightly narrowed to the tip; apex rounded, often with short projections of different shape. Tarsomeres 2–4 of fore tarsus apically broadened; broadenings with small strong spines, not tongue-shaped. Ratio

of fore femur : fore tibia = less than 0.50. Ratio of fore leg : hind leg = more than 2.03. Penis posteroventrally with a broadly V-shaped brownish sclerite. Styli ger sclerite broad, with moderate apophyses.

*Caenis ulmeriana* n. sp.  
(Figs. 4a–k)

**Holotype** ♂ (on microslide): R26, Sumatra, Ranau, 28.I.1929, A. THIENEMANN leg.

**Paratypes**: same data as holotype, 65 ♂♂, 7 ♀♀.

**Other material**: Sumatra, Singkarak, II.1929, 2 ♂♂. – Java, Klakah, XI.1928, 10 ♂♂. – Thailand, riv. Ping, Lamphun, 22.XII.1989, H. MALICKY leg., 10 ♂♂. – Thailand, riv. Thanlwin Myit, Mae Hong Son, 18.XI.1998, R. GRIMM leg., 2 ♂♂. – Thai-

land, riv. Kwai, 5.II.2006, coll. J.-M. ELOUARD, 23 ♂♂. – Sumatra, Barat, Ombilin, outlet of Singkarak Lake, 100°34'38"E, 0°32'59"S, 26.V.2010, coll. J.-M. ELOUARD, 1 ♂.

**Etymology**

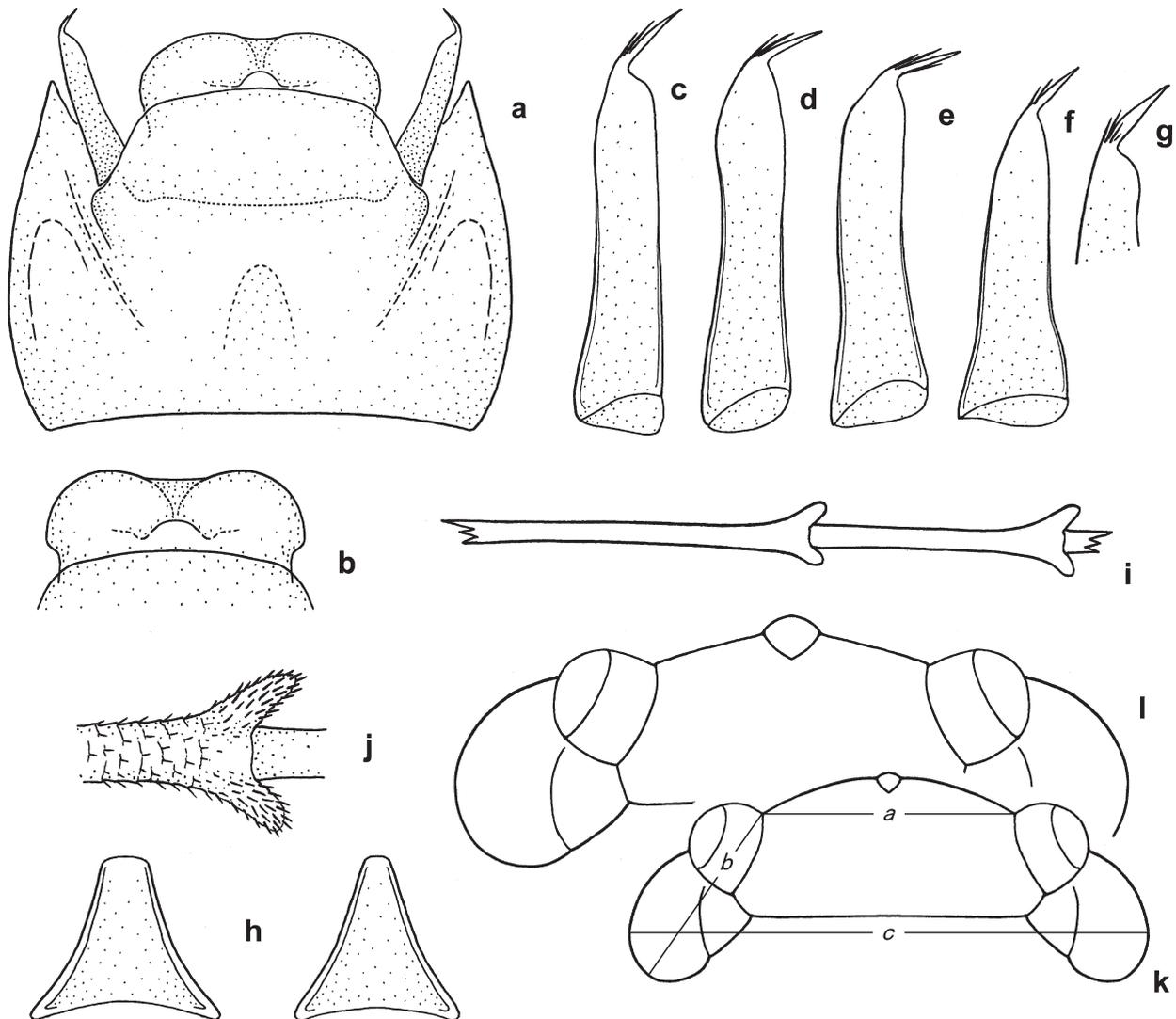
The species is named in honour of GEORG ULMER (Hamburg), the famous German entomologist, who redescribed *Caenis nigropunctata* in 1939.

**Description**

**Male imago**

**Measurements, ratios and colouration**

Body length: 2.4–2.6 mm; wing length: 1.9–2.2 mm; length of fore leg: 1.9–2.1 mm. Head ratios (see Fig. 4k):



**Fig. 4.** *Caenis ulmeriana* n. sp., ♂ (a–k) and *C. nigropunctatula* n. sp., ♂ (l). – a, b. Genitalia. c–g. Different shape of forcipis. h. Prosternal triangle. i. Tarsomeres 2 and 3 of fore tarsus. j. Fore tarsus, detail: apical end of tarsomere 2. k, l. Head, dorsal view.

c : a = 1.9–2.1, a : b = 1.3–1.5 (in the Thailand specimens from river Kwai, but not in that from river Ping, the head proportions are closer to those of *C. nigropunctatula*); ratio of fore femur : fore tibia = 0.36–0.45; ratio of fore tibia : fore tarsus = 1.35–1.53; ratio of fore leg : hind leg = 2.10–2.35; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 4.3–5.2 : 2.5–3.2 : 1.5–1.9 : 0.9–1.2; ratio of body length : length of cercus : length of terminal filament = 1 : 2.6 : 4.2; ratio terminal filum : cercus = 1.5–1.6.

Colouration and pigmentation of the ULMER material is not preserved. The Thailand material and the specimen from Sumatra is coloured as follows:

Colouration of cuticle: Thorax light yellowish-brown; other parts white.

Epidermal pigmentation: Frons blackish or grey. Vertex with two more or less intense blackish transverse bands, the posterior one often divided into two spots or dashes. Pronotum with a transverse black line and two paramedian spots. Sutures of mesonotum more or less blackish. Scutellum strongly pigmented. Metanotum and thoracic tergites I and II often with transverse bands or dashes. Pleura with black spots and dashes, particularly on ventral part and on prealar bridges. Abdominal terga I–VI (IX) with sublateral spots more or less extended medially, occasionally forming transverse bands.

#### Morphology

Head (Fig. 4k): Fore margin between lateral and frontal ocelli slightly bowed. Eyes and lateral ocelli clearly smaller as in *C. nigropunctatula*. Distance between inner margins of lateral ocelli relatively long. Base of antennal flagellum not dilated.

Thorax: Prosternal triangle with concave sides, tip more or less broadly rounded (Fig. 4h), without transverse strip. Tarsomeres 2–4 of fore tarsus apically with tongue-shaped projections, provided with short strong spines (Figs. 4i, j). Segment V extremely short (in specimens from the river Ping, tongue-shaped projections are a little shorter).

Abdomen: Lateral filaments of abdominal segments short. Without finger-like process on tergum II.

Genitalia and sternum IX as in Figs. 4a, b. Penis not as broad as in *C. nigropunctatula*, lobes very broadly rounded, hind margin of each half convex. Penis medio-laterally with a tongue-shaped process. Styliger sclerite broad without (Indonesia) or only with very short apophyses (Thailand). Forcipes with more or less parallel sides and a long tuft of spines, consisting of one strong spine and a few thin ones, more or less fused (Fig. 4c–e). Forcipes of males from Thailand are shorter and basally broadened (Fig. 4f), in the specimens from river Ping the strong spine is very voluminous (Fig. 4g).

#### Female imago

Besides the male paratypes also seven females were designated as paratypes, but these cannot be assigned to the males with certainty.

Larva unknown.

#### Differential diagnosis

*Caenis ulmeriana* can be distinguished from all other *Caenis* species by the following combination of characters: Male imago: Forcipes relatively short, straight, with an apical tuft of one strong spine and 3–4 thin spines, sometimes more or less fused together. Tarsomeres 2–4 of fore tarsus apically with tongue-shaped projections, provided with short, strong spines, segment 5 extremely short. Ratio of fore femur : fore tibia = less than 0.45. Ratio of fore leg : hind leg = more than 2.10. Penis medio-laterally with a tongue-shaped process. Penis lobes very broadly rounded, hind margin of each penis half convex. Styliger sclerite without or with only very short apophyses. On the morphological differences to *C. nigropunctatula* and *C. ranauensis* see Tab. 1.

#### Remarks

*Caenis ulmeriana* is distributed from Thailand to Java. Some characters are variable and more or less different between continental and island populations.

**Tab. 1.** Comparison of characters of three species of *Caenis*.

	<i>C. nigropunctatula</i>	<i>C. ulmeriana</i>	<i>C. ranauensis</i>
ratio fore femur : fore tibia	0.52–0.64	0.36–0.45	0.46–0.50
ratio fore leg : hind leg	1.46–1.90	2.10–2.35	2.03–2.15
head, fore margin	straight	bowed	bowed
fore tarsus segment 2–4, apex	broadened	with long processes	slightly broadened
penis, tongue-shaped process	no	yes	no
penis, V-shaped sclerite	no	no	yes
apophyses styliger sclerite	short	very short or lacking	moderate
forceps, apically	one strong spine	tuft of long spines	rounded, tip variable

*Caenis maratha* n. sp.

(Figs. 5a, b)

Holotype ♂ (on microslide): India, Poona, Maharashtra, 4.IX.1945, M. T. GILLIES leg.

Paratypes: same data as holotype, 2 ♂♂.

## Etymology

The species epithet is a noun in apposition and refers to the Indian people Maratha, predominantly living in the Indian state of Maharashtra.

## Description

## Male imago

## Measurements, ratios and colouration

Body length: 2.2–2.5 mm; wing length: 2.0–2.3 mm; length of fore leg: 2.1–2.4 mm. Ratio of fore femur : fore

tibia = 0.49–0.51; ratio of fore tibia : fore tarsus = 1.46–1.58; ratio of fore leg : hind leg = 1.85–1.95; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 4.2–4.6 : 3.0–3.3 : 2.1–2.3 : 1.3–1.5.

Colouration and pigmentation is not preserved.

## Morphology

Head: Base of antennal flagellum not dilated.

Thorax: Prosternal triangle elongated with concave sides, tip more or less rounded, without transverse strip. Tarsomeres 2–4 of fore tarsus apically broadened; broad-ening equipped with small strong spines.

Abdomen: Lateral filaments of abdominal segments short. Without finger-like process on tergum II.

Genitalia and sternum IX as in Fig. 5a. Penis narrow, more or less semicircular, without bulging lobes; ventral

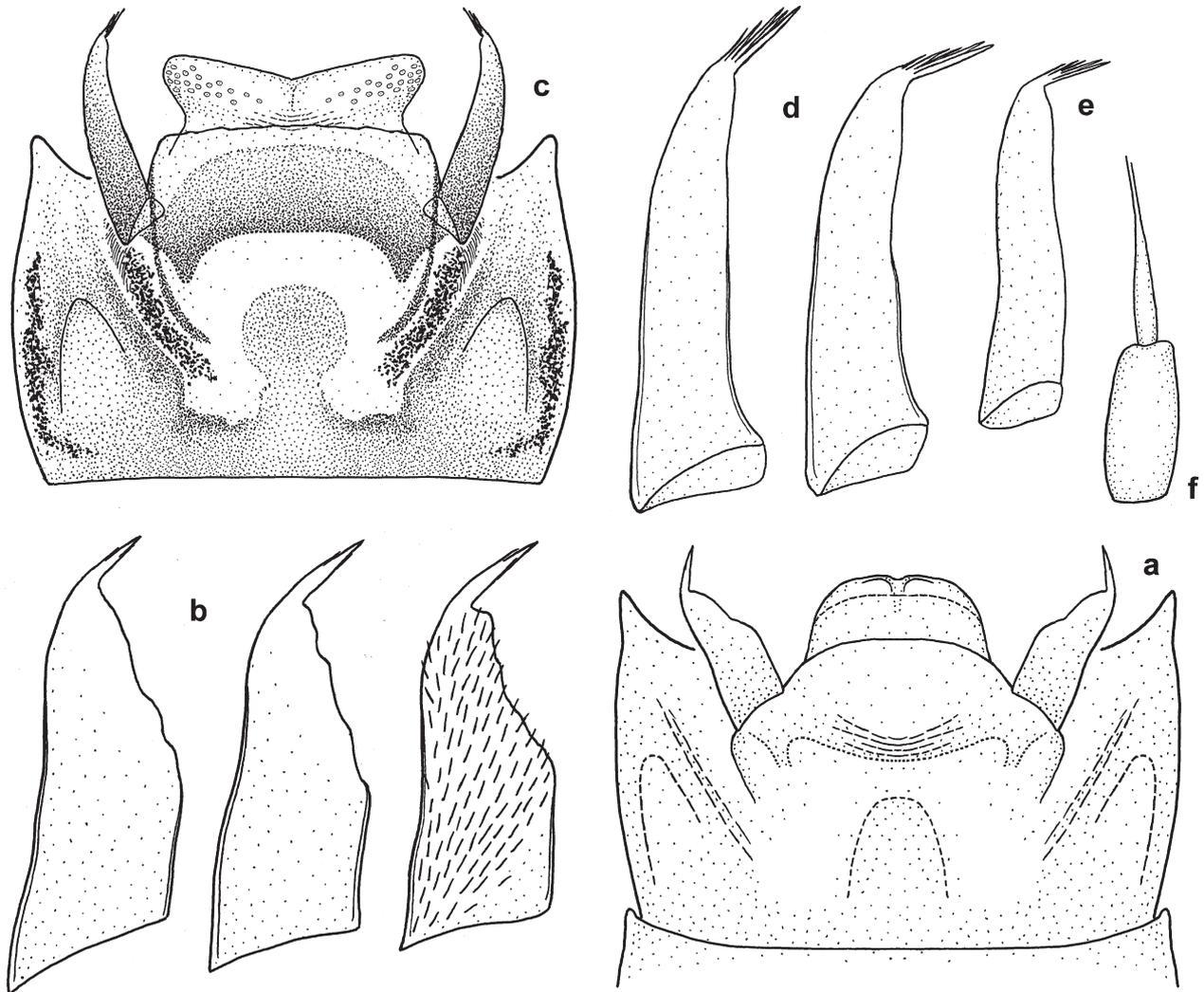


Fig. 5. *Caenis maratha* n. sp., ♂ (a–b), *C. annulata* ♂ (c–d) and *C. philippinensis*, ♂ (e–f). – a, c. Genitalia. b, d, e. Forcipes. f. Antennal pedicle and base of flagellum.

side covered with a fine lamella. Styliiger sclerite narrow, elliptical, and with short apophyses. Basal half of forcipes very broad, apical part abruptly narrowed to the tip, with a long and strong apical spine, and a few thin bristles, often hardly visible (Fig. 5b).

Female imago and larva unknown.

#### Differential diagnosis

*Caenis maratha* n. sp. can be distinguished from all other *Caenis* species by the following combination of characters: Tarsomeres 2–4 of fore tarsus apically broadened; broadenings equipped with spines. Penis narrow, without bulging lobes, ventral side with a fine lamella. Styliiger sclerite elliptical. Basal half of forcipes very broad, apical part abruptly narrowed, apically with a long spine.

#### *Caenis guttata* n. sp. (Figs. 6a–c)

**Holotype** ♂ (on microslide): Thailand, riv. Kwai, 5.II.2006, J.-M. ELOUARD leg.

#### Etymology

The name of the new species refers to the speckled pigmentation of the body, from Latin 'guttatus' for speckled.

#### Description

##### Male imago

##### Measurements, ratios and colouration

Body length: 2.0 mm; wing length: 1.6 mm; length of fore leg: 1.5 mm. Ratio of fore femur : fore tibia = 0.71–0.75; ratio of fore tibia : fore tarsus = 1.16–1.18; ratio of fore leg : hind leg = 1.33–1.34; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 1.8–1.9 : 1.4–1.5 : 1.7–1.8 : 1.3–1.5.

Colouration of cuticle: Head and mesonotum intensely brown, pro- and metanotum a little lighter, legs and abdominal terga I–VII yellowish-white, abdominal terga VIII–X and base of antenna light brown.

Epidermal pigmentation forming an intense blackish pattern: Head, pedicel and mesonotum diffusely pigmented, head with a blackish-brown band on posterior margin. Mesonotal pigmentation more intense along sutures and on scutellum. Pronotum and abdominal terga VIII–X speckled with black. Abdominal terga I–VII with transverse pigment bands on hind margin and large paratergal spots or blotches, terga I and II with a median black line and sublateral longitudinal dashes. Pleura and large parts of the ventral side speckled with black. Abdominal sterna with a median longitudinal row of spots. Proster-

nal triangle strongly pigmented (Fig. 6c). Additionally to preapical black spots, all femora also with median dashes, fore femora additionally also with basal dashes.

#### Morphology

Head: Base of antennal flagellum not dilated.

Thorax: Prosternal triangle long and narrow, with slightly convex sides and rounded tip, strongly pigmented (Fig. 6c). Tarsomeres 2–4 of fore tarsus apically scarcely broadened and provided with just a few short spines. Tarsomere 2 only about 1.8 times the length of tarsomere 1. Tarsomeres 2–5 not very different in length: 2 about as long as 4, 3 about as long as 5.

Abdomen: Lateral filaments of abdominal segments short. Without finger-like process on tergum II.

Genitalia and sternum IX as in Fig. 6a. Penis not preserved. Styliiger sclerite elongated, anterior margin distant from base of forcipes, with two narrow apophyses of moderate length. Forceps with a very long spine angled to the short and broad shaft. Spine about two-thirds as long as shaft. Surface of forceps equipped with long trichomes (Fig. 6b).

Female imago and larva unknown.

#### Differential diagnosis

*Caenis guttata* n. sp. can be distinguished from all other *Caenis* species by the following combination of characters: Forceps short and broad, with a very long apical spine, about two-thirds the length of forceps shaft. Styliiger sclerite elongated, anterior margin far away from base of forcipes. Tarsomere 2 of fore leg only about 1.8 the length of tarsomere 1. Tarsomeres 2–5 of similar length. Dorsal and ventral side with an intense blackish pigment pattern.

#### Remarks

Only a single specimen is available from this species. Unfortunately the genitalia are partly damaged. The remaining characters however are so striking that a description of a new species seems to be justified.

#### *Caenis gephyria* n. sp. (Figs. 6d–g)

**Holotype** ♂ (on microslide): Thailand, riv. Kwai, 5.II.2006, J.-M. ELOUARD leg.

**Paratypes**: Thailand, riv. Kwai, 7.II.2006, J.-M. ELOUARD leg., 4 ♂♂.

#### Etymology

The name of the species was chosen with reference to the famous bridge across the river Kwai. The latinized Greek term *gephyrius* means 'belonging to the bridge'.

## Description

## Male imago

## Measurements, ratios and colouration

Body length: 1.9–2.1 mm; wing length: 1.5–1.7 mm; length of fore leg: 1.5–1.6 mm. Ratio of fore femur : fore tibia = 0.40–0.46; ratio of fore tibia : fore tarsus = 1.39–1.48; ratio of fore leg : hind leg = 1.98–2.01; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 4.1–4.2 : 2.5–2.6 : 1.8–1.9 : 1.4–1.5; ratio of body length : length of cercus : length of terminal filament = 1 : 2.5 : 3.5; ratio terminal filament : cercus = 1.4.

Colouration of cuticle: Mesonotum yellowish-brown. Head and metanotum a little lighter. Pronotum anteriorly and sublaterally light yellowish-brown. Antennae and legs weakly tinted.

Epidermal pigmentation: No pigments present.

## Morphology

Head: Fore margin between lateral and frontal ocelli slightly bowed. Base of antennal flagellum not dilated.

Thorax: Mesonotum broad. Outlines of prosternal triangle vague, without clear lateral ridges (Fig. 6g). Tarsomeres 2–4 of fore tarsus apically a little more broadened as in *C. guttata*, but not as broad as in *C. nigropunctatula* or *C. ranauensis*.

Abdomen: Lateral filaments of abdominal segments short triangular. Without finger-like process on tergum II.

Genitalia and sternum IX as in Figs. 6d, e. Penis apically narrow (width about 0.5 the distance of the extreme lateral points of the forceps bases, see key to males), basally strongly broadened, lobes short and rounded. Styliger sclerite broad with short apophyses. Posterior margin of central sclerite strongly sclerotized and serrated. Forcipes short and broad, with a thin, relatively long spine. Antero-lateral process of segment IX long (Fig. 6f).

Female imago and larva unknown.

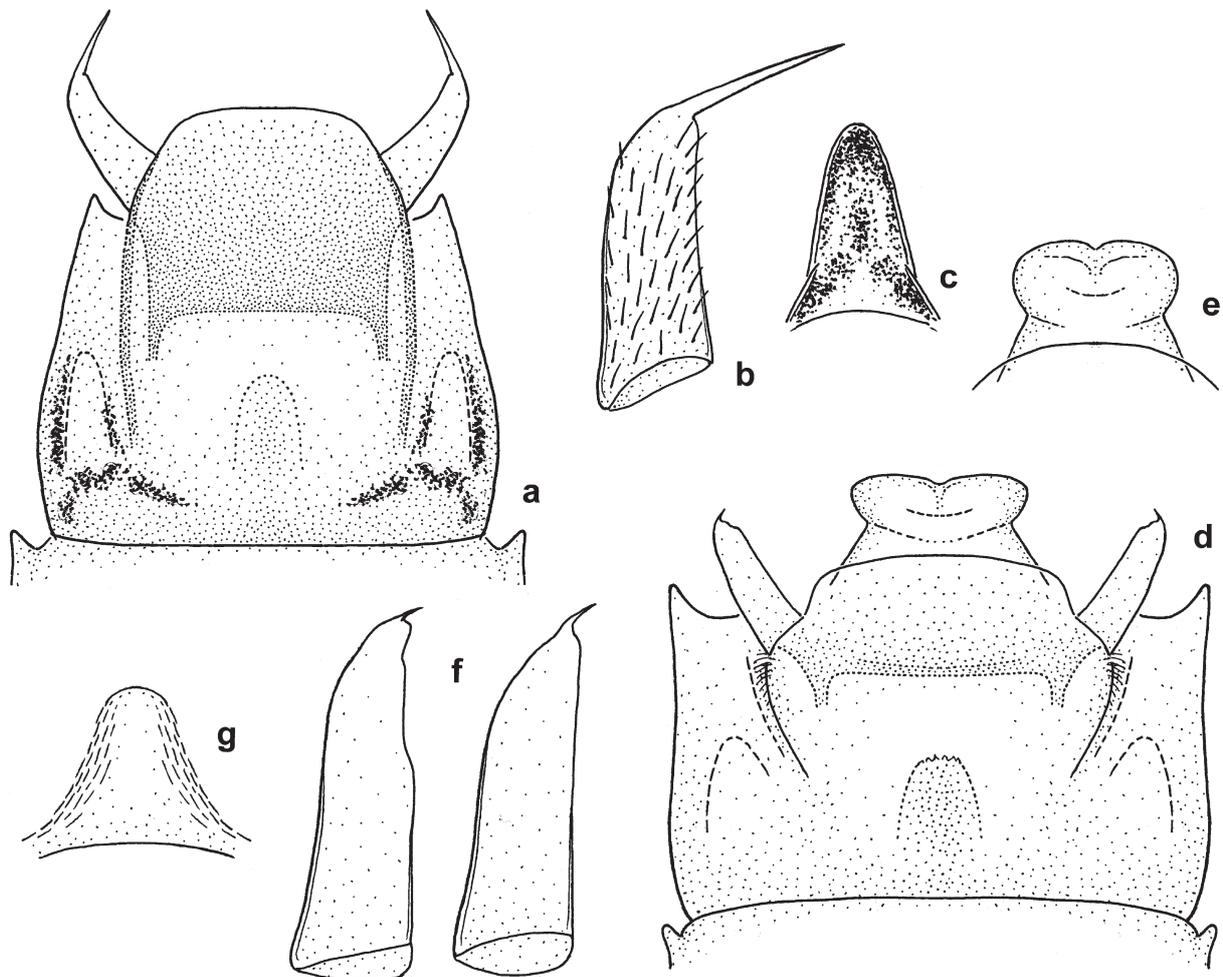


Fig. 6. *Caenis guttata* n. sp., ♂ (a–c), *C. gephyria* n. sp., ♂ (d–g). – a, d, e. Genitalia. b, f. Forcipes. c, g. Prosternal triangle.

## Differential diagnosis

*Caenis gephyria* can be distinguished from all other species of *Caenis* by the following combination of characters: Forceps short and broad, with a single thin apical spine. Outlines of prosternal triangle vague, without clear lateral ridges. Tarsomeres 2–4 of fore tarsus apically slightly broadened and equipped with spines. Penis narrow, with short rounded lobes. Antennal flagellum not dilated.

*Caenis picea* Kimmins, 1947  
(Figs. 7a–c)

KIMMINS (1947: 99).

## Material examined

Holotype ♂: India, Calcutta, Baranagar-Kamarhati, 29.XII.1945, D. E. KIMMINS leg. – Paratypes: same data as holotype, 6 ♂♂, 2 ♀♀. – Other material: Thailand, riv. Kwai, 5.II.2006, J.-M. ELOUARD, 6 ♂♂. – Thailand, riv. Kwai, 7.II.2006, J.-M. ELOUARD, 20 ♂♂.

## Redescription

## Male imago

## Measurements, ratios and colouration

Body length: 2.4–2.6 mm; wing length: 2.0–2.1 mm; length of fore leg: 2.1 mm. Ratio of fore femur : fore tibia = 0.49–0.53; ratio of fore tibia : fore tarsus = 1.35–1.52; ratio of fore leg : hind leg = 1.84–2.10; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 3.1–4.0 : 1.7–2.1 : 1.3–1.7 : 1.1–1.4; ratio of body length : length of cercus : length of terminal filament = 1 : 2.8 : 3.8; ratio terminal filum : cercus = 1.35.

Colouration of cuticle: Meso- and metanotum yellowish-brown, head and pronotum a little lighter. Other parts yellowish-white or white.

Epidermal pigmentation: Head grey with a lighter transverse band on vertex; anterior part of the latter often with six longitudinal black lines. Pronotum grey with two paramedian blackish spots and two lateral marks on each side. Prealar bridges and pleura grey with blackish sutures. Mesonotum greyish shaded, particularly behind transverse interscutal sutures and scutellum. Abdominal terga III–VI blackish, terga before and behind light. Tergum IX often with a medio-longitudinal black dash. Paratergal spots and dashes intense.

## Morphology

Head: Vertex domed, frons strongly sloping. Base of antennal flagellum not dilated.

Thorax: Sides of prosternal triangle weakly concave or S-shaped, tip more or less broadly rounded (like in Fig. 3i) or cut, without transverse strip. Tarsomeres 2–4 of fore tarsus apically only slightly broadened; broadenings equipped with small strong spines.

Abdomen: Lateral filaments of abdominal segments short. Tergum II with a short cone or finger-like process.

Genitalia and sternum IX as in Figs. 7a, b. Penis lobes broadly rounded, hind margin of each half more or less convex. Penis ventrally with a broadly V- or heart-shaped brown sclerite, variable (Fig. 7b right half from Thailand). Styliger sclerite with apophyses of moderate length. Central sclerite elongated oval. Forceps broad, apically with a few short bristles, hardly longer than bristles from the surface, sometimes more or less fused together (Thailand, Fig. 7c). Styliger sclerite, central sclerite, and basolateral parts of tergite IX brown.

## Female imago

Besides the male paratypes also two females were designated as paratypes, but these cannot be assigned to the males with certainty.

Larva unknown.

## Remarks

*Caenis picea* is similar to the Palearctic species *Caenis lactea*, both with domed vertex, very similar genitalia and the characteristic pigmentation of abdominal terga. They can be distinguished by body size (*C. picea* 2.5 mm, *C. lactea* 4.0 mm), fore leg tarsomeres 2–4 (apically broadened and equipped with strong spines in *C. picea*, without those spines in *C. lactea*, borders between segments oblique in lateral view) and shape of forcipes that are medially more or less fitted at the waist in *C. lactea*.

*Caenis incurva* n. sp.  
(Figs. 7d–f)

Holotype ♂: India, Calcutta, Baranagar-Kamarhati, 29.XII.1945, D. E. KIMMINS leg.

## Etymology

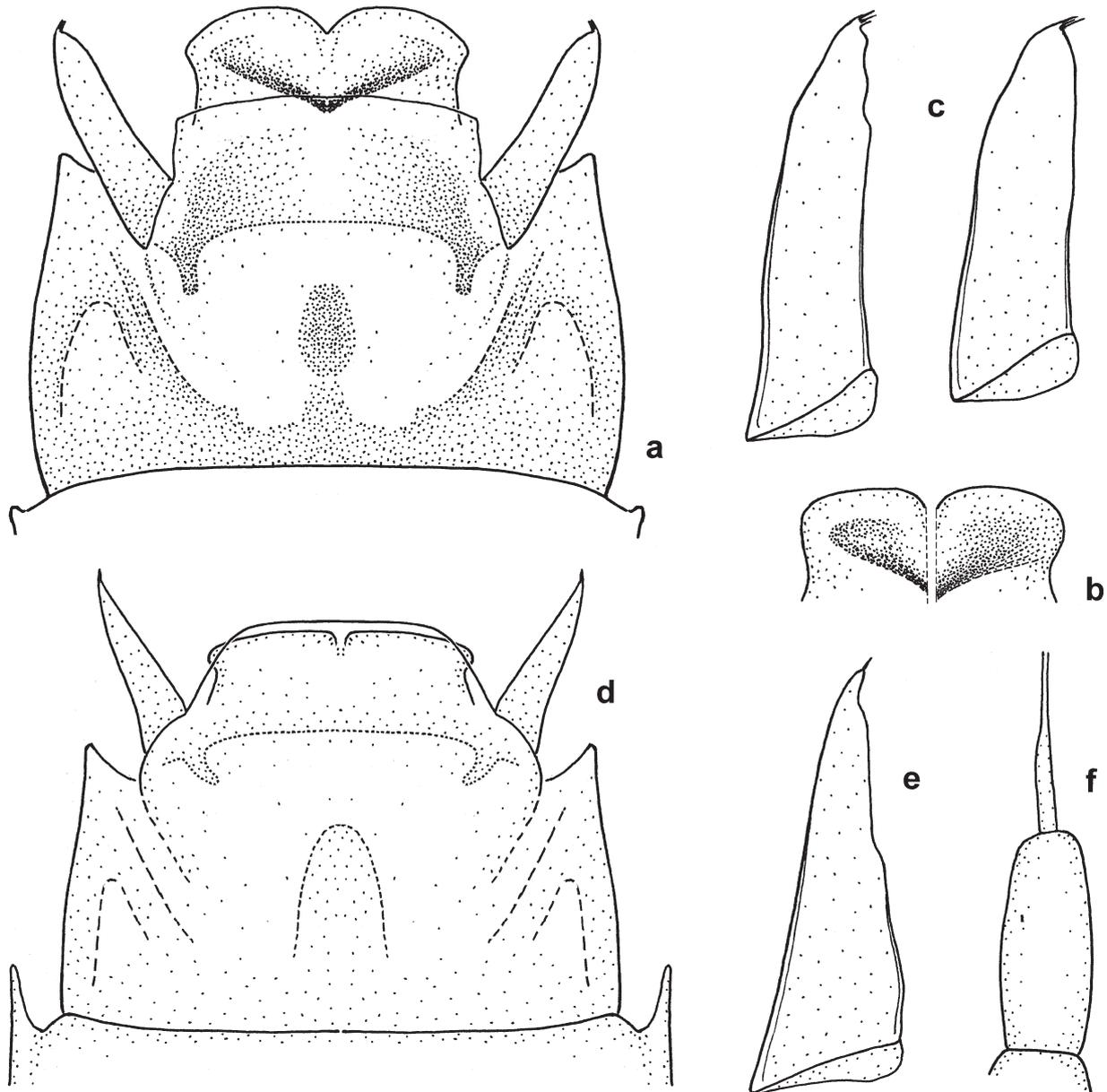
The species epithet refers to the strongly bowed apophyses of the styliger sclerite.

## Description

## Measurements, ratios and colouration

Body length: 2.8–2.9 mm; wing length: 2.6 mm; length of fore leg: 2.5 mm. Ratio of fore femur : fore tibia = 0.78; ratio of fore tibia : fore tarsus = 1.16; ratio of fore leg : hind leg = 1.52; ratio of segments of fore tarsus 1<sup>st</sup> : 2<sup>nd</sup> : 3<sup>rd</sup> : 4<sup>th</sup> : 5<sup>th</sup> = 1 : 3.2 : 2.0 : 1.7 : 1.3; ratio of body length : length of cercus : length of terminal filament = 1 : ± 1.4–1.5 : ± 1.7; ratio terminal filum : cercus = 1.33–1.39.

Colouration of the specimen is not preserved.



**Fig. 7.** *Caenis picea* Kimmins, ♂ (a–c), *C. incurva* n. sp., ♂ (d–f). – a, b, d. Genitalia. c, e. Forceps. f. Antennal pedicel and base of flagellum.

#### Morphology

**Head:** Base of antennal flagellum slightly dilated, dilated part half as long as pedicel (Fig. 7f).

**Thorax:** Prosternal triangle equilateral, sides clearly concave. Tarsomeres 2–4 of fore tarsus apically clearly broadened; broadenings equipped with small strong spines (intermediate between Figs. 1k, l and 3j, k).

**Abdomen:** Lateral filaments of abdominal segments of moderate length.

Genitalia and sternum IX as in Fig. 7d. Penis short, broad, and stocky, covered by styliiger plate, lobes short and rounded. Styliiger sclerite with apophyses strongly bent medially. Sides of forceps evenly converging, lateral side weakly S-shaped, tip with a short thin spine (Fig. 7e).

#### Differential diagnosis

*Caenis incurva* can be distinguished from all other *Caenis* species by the following combination of charac-

ters: Tarsomeres 2–4 of fore tarsus apically clearly broadened and equipped with small strong spines. Penis with very short lobes, covered by the styliger plate. Apophyses of styliger sclerite strongly bent medially. Sides of forceps evenly converging, tip with a short thin spine.

#### Remarks

Among the paratype specimens of *Caenis picea* I found a single specimen of another species, as described above. First I took it for a specimen of *Caenis piscina*, also described from the surroundings of Calcutta. However, a further examination of all (dried) type specimens of the latter species showed significant differences, so this specimen is attributed to a new species.

#### *Caenis piscina* Kimmins, 1947

KIMMINS (1947: 99).

#### Material examined

Holotype ♂ (dried): India, Calcutta, X.1945, D. E. KIMMINS leg. – Paratypes: same data as holotype, 4 ♂♂, 1 ♀.

All type specimens are preserved in dried condition. Genitalia are strongly deformed, even the shape of the relatively short forcipes cannot be observed. Fore legs are lacking, preserved legs without tarsi. As these missing body parts bear important taxonomic characters, a redescription on the basis of modern diagnostic characters and a comparison with the herein described species is impossible. The epidermal pigmentation however (abdomen figured by KIMMINS 1947) may help to identify the species at a later time when fresh material from the locus typicus or adjacent regions will be available.

Epidermal pigmentation: Head greyish. Pronotum with grey marks and dashes. Pleura, particularly prealar bridges, and coxae with grey to blackish spots and dashes. Hind part of mesonotum shaded with grey. Scutellum grey, sutures darker. Abdominal terga with a pigment pattern as shown in KIMMINS 1947: fig. 13 (in males the pigmentation often reduced and lighter). Paratergal spots and dashes intense. Mid and hind femora with preapical blackish spots.

#### *Caenis perpusilla* Walker, 1853

WALKER (1853: 585); EATON (1884: 148); NEEDHAM (1909: 191); KIMMINS (1960: 305).

#### Material examined

Holotype ♂ (dried): Sri Lanka (detailed locality not mentioned on label).

The single type specimen I received for investigation from the BMNH is preserved in dried condition. The

treatment with lactic acid and a transfer into 70 % ethanol did not lead to an improved condition. Because of the strong deformation nearly no diagnostic features can be observed or reliably interpreted. Both fore legs that bear important diagnostic characters are broken off and are lacking. Under these circumstances a redescription on the base of modern diagnostic characters and a comparison with the here described species is impossible. *Caenis perpusilla* is therefore declared as ‘species inquirenda’. Already EATON (1884) stated that “an adequate description of the species” based on the dried type specimen is impossible, “and therefore the name may rank as a mere catalogue name”.

#### *Caenis annulata* Navás, 1923 (Figs. 5c, d)

NAVÁS (1923: 1).

#### Material examined

Syntypes: 4 ♂♂, Philippines, Vigan, 1917, F. MAS leg.

The type specimens are preserved in dried condition. Therefore only the following characters can be studied:

#### Measurements and colouration

Body length: 2.4–2.5 mm; wing length: 3.0–3.2 mm; length of fore leg: 2.5 mm.

Colouration of cuticle: Mesonotum and tergum X dark brown, head and pronotum a little lighter, abdominal terga brownish. Edges of femora dark brown.

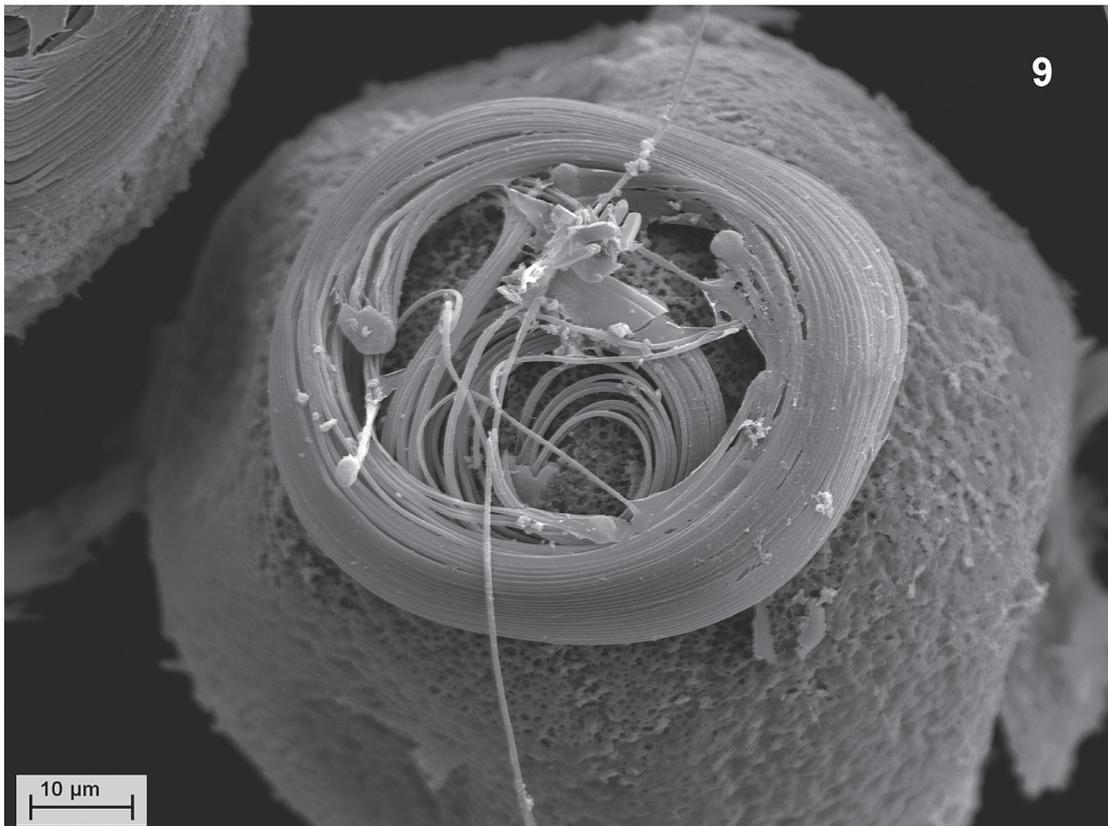
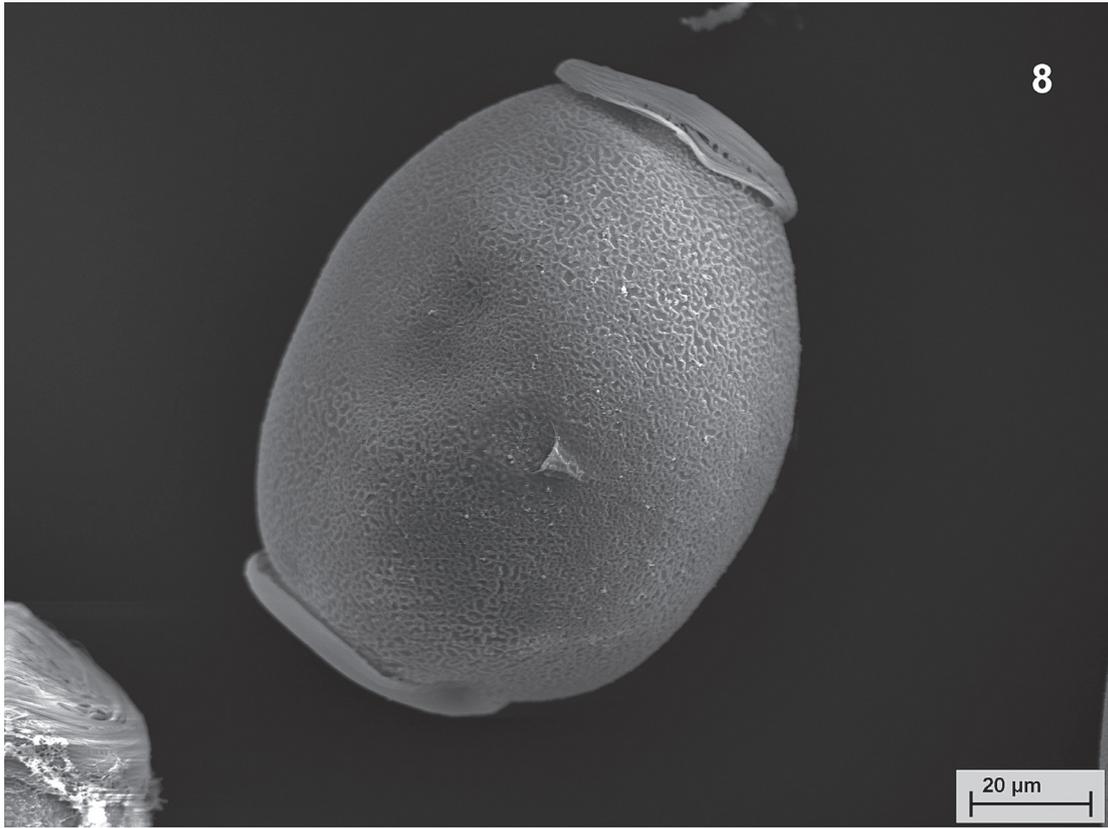
Epidermal pigmentation: Head and pronotum with blackish pigment-pattern. Abdominal terga I–VI with broad strongly pigmented transverse bands, terga VII and VIII with sublateral oblique marks.

Genitalia and sternum IX as in Fig. 5c. Penis lobes short, broadly triangular, with a field of small round sensillae. Styliger sclerite with broad apophyses of moderate length. Lateral sclerites long and very narrow, fibula-shaped. Central sclerite circular. Forcipes slightly bowed, with an apical tuft of long spines (Fig. 5d). Genital sclerites, forcipes, and basolateral parts of sternum IX brown. Blackish pigments between lateral and basolateral sclerites and along the lateral margin.

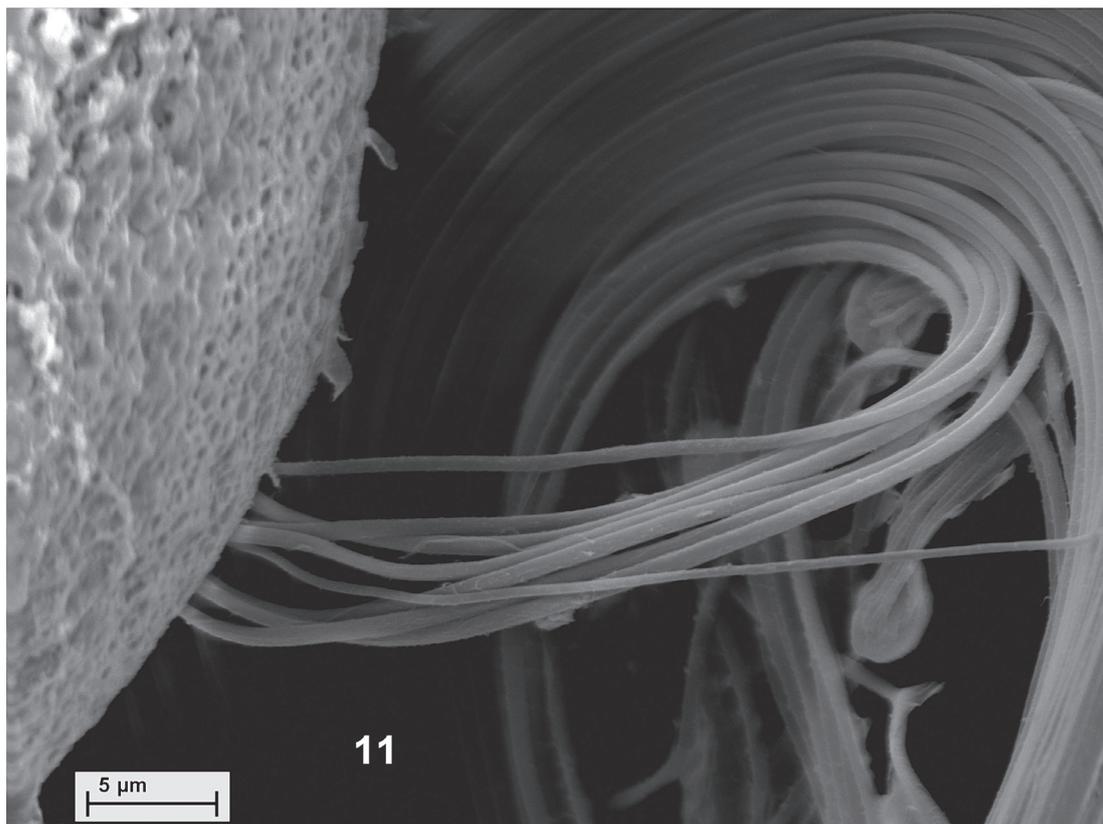
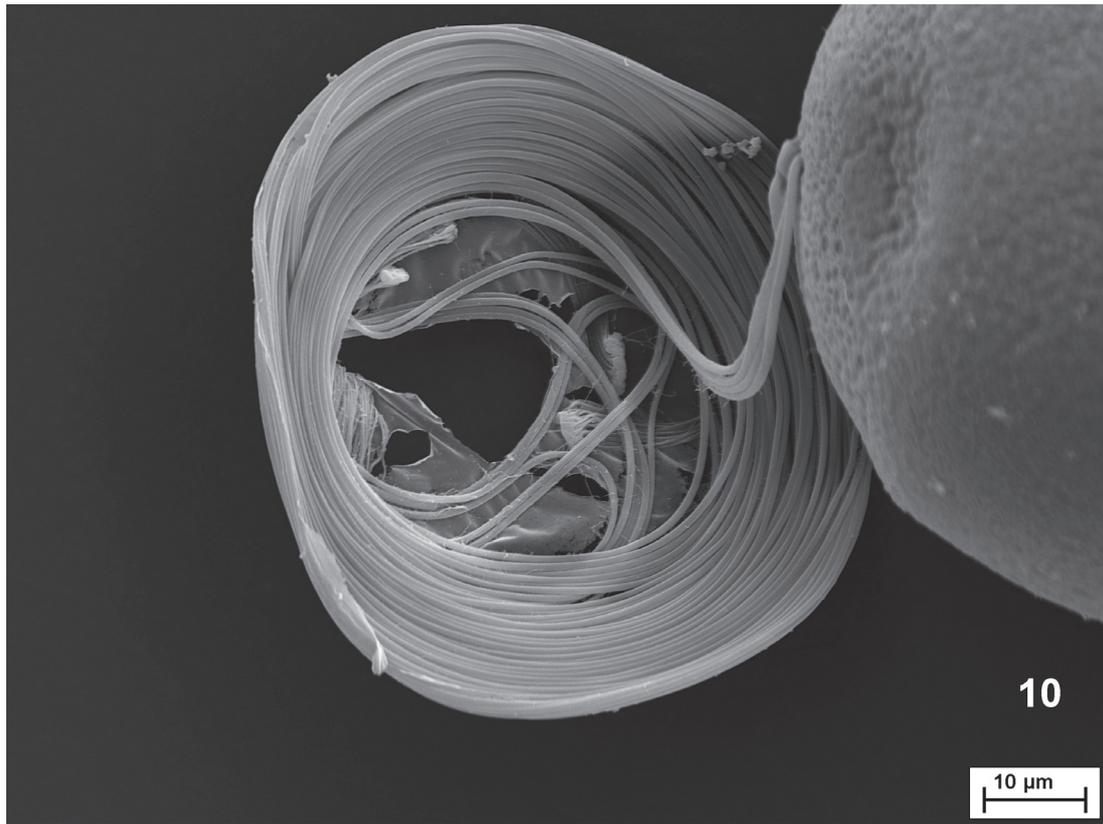
For a complete redescription of the species new material from the locus typicus (northern part of Luzon) would be necessary. Genital characters, however, are sufficient for the admission into the key to males (section 4).

#### Differential diagnosis

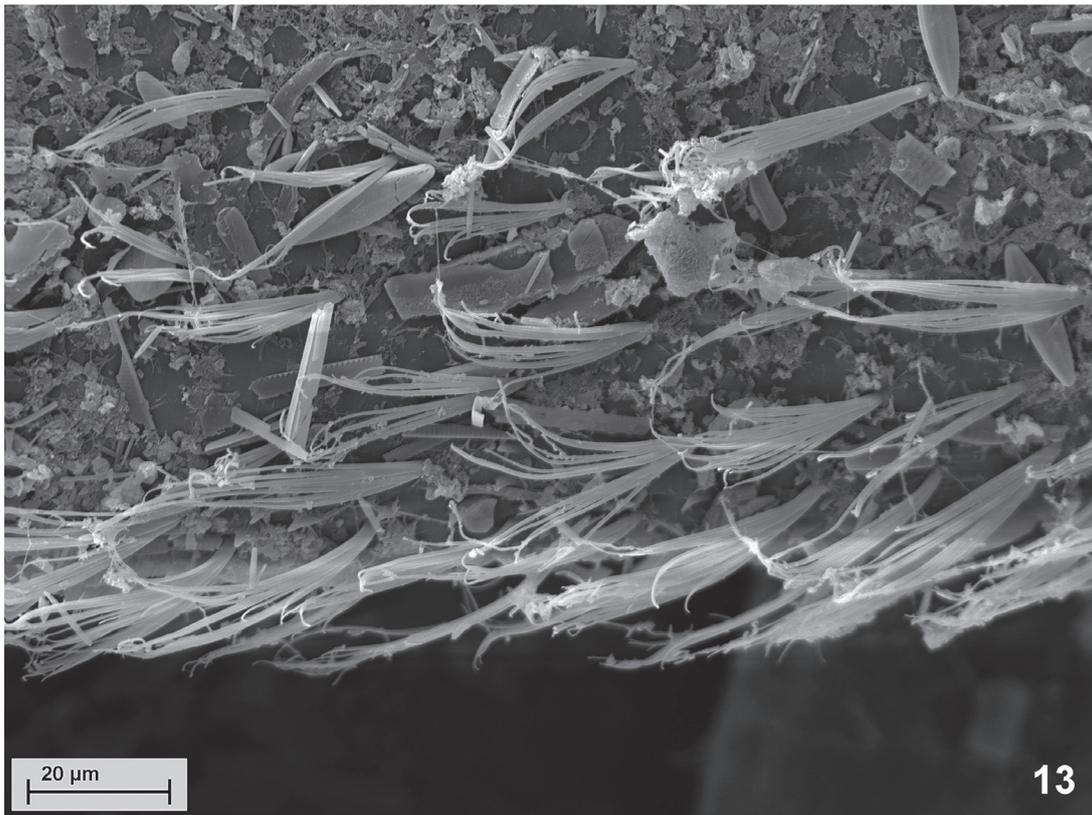
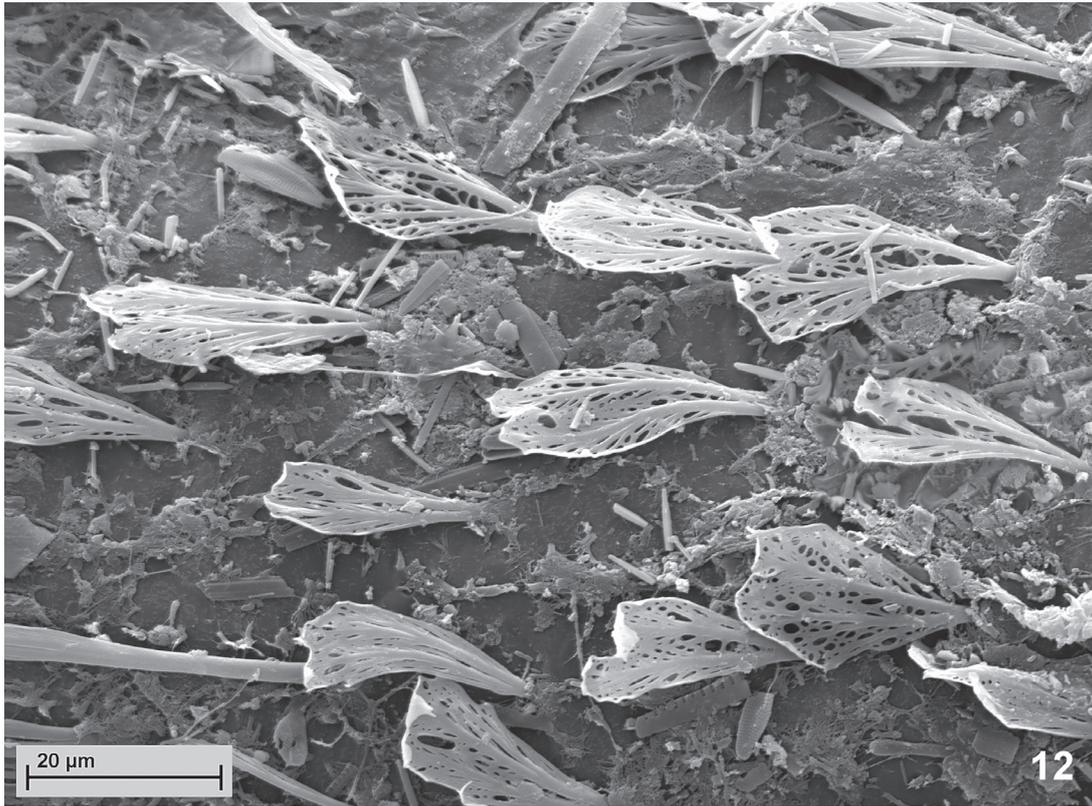
*Caenis annulata* can be distinguished from all other *Caenis* species of the Oriental Region by the following combination of characters: Penis lobes triangular, with a



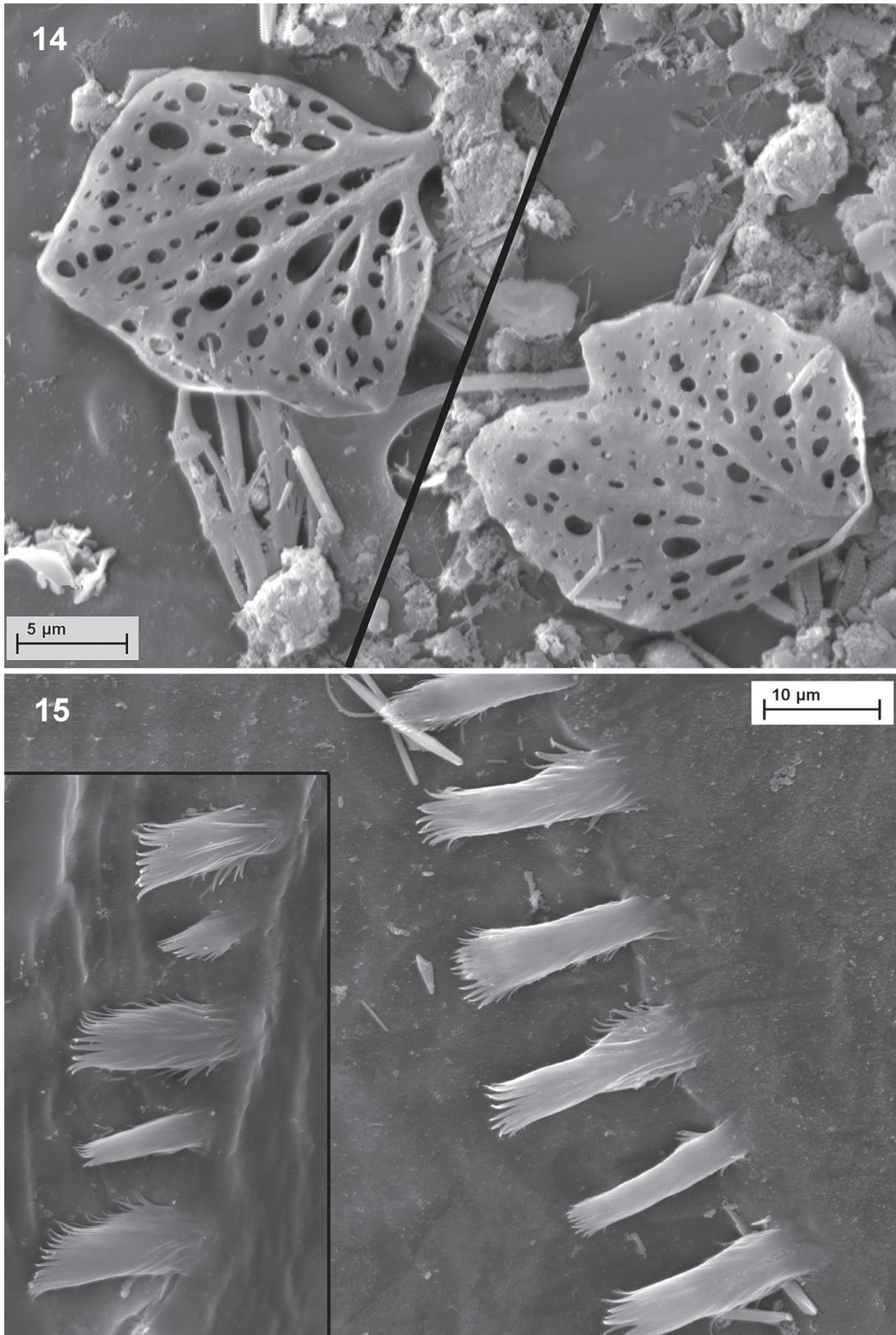
**Figs. 8–9.** *Caenis nigropunctatula* n. sp. – 8. Egg. 9. Egg, epithema.



**Figs. 10–11.** *Caenis nigropunctatula* n. sp., egg. – 10. Epithema, inner side. 11. Epithema, insertion of threads.



**Figs. 12–13.** *Caenis nigropunctatula* n. sp., larva. – 12. Tongue-shaped bristles from hind femur. 13. Branched bristles from margin of mid femur.



**Figs. 14–15.** *Caenis nigropunctatula* n. sp., larva. – 14. Shield-shaped bristles of mesonotum. 15. Operculate gill, microtrichia from the row on ventral side (small frame: from the end of the row).

field of small round sensillae. Genital sclerites, forcipes, and basolateral parts of sternum IX strongly brown. Lateral sclerites long and fibula-shaped. Central sclerite circular. Forcipes with an apical tuft of long spines.

*Caenis pumila* Navás 1923

NAVÁS (1923: 1).

Material examined

Holotype ♂ (dried): Philippines, Vigan, 1918, F. MAS leg.

In the compilation of types described by NAVÁS (see ALBA-TERCEDOR & PETERS 1985) the authors state: "Type very damaged and without head". Additionally it has to be stated that its genitalia are deformed and lack forcipes. *Caenis pumila* therefore can not be identified and is hereby regarded as 'species inquirenda'.

*Caenis philippinensis* Ulmer, 1924  
(Figs. 5e, f)

ULMER (1924: 48, sub *Caenodes philippinensis*)

Material examined

Syntypes: 16 ♂♂, Philippines, Bilaran, 21.X.1915, BOETTGER leg.

Obviously the type specimens had been in dried condition, but at some point they were transferred into 75 % ethanol. Of all diagnostic characters, only the shape of antennal base and of forcipes can be recognized. The base of the antennal flagellum is dilated (Fig. 5f) and the forcipes tip is provided with a tuft of long spines (Fig. 5e).

About 30 species of *Caenis* show this combination of characters, and *Caenis philippinensis* has to be assigned to this group. However, a redescription of the species is only possible once new material from the locus typicus (southern part of Luzon) will become available.

*Caenis nigrostriata* Navás, 1932

NAVÁS (1932: 20).

Material examined

Holotype ♀ (dried): India, Bandra, Mumbai, 20.IX.1929.

This species is only known from its holotype, a heavily damaged female preserved in dry condition. *Caenis nigrostriata* is therefore regarded as 'species inquirenda'.

*Caenis demoulini* van Bruggen, 1954

VAN BRUGGEN (1954: 11).

I have not seen the types, deposited in the Rijksmuseum van Natuurlijke Historie, Leiden. However, because all type specimens are females, it is impossible to determine and identify them by morphological methods. *Caenis demoulini* therefore is declared as 'species inquirenda'.

4 Key to males of Oriental *Caenis*

- 1 Tarsomeres 2–3 of fore tarsus each with one apico-median projection (MALZACHER 2013: fig. 1f)..... 2
- Tarsomeres 2–4 of fore tarsus apically with a lateral and a median projection or broadening, or only slightly broadened (Figs. 1k, l, 4i, j)..... 4
- 2 Forceps very long, slender and pointed. Penis rectangular, shaft of penis laterally inflated (MALZACHER 2013: figs. 3a, b)..... *C. fregatula*
- Forceps with apical tuft of spines (MALZACHER 2013: figs. 1b, 2c). Penis differently shaped..... 3
- 3 Forceps long (length to basal width about 7 : 1), slightly curved laterally (MALZACHER 2013: fig. 1b). Styliiger sclerite without apophyses..... *C. unidigitata*
- Forceps shorter (length to basal width about 5 : 1), straight or slightly bent medially (MALZACHER 2013: fig. 2c). Styliiger sclerite with thin apophyses..... *C. sebastiani*
- 4 Forceps with a very long spine angled to the short and broad shaft. Ratio length of shaft to length of spine about 1.5 (Fig. 6b). Styliiger sclerite elongated, anterior margin far away from the base of forcipes (Fig. 6a). Segment II of fore tarsus about 1.8 times the length of segment I..... *C. guttata*
- Forceps with clearly shorter apical spines or bristles or without any. Anterior margin of styliiger sclerite more or less on the same line with forcipes bases. Segment II of fore tarsus more than 3 times the length of segment I..... 5
- 5 Apophyses of styliiger sclerite curved medially (Fig. 7d). Sides of forcipes evenly converging, ending apically in a short thin spine (Fig. 7e). Lateral abdominal filaments of moderate length..... *C. incurva*
- Apophyses of styliiger sclerite straight or lacking. Sides of forcipes not evenly converging. Lateral abdominal filaments short or very short..... 6
- 6 Forceps apically with a tuft of long spines or with a long strong spine and a few thin bristles more or less fused..... 7
- Forceps with short bristles, a short spine or a more or less rounded tip..... 9
- 7 Genital sclerites and forcipes brown. Central sclerite large and round (Fig. 5c). Forcipes with a tuft of long spines (Fig. 5d)..... *C. annulata*
- Genital sclerites and forcipes not or only weakly coloured. Forcipes apically with a long strong spine or a few thin bristles more or less fused..... 8
- 8 Sides of forcipes parallel or more or less apically converging (Figs. 4c–f). Penis with lobes laterally slightly protruding and a tongue-shaped ventral lamella (Fig. 4a). Tarsomeres 2–4 of fore tarsus with tongue-shaped projections (Fig. 4j)..... *C. ulmeriana*
- Basal half of forcipes very broad, with parallel sides, apical part abruptly narrowed to the tip (Fig. 5b). Penis narrow, semicircular, lobes laterally not protruding, ventral side of penis covered by a broad lamella (Fig. 5a). Tarsomeres 2–4 of fore tarsus apically broadened; broadenings equipped with small strong spines..... *C. maratha*

- 9 Penis anvil-shaped, hind margin straight with two narrow transverse sclerites. Forceps long and narrow, slightly bent medially. Tarsomere 2 of fore tarsus 1.5 times as long as tarsomeres 3–5 together. – Styliiger sclerite without apophyses (MALZACHER 2013: figs. 4a, b f). ..... *C. bidigitata*
- Penis and forceps differently shaped. Tarsomere 2 of fore tarsus shorter. .... 10
- 10 Forceps long, with more or less parallel sides, slightly bent laterally, with a short broad spine inserting medially. – Prosternal ridges straight, forming a broad trapezoid (MALZACHER 2013: figs. 6a–d). ..... *C. abdita*
- Forceps sides converging and/or forceps short. .... 11
- 11 Small species, body length at most 2.1 mm, wing length at most 1.7 mm, fore leg length at last 1.6 mm. Outlines of prosternal triangle vague, without clear lateral ridges (Fig. 6g). Forceps short and broad (Fig. 6f). Apical width of penis about 0.5 the distance of the extreme lateral points of the forceps bases (Fig. 6d). ..... *C. gephyria*
- Body longer than 2.4 mm, wing longer than 2.0 mm, fore leg longer than 2.1 mm. Prosternal triangle with clear lateral ridges. Apical width of penis about 0.7 and more the distance of the extreme lateral points of the forceps bases. .... 12
- 12 Tip of forceps rounded, very different shapes (Figs. 3c–g). Prosternal ridges apically forming a broadly rounded triangle with straight or slightly convex sides (Fig. 3i). ..... *C. ranauensis*
- Forceps apically with a short spine or a few short bristles. Prosternal triangle with more or less rounded tip, sides concave or S-shaped. .... 13
- 13 Penis ventrally with a large V- or heart-shaped brown sclerite (Figs. 7a, b). Forceps long and voluminous, apically with a few short or very short bristles often fused together (Fig. 7c). Genital sclerites more or less brownish. Abdominal tergum II with a short finger-like process. .... *C. picea*
- Penis broad, without V-shaped sclerite (Figs. 1a, b). Forceps small, apically with a short spine (Figs. 1c–i). Genital sclerites uncoloured, often hardly visible. Abdominal tergum II without finger-like process ..... *C. nigropunctatula*

## 5 Conclusions

The types of five Oriental species of *Caenis* are in bad condition or represented only by females. Therefore they cannot be redescribed on the base of modern diagnostic characters and a comparison with valid species of the region is impossible. *Caenis perpusilla*, *C. nigropunctata*, *C. pumila*, *C. nigrostriata*, and *C. demoulini* are therefore regarded as ‘species inquirenda’. The material from the coll. G. ULMER determined by ULMER himself as *Caenis nigropunctata* could be sorted into three new species, namely *C. nigropunctatula*, *C. ranauensis*, and *C. ulmeriana*. Three further new species described from specimens that I received from M. T. GILLIES and M. SARTORI are *Caenis maratha* from India, and *C. guttata* and *C. gephyria* both from Thailand. *Caenis annulata* and *C. picea* could be redescribed. A paratype of *Caenis picea* was removed and described as the new species *C. incurva*. Together with five species from Borneo (MALZACHER 2013), altogether 14 species are now described on the base of modern diagnostic criteria and a key is provided for these species. *Caenis*

*pyncacantha* (see JIA et al. 2010) from which no material was available to me can be assigned to a species-group with dilated base of antennal flagellum and an apical tuft of spines on forceps. However, for integration into the key of males, some other details e. g. the structure of fore tarsus would be necessary. The same applies to *Caenis philippinensis*. Unfortunately I could not get the type of *Caenis sri-nagari*, described by TRAVER (1939), from Northern India, deposited in the Purdue Entomological Research Collection, West Lafayette. However, it is quite possible that the latter species belongs to the Palearctic region. *Caenis kimminsis* and *C. dangi*, described by ALI (1967) and SOLDÁN (1986), and the species described by KANG & YANG (1994, 1996) and TONG & DUDGEON (2002) are known only from larvae. A conspecificity of these species with species only known as imago cannot be ruled out.

Five species from China not mentioned above were recorded by ZHOU & ZHENG (2004): *Caenis parviforcipis* Zhou & Zheng, 2004, *C. sinensis* Zhou & Zheng, 2004, *C. nigropunctata*, *C. rivulorum* Eaton, 1884 and *C. melanoleuca* Zhou & Zheng, 2004. Based on the figures of genitalia and partly also antenna three of them have to be assigned to the Palearctic fauna because they are closely related to species of this bioregion: *Caenis rivulorum* (a Palearctic species at all), *C. parviforcipis* (close to *C. robusta* Eaton, 1884) and *C. sinensis* (close to *C. horaria* Linnaeus, 1758). This seems to be an introgression of Palearctic species into the Oriental Region (compare BARBER-JAMES et. al. 2008). The species determined as *Caenis nigropunctata* in ZHOU & ZHENG (2004) is not identical with one of the herein described species. Characters that can be taken from two drawings and the very short description are: base of antennal flagellum strongly dilated, forceps with an apical tuft of spines and penis lobes rounded. That is not sufficient for the description of a new species. From the shape of the forcipes *Caenis melanoleuca* could also belong to the Palearctic fauna, but ZHOU & ZHENG mentioned that in some specimens the forcipes are contracted and nearly totally covered by the styliiger plate. This means that they are probably provided with well developed forceps muscles. Hence this species cannot belong to the genus *Caenis* which does not have those strong muscles.

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