

The West African species of *Caenis* Stephens (Insecta: Ephemeroptera)

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A b s t r a c t

The present paper is the result of the examination of several thousand specimens of the genus *Caenis* Stephens, 1835 (Ephemeroptera) which were collected in West Africa in more than 200 light trap samples from 32 rivers in Guinea, Mali, Ivory Coast, Togo and Ghana. Five new species are described: *Caenis vermicifera n. sp.* (Ivory Coast, Guinea), *C. nigricola n. sp.* (Mali, Guinea), *C. jinjanoides n. sp.* (Guinea, Ivory Coast), *C. kohli n. sp.* (Guinea), and *C. orthostilata n. sp.* (Mali). The extensive materials allow to add distributional data to previously known species. *C. elouardi*, *C. cibaria kunda*, *C. gilliesi*, *C. jinjana*, *C. antelucana*, *C. brevipes*, *C. bernieri*, and *C. pallida* are redescribed. The eggs of most of the treated species are described based on SEM pictures. Several questions concerning supposed species relationships are discussed. The subspecies rank of *C. brevipes occidentalis* Malzacher, 1993 is rejected.

K e y w o r d s : *Caenis*, West Africa, new species, distribution, variability of characters.

Z u s a m m e n f a s s u n g

Die vorliegende Arbeit ist eine Auswertung von mehreren Tausend Individuen der Gattung *Caenis* Stephens, 1835 (Ephemeroptera), die in mehr als 200 Lichtfallen-Proben von 32 Flüssen in Westafrika (Guinea, Mali, Elfenbeinküste, Togo und Ghana) gesammelt worden sind. Fünf neue Arten werden beschrieben: *Caenis vermicifera n. sp.* (Elfenbeinküste, Guinea), *C. nigricola n. sp.* (Mali, Guinea), *C. jinjanoides n. sp.* (Guinea, Elfenbeinküste), *C. kohli n. sp.* (Guinea) und *C. orthostilata n. sp.* (Mali). Das umfassende Material liefert zusätzliche Verbreitungsgaben für bereits bekannte Arten. *C. elouardi*, *C. cibaria kunda*, *C. gilliesi*, *C. jinjana*, *C. antelucana*, *C. brevipes*, *C. bernieri* und *C. pallida* werden wiederbeschrieben. Die Eier der meisten hier behandelten Arten werden mit Hilfe von SEM-Aufnahmen dargestellt. Einige Fragen zum vermuteten Verwandtschaftsverhältnis von Arten werden diskutiert. Der Status von *C. brevipes occidentalis* Malzacher, 1993 als Unterart wird verworfen.

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1 Introduction

Until the end of the 1970s, Caenidae of the Ethiopian region were only known from South, East and Central Africa (references see MALZACHER 1993). In 1983 SOLDÁN described a

new species (*Clypeocaenis afrosetosa*) from the Upper Volta region (also included in the here examined material with a record from Guinea, Niandan). Three species of *Caenis* were described from West Africa by MALZACHER (1990): *C. elouardi* from Guinea, and *C. gilliesi* and *C. antelucana* from

Senegal and Gambia. Furthermore, the species *C. cibaria* (ssp. *kunda*), *C. jinjana* and *C. brevipes* (ssp. *occidentalis*), previously only known from East Africa, were recorded in the same paper. Recently the number of Caenidae species found in West Africa (Senegal, Gambia, Guinea, Mali, Ivory Coast, Ghana, and Togo) rose to 13 by the descriptions of *Afrocercus guinensis*, *A. sartorii*, *A. inflatus*, *Tigrocercus contractus* (MALZACHER & STANICZEK 2006), *Aenigmocaeenis morgensterni*, and *Niandancus alienus* (MALZACHER 2009). In the present paper additional species of the genus *Caenis* are described that raise the total number of Caenidae from West Africa to 18. Diagnoses and distribution records of previously known species of *Caenis* are improved. Some female stages could be assigned to males, and the structure of their eggs is shown by SEM pictures.

Acknowledgements

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2 Materials and methods

The examined material, consisting of samples from light traps and preserved in 75 % ethanol, was collected between 1983 and 1988, and to a smaller part between 1974 and 1978 by the ORSTOM team of Dr. JEAN-MARC ELOUARD (Montpellier) and kindly made available by Dr. MICHEL SARTORI (Lausanne). The collections were acquired during the Onchocerciasis Control

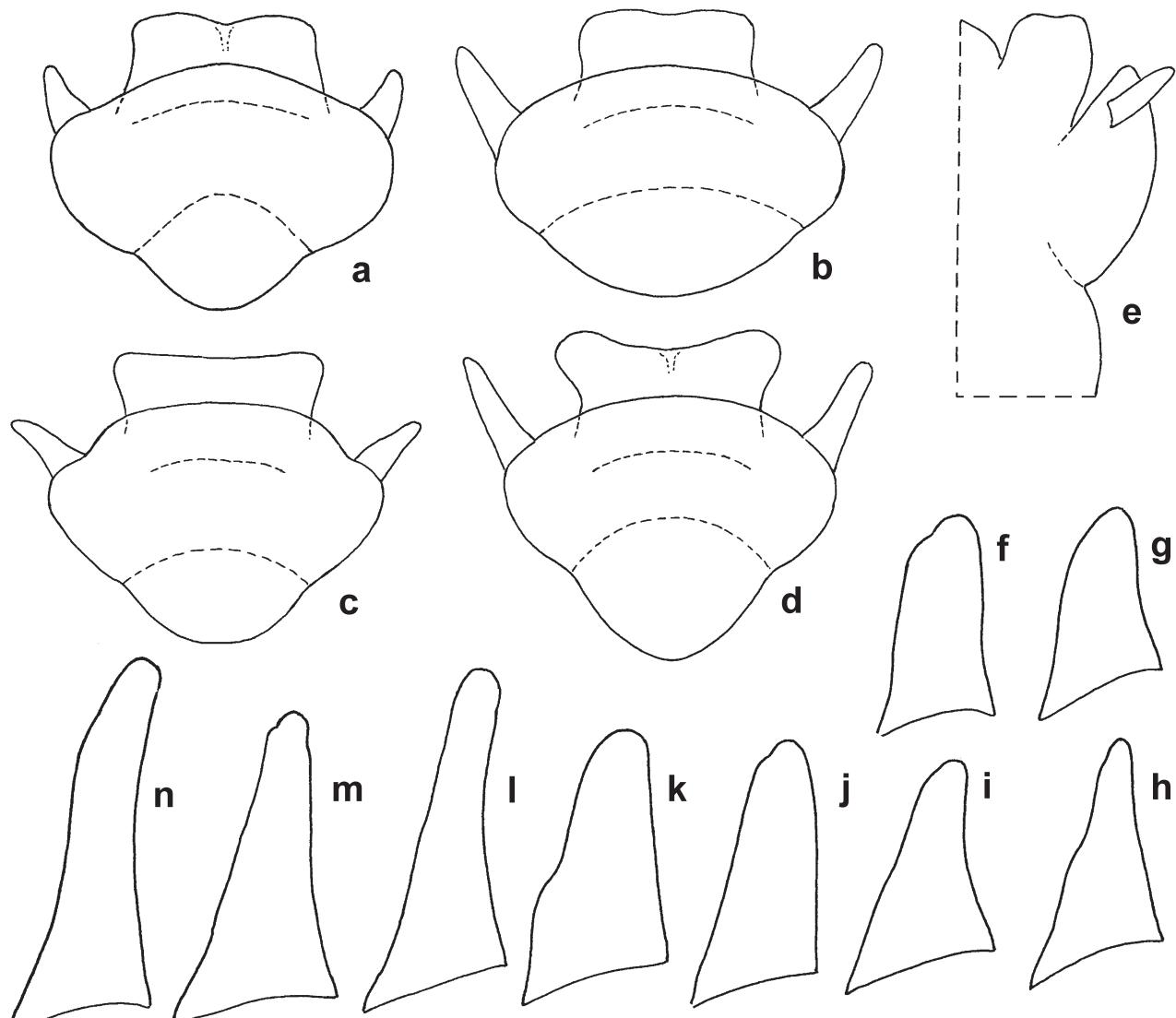


Fig. 1. *Caenis elouardi*, ♂, genitalia. – a–d. Different shapes of styliger. e. Styliger, lateral view. f–n. Different shapes of forcipes.

Programme in West Africa (LE BERRE et al. 1990). Most of the samples, about 120, were collected in Guinea near 19 rivers and streams, the others in Mali (57 samples, 5 rivers), Ivory Coast (25 samples, 6 rivers), Ghana (4 samples, 1 river) and Togo (4 samples, 1 river). 4 samples from Ghana were collected by Dr. SEBASTIAN ENDRÖDY-YOUNGA (see GATTOLLIAT & SARTORI 2006).

Where available, the number of males and females is given in the material part. "Several" is used for a small indefinite number of specimens (from 3 to about 10). In case of mass samples, only a smaller sample of 50 or 100 specimens was determined, and the percentage of individuals of a species in the respective *Caenis*-sample is indicated. The abbreviation 'SI' is used for 'subimago'.

The majority of the material, including the types of the newly described species, is stored in the Musée Cantonal de Zoologie, Lausanne, Switzerland. A small number of additional specimens is 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/Pd layer, and examined with an ISI-SS40 scanning electron microscope at 10 kV.

3 Systematic account

3.1 *Caenis elouardi* Malzacher, 1990 (Figs. 1, 2a–j, 14–17)

MALZACHER (1990: 8).

Material examined

Ghana: River Black Volta, Brong Ahafo region, 27.X.1965, 6♂♂, 1♀.

Togo: River Mono, Kpessi, 30.XI.1985, 2♀♀.

Ivory Coast: River Sassandra, Lengekoro, 12.VIII.1984, 6♂♂. – River Cavally, Grié (Toulepleu region), 1.II.1988, 9♀♀. – River Cavally, Tai, 10.II.1988, 10♂♂, 16♀♀. – River Cavally, Tiboto-Grabo, 11.II.1988, 3♂♂, 2♀♀. – River Cavally, Sotowate near Grabo, 26.II.[1988?], 1♂.

Guinea: River Feredougouba [no locality], 4.III.1985, 1♂, 1♀. – River Feredougouba, Badala, 30.III.1985, ca. 70♀♀. – River Kolente, Kora, 10.II.1986, 32♂♂, ca. 60♀♀. – River Kaba (= Little Scarcies), road Faranah-Mamaou, 7.II.1986, 7♂♂.

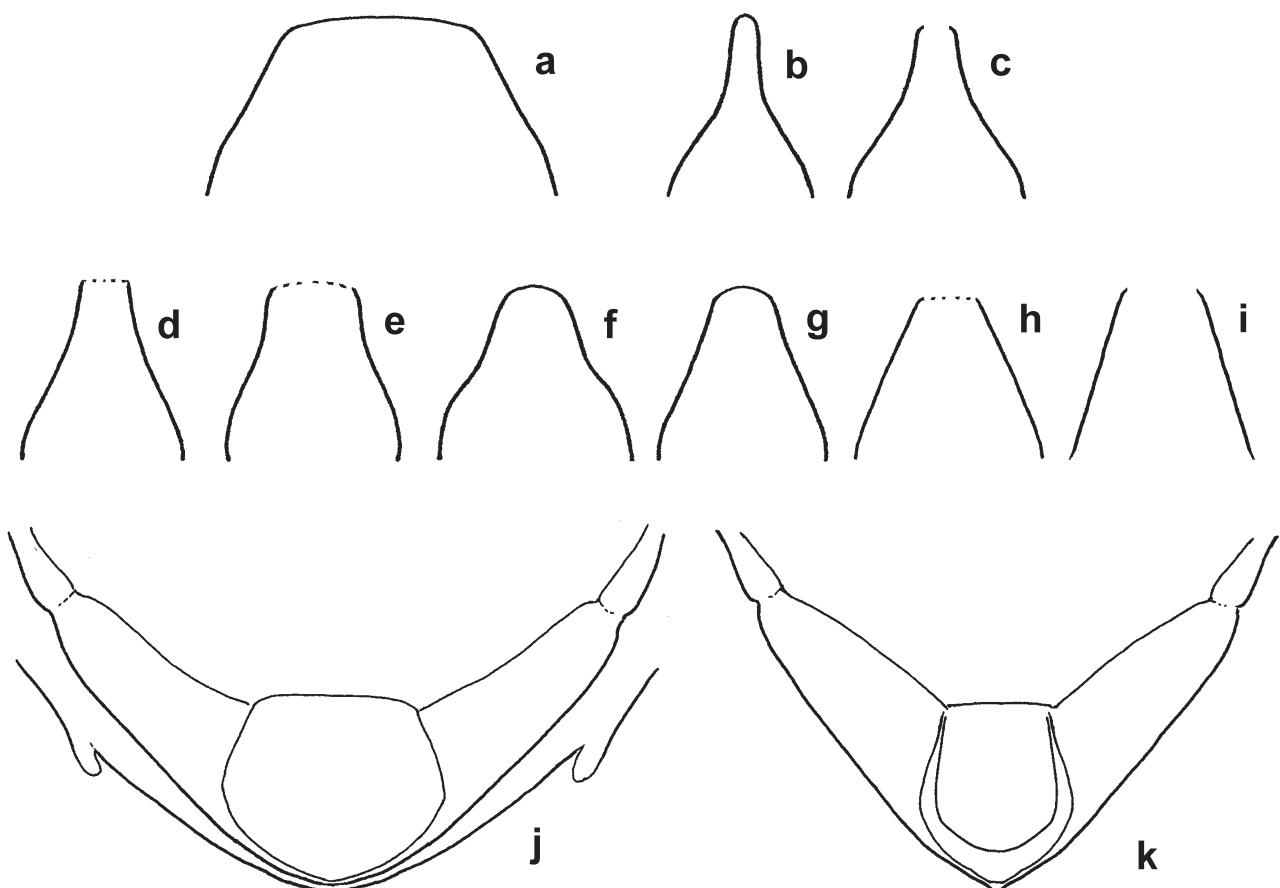


Fig. 2. *Caenis elouardi* (a–j), *C. vermicifera* n. sp., ♂ (k). – a–i. Different shapes of prosternal ridges, ♀ (a), ♂♂ (b–i). j, k. Scutellum.

7♀♀. – River Kaba (= Little Scarcies), Kaba, 23.I.1987, 1♂, 1♀. – River Koumba, near Sita, 26.I.1987, 1♀. – River Diani, N'zébélá, 31.I.1988, 5♀♀. – River Makona, Bofossou, 29.I.1988, 2♂♂, 2♀♀; 2.IX.1988, 6♂♂, 2♂♂ SI. – River Niandan, Bama-koya, 25.X.1984, 5♂♂, 1♀. – River Niandan, Kissidougou, 22.I.1987, 1♂. – River Niandan, Sassambaya (locus typicus), 27.III.1985, 11♂♂, 6♀♀; 21.III.1986, 2♂♂, 6♀♀; 19.IV.1986, 1♀; 20.IV.1986, 6♂♂, 1♀; 14.V.1986, 3♂♂, 1♀; 17.VI.1986, 1♂, 1♀; 9.XII.1986, 13♂♂, 5♀♀; 10.XII.1986, 8♂♂, 1♀; 20.I.1987, 3♂♂; 25.XI.1987, 1♂; 26.XI.1987, 1♂; 5.IV.1988, 3♂♂.

Redescription

Male imago

Measurements, ratios and colouration

Body length 3.8–4.8 mm; wing length 3.0–3.3 mm; length of fore leg 2.2–2.4 mm (Ghana: 1.8–2.0 mm); fore femur to fore tibia length = 0.78–0.89; fore tibia to fore tarsus length = 0.88–0.98; fore leg to hind leg length = 1.25–1.33 (Ghana: 1.10–1.15); 1st: 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 2.4–2.9 : 1.3–1.6 : 1.2–1.5 : 1.1–1.4; body length to length of cercus to length of terminal filum = 1 : 2.86–2.95 : 2.10–3.14; terminal filum to cercus length = 1.06–1.14.

Colouration of cuticle: Meso- and metathorax orange-brown, other parts orange to yellowish-white.

Epidermal pigmentation: Vertex, posterior part of frons between the lateral ocelli, eye-bases and an apical ring on pedicel (MALZACHER 1990: fig. 4c) intensively blackish-brown. Pronotum grey with round, paramedian brighter areas. Sutures on mesonotum and scutellum blackish-brown, areas between the sutures more or less greyish. Metanotum and abdominal tergites I and II with greyish-brown transverse bands, tergites VII–X grey, III–VI light, sometimes lateral parts more or less shaded with grey. Fore legs and some spots and dashes surrounding mid and hind coxae greyish-brown. Basal parts of C, SC and R1 reddish-brown.

Morphology

Head: Base of antennal flagellum only slightly dilated; dilated part 0.4 times length of pedicel (MALZACHER 1990: fig. 4c).

Thorax: Prosternal ridges inconspicuous and narrow, forming a bell-shaped or trapezoid structure (Fig. 2a–i). Distance between fore coxae relatively wide (MALZACHER 1990: fig. 4e). Mesonotum elongated (length 1.5–1.6 times width of head). Hind margin of scutellum broadly rounded, without tip, central field large, shaped like a rounded pentagon (Fig. 2j). Metanotum with a weak transverse ridge, posteriorly with a broad and thin lamella (MALZACHER 1990: fig. 4f).

Abdomen: Tergum II without a finger-like process. Lateral filaments lacking.

Genitalia and sternum IX as in MALZACHER (1990: fig. 4a). Genitalia hardly sclerotized, very variable in shape (Fig. 1a–d), bulging out like a sack from sternum IX (Fig. 1e). Penis short and broad, with rounded corners and a basal sclerite, lobes short and variable. Forceps apically rounded, short or very short, highly variable in shape (Fig. 1f–n), thus the ratio of the distance between the extreme lateral points of the forceps bases to forceps length ranges between 2.8 and 4.7. Segment IX scarcely sclerotized, without posterolateral processes.

Female imago

Measurements and colouration

Body length 5.8–8.3 mm; wing length 4.2–5.0 mm.

Same colouration as in males, but pigmentation of abdomen often weaker. The apical blackish ring on the pedicel, in combination with the large size, is characteristic for females.

Morphology

Scutellum (particularly central region) and prosternal trapezoid broader than in males (Fig. 2a), the latter with inconspicuous ridges which are sometimes barely visible.

Egg

Chorion strongly pored, surface between pores often bulging (Fig. 17b); pore channels deeply reaching into the chorion, passing through the whole exochorion, often bifurcate (Fig. 17a). One flat, cap-shaped epithema of different extension (Fig. 14); very fine extraepithelial threads with small terminal knobs leading from margin of epithema (Fig. 15). One very short micropyle with a broad mouth and large, round sperm guide (Fig. 16).

Larva unknown.

Distribution

Widely distributed in West Africa, becoming rare towards the west. No records from Mali, Senegal and Gambia.

3.2 *Caenis vermicifera* n.sp.

(Figs. 2k, 3, 18)

Holotype, ♂ (dissected, on microslide), **Ivory Coast**, River Maraoué, Entomokro, 17.VI.1976.

Paratypes: Same data as holotype, 1♂ and 4♂♂ SI, 2♀♀ and 4♀♀ SI.

Other material: **Guinea**, River Milo, Boussoulé, 19.IV.1986, 1♂.

Etymology

The species name ‘vermicifera’ refers to the characteristic vermiciform process on the mesonotum.

Description

Male imago

Measurements, ratios and colouration

Body length 2.1–2.3 mm; wing length 1.9–2.1 mm; length of fore leg 1.2–1.3 mm; fore femur to fore tibia length = 0.58–0.60; fore tibia to fore tarsus length = 1.00–1.14; fore leg to hind leg length = 1.52–1.62; 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 3.0 : 1.8 : 1.7 : 1.4.

Colouration of cuticle: Meso- and metathorax yellowish-brown, head and prothorax a little lighter, abdomen yellowish, cerci whitish.

Epidermal pigmentation: Greyish pigment very sparsely and diffuse on vertex, pronotum and abdominal terga.

Morphology

Habitus: Body broad and sturdy, outline rounded, abdomen short.

Head: Relatively short and broad. Eyes small. Base of antennal flagellum not dilated (Fig. 3h), pedicel more than 3 times as long as scape and about 3 times as long as wide.

Thorax: Prosternal ridges only slightly converging anteriorly, forming a narrow trapezoid (Fig. 3e). Mesonotal membrane producing a long vermiform process as long as

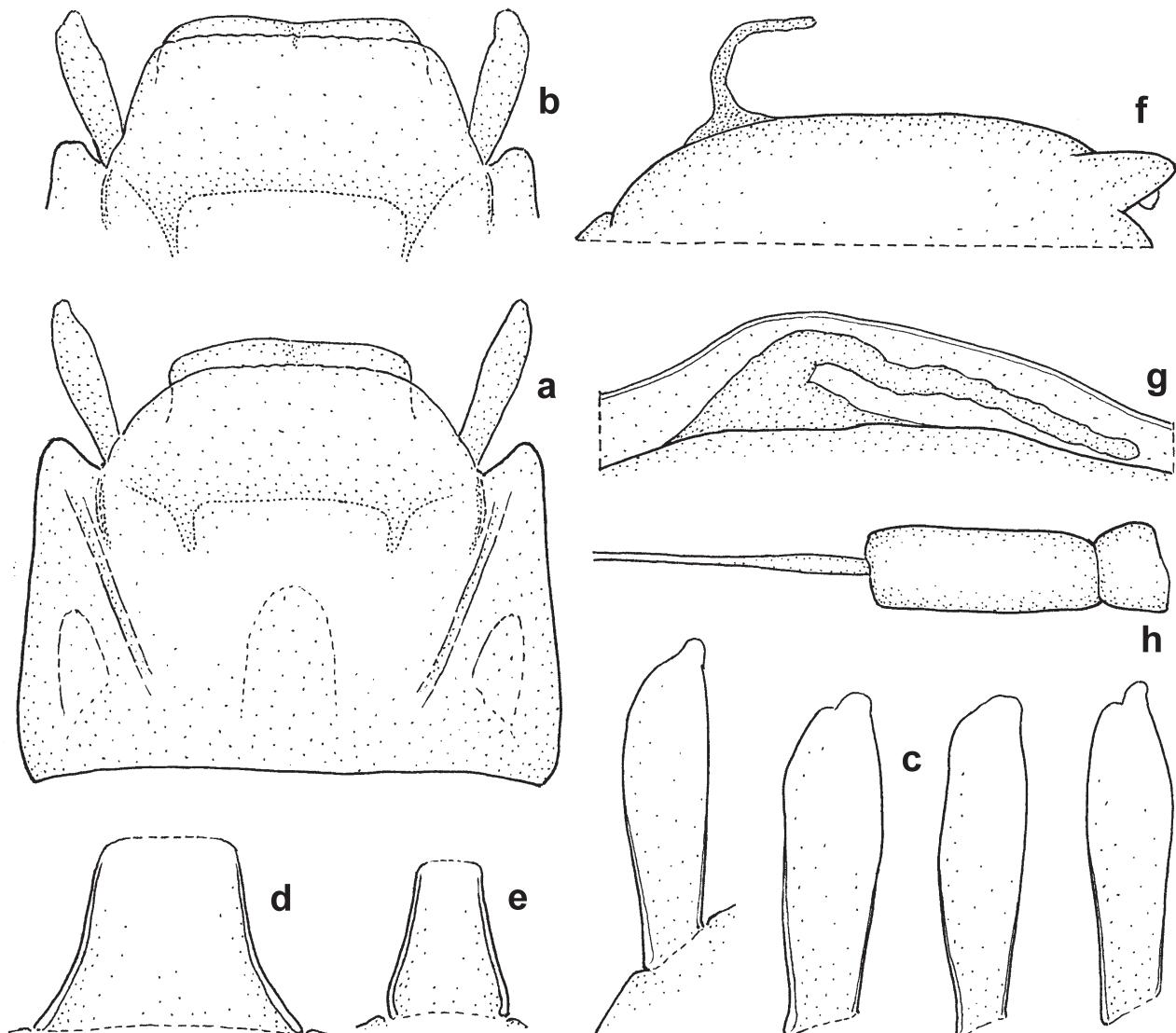


Fig. 3. *Caenis vermisera* n. sp., ♂ (a–c, e–h), ♀ (d). – **a, b.** Genitalia. **c.** Different shapes of forceps. **d, e.** Prosternal trapezoid. **f.** Mesonotum with vermiform process, lateral view. **g.** Vermiform process of mesonotal membrane, covered by the subimaginal cuticle. **h.** Antennal scape, pedicel and base of flagellum.

one-third of the mesonotal suture (Fig. 3f). The vermiform process is present in subimagines, sometimes below the subimaginal skin (Fig. 3g), but broken off in most imagines. Scutellum V-shaped and posteriorly pointed (Fig. 2k).

Abdomen: Tergum II with a thin, finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in Fig. 3a, b. Penis short and broad, with rounded corners and barely separated lobes, often nearly totally covered by the styliger plate. Stylicher sclerite with thin, sometimes pointed apophyses of moderate length. Basolateral sclerite long and straight, often forming a shallow groove (Fig. 3a). Forceps short, club-shaped, basally narrowed, apically rounded and often with a small bump (Fig. 3c). Ratio of distance between extreme lateral points of forceps bases to forceps length 2.2–2.4. Sternum IX nearly quadrate, posterolateral processes short and broadly rounded (Fig. 3a, b).

F e m a l e i m a g o

Measurements and colouration

Body length 2.8–3.2 mm; wing length 2.5–2.8 mm.

Same colouration as in males.

Morphology

As in males, except of prosternal trapezoid broader (Fig. 3d), ridges more inconspicuous, sometimes hardly visible. Abdominal segments VII–IX with short and bump-like posterolateral processes. The presence of a vermiform process on the mesonotum is characteristic for females.

E g g

Chorion without any structure. One very flat epithema covering up to one-third of the egg surface, with tiny knobs (Fig. 18). One short and inconspicuous micropyle with a small oval sperm guide.

Larva unknown.

Differential diagnosis

Caenis vermicifera n. sp. is similar to *C. elouardi* and *C. ghibana* Malzacher, 1990 (see discussion, chapter 5). For the differences see key below (chapter 4) and discussion.

Distribution

This species is known from the type locality, River Maraoué, Central Ivory Coast, and from River Milo, North East Guinea.

3.3 *Caenis cibaria kunda* Malzacher, 1993

(Fig. 4)

MALZACHER (1993: 393).

Material examined

Guinea: River Milo, Bousoulé, 19.IV.1986, 3%; 18.III.1987, 2%. – River Loffa, Macente, 30.I.1988, 20%. – River Nian-dan, Sassambaya, 17.–18.VI.1986, 15–22%; 8.II.1988, 4%; 19.IV.1986, 2%; 15.V.1986, 16%; 12.IV.1988, 4%; 19.III.1987, 2%; 23.V.1986, 4%; 28.VIII.1986, 4%.

Mali: River Niger, Tienfala, 23.V.1986, 4%; 28.VIII.1986, 4%. – River Senegal, Chutes du Felou, 13.I.1986, 5♂♂. – River Bakoye, Kokofata, 24.X.1986, 28%; 4.VIII.1987, 4%; 23.VIII.1987, 20%; 20.XI.1987, 18%.

Redescription

M a l e i m a g o

Measurements, ratios and colouration

Body length 2.1–2.8 mm; wing length 1.6–2.0 mm; length of fore leg 1.5–1.8 mm; fore femur to fore tibia length = 0.58–0.68; fore tibia to fore tarsus length = 0.97–1.29; fore leg to hind leg length = 1.64–1.90; 1st: 2nd: 3rd: 4th: 5th fore tarsal segments length = 1 : 2.8–3.9 : 1.8–2.4 : 1.7–1.8 : 1.2–1.4; body length to length of cercus to length of terminal filum = 1 : 1.7 : 2.2; terminal filum to cercus length = 1.3.

Colouration of cuticle: Meso- and metathorax orange-yellowish-brown, other parts yellowish to white.

Epidermal pigmentation: While the pigmentation of the type specimens from Gambia is very similar to *Caenis cibaria* from East Africa (MALZACHER 1993), the pigmentation of here described specimens from Mali and Guinea is very sparse. Only diffuse greyish pigment can be found on vertex and abdominal terga. Scutellum and sutures of mesonotum sometimes slightly pigmented.

Morphology

Head: Dilatation of base of antennal flagellum 0.7 times length of the pedicel, and at least one-third of its width.

Thorax: Prosternal triangle isosceles, more or less elongated with rounded tip. Length of mesonotum 1.26–1.34 times width of head. Segments II–IV of fore tarsus apically with lateral tufts of strong spines.

Abdomen: Tergum II without a finger-like process. Lateral filaments very short or absent.

Genitalia and sternum IX as in MALZACHER (1993: fig. 6b). Penis broad, lobes very short, posterior margin rounded, with a median incision with rounded corners and a basal sclerite. Fore margin of styliger sclerite convex, apophyses parallel or slightly converging anteriorly. Forceps as in MALZACHER (1993: fig. 5d), broader and shorter as in *Caenis cibaria cibaria* (compare MALZACHER 1993: figs. 5c, 6a).

Populations of *Caenis cibaria kunda* from the Fouta Djalon region of Central West Guinea have some different characters:

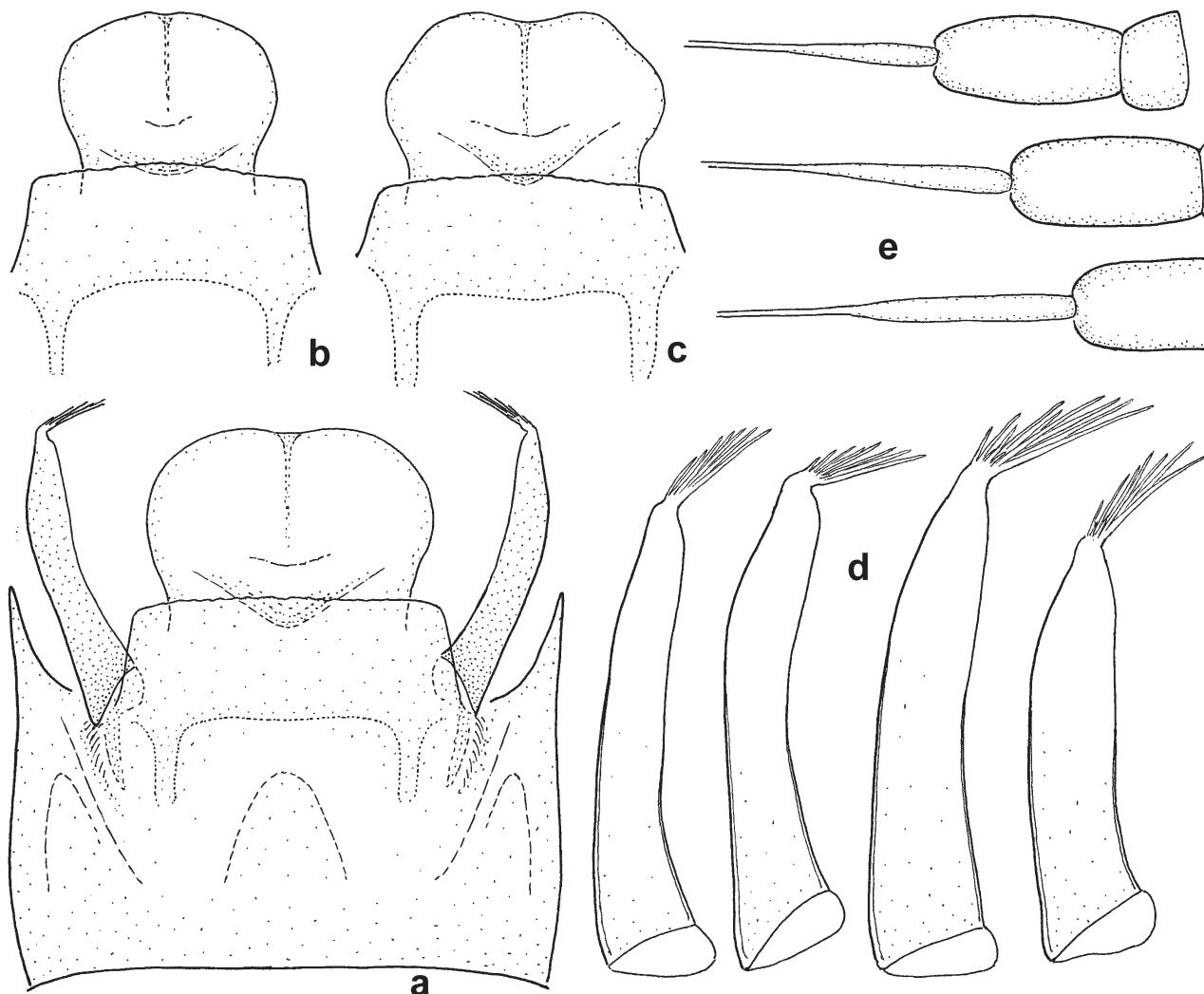


Fig. 4. *Caenis cibaria kunda*, population from Fouta Djalon region, ♂. – **a–c.** Genitalia with different penis shapes. **d.** Different shapes of forcipes. **e.** Antennal base, different shapes of flagellum base.

Material examined

Guinea: River Kokoulou, road Pita–Madina, 25.I.1987, 105 ♂♂. – River Kaba (= Little Scarcies), Kaba, 23.I.1987, 6 ♂♂ and 9 ♂♂ SI. – River Kaba, Tene, 24.I.1987, 65 ♂♂. – River Koumba, near Sita, 26.I.1987, 34 ♂♂. – River Konkouré, Linsan near Mourou, 29.I.1987, ca. 100 ♂♂ and several ♂♂ SI. – River Bafing, Timbo, 31.I.1987, 4 ♂♂ and 6 ♂♂ SI.

Differences in measurements and colouration

Most specimens are distinctly longer (body length 2.7–4.0 mm, wing length 2.0–3.0 mm).

The pigmentation is often more conspicuous and is similar to that of *Caenis cibaria* from East Africa, and *C. cibaria kunda* from Gambia. Description of such specimens:

Colouration of cuticle: Meso- and metathorax yellowish-brown, head, prothorax and legs lighter yellowish-brown, abdomen yellowish or white, cerci whitish.

Epidermal pigmentation: Fore margin of frons and a band between the lateral ocelli blackish, sometimes with a line on hind margin which is more or less interrupted in the middle or reduced to two black spots. Other parts of the head pale or weakly pigmented. Pronotum with two paramedian, short, blackish dashes which connect a transversal streak with the blackish edged hind margin. Two blackish marks at lateral margins. Sutures of mesonotum more or less blackish, scutellum strongly pigmented. Metanotum, pleura and coxae with streaks and dashes. Femora with greyish preapical spots. Abdominal terga with broad transverse bands which are more or less interrupted in the middle.

Morphological differences

Dilated part of antennal flagellum of different length, often elongated and with nearly parallel margins (Fig. 4e). Penis rounded, often nearly circular (Fig. 4a, b). Forceps in most cases broader (Fig. 4d). Apical spines very long and thin, even in their basal part not fused, therefore often broken off in preserved specimens. Transitional stages to other populations of *Caenis cibaria kunda* are observed for all these characters.

Female imago and larva unknown.

Distribution

Caenis cibaria kunda seems to be less abundant and not as widely distributed in West Africa as most of the other species. The subspecies is only known from Gambia, East and Central Guinea, and western Mali. *C. cibaria cibaria* is widely distributed in lakes and big rivers in the East African rift valley region.

3.4 *Caenis gilliesi* Malzacher, 1990 (Figs. 7j–k, 19–21)

MALZACHER (1990: 10).

Material examined

Togo: River Mono, Kpessi, 30.XI.1985, 46 ♂♂, 5 ♀♀. – River Mono, Landa, 1.XII.1985, several ♂♂.

Ivory Coast: River Bagoé-Bani; Kouto, 10.III.1976, several ♂♂. – River Maraoué, Entomokro, 2.VIII.1977, 50 ♂♂, 15 ♀♀. – River Cavally, Tiboto-Grabo, 22.II.1978, 7 ♂♂; 11.II.1988, several ♂♂. – River Cavally, Lieupleu, 3.II.1988, several ♂♂. – River Cavally + N'ze, Tai, 10.II.1988, several ♂♂. – River Bandama, Badikaha, 18.IX.1985, several ♂♂. – River Bandama, Bema, 21.VIII.1985, several ♂♂; 17.IX.1985, several ♂♂.

Guinea: River Bafing, Timbo, 31.V.1983, 1 ♂, 31.I.1987, 10 %. – River Milo, Boussoulé, 28.III.1984, several ♂♂; 22.XII.1984, several ♂♂; 24.I.1985, 3 ♂♂, 1 ♀; 28.III.1985, 40 % incl. 7 ♀♀; 26.IV.1985, 20 ♂♂; 15.V.1985, several ♂♂; 31.VI.1985, 32%; 2.IV.1986, several ♂♂; 22.III.1986, 12%; 10.XII.1986, several ♂♂; 22.I.1987, 64%; 17.II.1987, several ♂♂; 17.III.1987, 62%; 7.V.1987, 12 ♂♂. – River Niger, Kouroussa, 27.I.1985, 14 ♂♂. – River Feredougouba, Badala, 4.III.1985, 52%; 30.III.1985, 26 ♂♂; 13.V.1985, several ♂♂. – River Sankarani, Mandiana, 7.V.1985, 30 ♂♂, 8 ♀♀; 28.V.1985, several ♂♂. – River Tomine, Télimélé, 27.I.1986, 2 ♂♂. – River Kaba, Faranah-Mamaou, 7.II.1986, 70%; 23.I.1987, 2 ♂♂. – River Kaba, Tene, 24.I.1987, 21 %. – River Kolente, Kolente, 9.II.1986, 99 %. – River Kolente, Kora, 10.II.1986, 70 %. – River Dubreka, Dubreka, 10.II.1986, 99 %. – River Kakrima, Kouri, 15.II.1986, 54 % incl. 11 ♀♀. – River Badi, Samou Adé, 18.II.1986, several ♂♂; 11.V.1987, several ♂♂. – River Niandan, Sassambaya, 19.IV.1986, 16 ♂♂; 20.IV.1986, several ♂♂; 14.V.1986, 5 ♂♂; 18.III.1987, 2%; 25.XI.1987, 1 ♂; 5.IV.1988, several ♂♂. – River Kokoulou, road Pita-Madina, 25.I.1987, 46 %. – River Kouumba, near Sita, 26.I.1987, 16 % incl. 8 ♀♀. – River Konkouré, Acondea, 28.I.1987, 10 ♂♂; 2.V.1987, 100 %. – River Makona, Nangoa, 19.II.1987, several ♂♂. – River Loffa, Macenta, 30.I.1988, several ♂♂. – River Diani, N'zébéla, 31.I.1988, several ♂♂.

Mali: River Bakoye, Kokofata, 17.IX.1985, 1 ♂; 8.XII.1986, several ♂♂; 12.I.1987, 2 ♂♂; 9.II.1987, 1 ♂; 16.IX.1987, several ♂♂; 5.X.1987, 1 ♂; 19.XI.1987, several ♂♂. – River Falémé [no locality], 18.I.1986, several ♂♂.

Redescription

Male imago

Measurements, ratios and colouration

Body length 1.7–2.2 mm (2.4 mm Sita, Kaba); wing length 1.5–1.8 mm (2.3 mm Kaba); length of fore leg 1.3–1.6 mm; fore femur to fore tibia length = 0.62–0.75 (0.71–0.81 Mono, 0.75–0.79 Sita); fore tibia to fore tarsus length = 0.98–1.13 (–1.15 Mono, Sita); fore leg to hind leg length = 1.49–1.68 (1.65–1.91 Mono, 1.53–1.68 Sita); 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 2.4–3.2 (3.5) : 1.5–2.1 (1.9–2.5) : 1.6–2.2 (1.8–2.7) : (1.2) 1.3–1.7 (2.1); body length to length of cercus to length of terminal filum = 1 : 1.75–2.2 : 2.75–3.8.; terminal filum to cercus length = 1.6–1.7.

Colouration of cuticle: Meso- and metathorax reddish-brown, head and prothorax lighter, abdomen yellowish-white to reddish-white, cerci white.

Epidermal pigmentation (of the Senegal material, see MALZACHER 1990: fig. 6b): Frons and vertex regularly greyish-brown, posterior vertex sometimes with a dark brown transverse band. Pronotum diffusely greyish with a transverse line and two paramedian black spots near hind margin which may be fused with the transverse line. Scutellum and posterior sutures of mesonotum strongly pigmented (sometimes forming a V-shaped mark or two oblique dashes), like prealar bridges and surrounding of coxae. Abdominal terga I and II with narrow, III–VI with broad greyish-brown transverse bands, on segments VII–VIII more conspicuous but interrupted in the middle, IX with a narrow transverse band on fore margin. Deep black paratergal dashes on segments VII–IX and preapical spots on femora very conspicuous. – Most populations from Mali, Guinea and Ivory Coast possess a severely reduced pigmentation. Even the paratergal and femoral dashes are often nearly invisible. Specimens from Ivory Coast, River Maraoué have a yellow meso- and metathorax. All other parts are yellowish-white or white.

Morphology

Head: Eyes relatively small. Base of antennal flagellum dilated; dilated part about as long as pedicel, but of different width (MALZACHER 1990: fig. 6e).

Thorax: Shape of prosternal triangle variable, equilateral or isosceles, often with broadly rounded tip (MALZACHER 1990: fig. 6f). Segments II–IV of fore tarsus apically with lateral tufts of strong spines (MALZACHER 1990: fig. 6a).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in MALZACHER (1990: fig. 6c). Penis short and broad, semi-elliptical, hind margin often with a median incision, nearly without separated lobes, ventrally with a transverse brownish flat V-shaped sclerite. Apophyses of styliger sclerite very long and bent, anteriorly diverging. Forceps long and bent, variable in shape even within the same population (Fig. 7j, k), projecting about one-third of their length over the penis (MALZACHER 1990: fig. 6c, d); apically with three short spines, two of them sturdy and basally broadened (MALZACHER 1990: fig. 6d).

F e m a l e i m a g o

Measurements and colouration

Body length (2.3 mm Mandiana) 2.7–3.3 mm; wing length 2.3–2.6 mm.

Same colouration as in males. Females are characterized by the strongly pigmented scutellum, paratergal dashes and preapical spots on the femora in combination with a small size.

Morphology

Not different from males.

E g g

Chorion smooth when observed through a light microscope; very fine and densely pored in SEM pictures, with a honeycomb-like pattern of flat ridges (Fig. 21). Two flat epithemata with very small knobs (Fig. 19). One thin micropyle with scarcely broadened mouth and a finely edged oval sperm guide (Fig. 20).

Larva unknown.

Distribution

Widely distributed and with high abundance in West Africa. This species is, included in 78 samples from 19 localities, sympatric with *Caenis jinjana* in 40 samples from 15 localities and with *C. nigricola* in 24 samples from 13 localities.

3.5 *Caenis nigricola* n.sp.

(Figs. 5, 6, 22–24)

H o l o t y p e, ♂ (on microslide): **Mali**, River Niger, Gao, 7.IX.1987.

P a r a t y p e s: Same data as holotype, 12 ♂♂, 4 ♀♀. – Same locality as holotype, 7.IX.1988, 14 ♂♂, 5 ♀♀.

O t h e r m a t e r i a l: **Mali**, River Niger, Bamako, 14.IX.1984, 14 ♂♂, 4 ♀♀. – **Guinea**: River Milo, Boussoulé, 28.III.1984, several ♂♂; 28.III.1985, 38%; 26.IV.1985, 5 ♂♂; 31.VI.1985, 6%; 22.III.1986, 8%; 2.IV.1986, several ♂♂; 10.XII.1986, several ♂♂; 22.I.1987, 2%; 17.III.1987, 14%; 7.V.1987, 9 ♂♂. – River Niandan, Bamakoye, 10.IX.1984, several

♂♂. – River Niger, Kouroussa, 27.I.1985, 3 ♂♂. – River Niandan, Sassambaya, 21.III.1986, 4 ♂♂; 18.III.1987, 1 ♂.

Etymology

The name ‘nigricola’ (Latin) was chosen because the species inhabits great parts of the River Niger.

Description

M a l e i m a g o

Measurements, ratios and colouration

Body length 1.5–1.8 mm (the smallest Caenidae species); wing length 1.4–1.5 mm; length of fore leg 1.2–1.3 mm; fore femur to fore tibia length = 0.73–0.80; fore tibia to fore tarsus length = 1.00–1.09; fore leg to hind leg length = 1.50–1.58; 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 3.7–4.2 : 1.9–2.2 : 1.6–2.0 : 1.3–1.7; body length to length of cercus to length of terminal filum = 1 : 2.2 : 3.2.

Colouration of cuticle: Meso- and metathorax yellowish-brown, head and prothorax slightly lighter, abdomen yellowish, cerci whitish.

Epidermal pigmentation: Head white, without pigmentation. Pronotum with two blackish-grey paramedian spots and anterolateral corners with smoky grey marks. Posterior parapsidal sutures on posterior parts of mesonotum strongly pigmented, anterolaterally extended forming zigzag bands up to the wing bases. Together with the pigmented margins of the scutellum there are two V-shaped marks behind each other which are characteristic for this species. Pleura with spots and lines, particularly around coxae. Abdominal terga I and II with transverse bands which are more or less interrupted in the middle. Other terga very light but with conspicuous paratergal dashes. Femora with preapical spots. Fore legs more or less smoky grey. Pigmentation more or less reduced in most populations, often nearly entirely absent.

Morphology

Head: Base of antennal flagellum slightly dilated (Fig. 6j).

Thorax: Prosternal triangle broad, apically rounded or trapezoid. Segments II–IV of fore tarsus apically with small lateral tufts of stronger spines (Fig. 6i).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in Fig. 5a–c. Penis short and broad, semicircular, without separate lobes, ventrally with a transverse brownish sclerite, sickle-shaped or shaped like a flat V. Styler sclerite with short, often barely visible apophyses. Forceps short and broad, often a little stocky and with parallel sides (Fig. 6a–d), apically with a sturdy spine and laterally accompanied with a thin and inconspicuous second spine (Fig. 6g).

Female imago

Measurements and colouration

Body length 1.9–2.1 mm; wing length 1.7–1.8 mm.

Same colouration as in males. Females are characterized by V-shaped marks on mesonotum, paratergal dashes and preapical spots on femora in combination with a small size.

Morphology

Not different from males.

Egg

One regular flat epithema with small knobs (Figs. 22, 24). Chorion densely pored, hardly visible under a light

microscope. Mouth of single micropyle not broadened, sperm guide a little deepened, densely pored like chorion (Fig. 23).

Larva unknown.

Differential diagnosis

Caenis nigricola n. sp. is similar to *C. cibaria* and *C. gilliesi* (see discussion, chapter 5). For differences see couplets 5 and 6 in the key below (chapter 4).

Populations of *Caenis nigricola* from the region west of the upper Niger and its tributaries differ in some male characters:

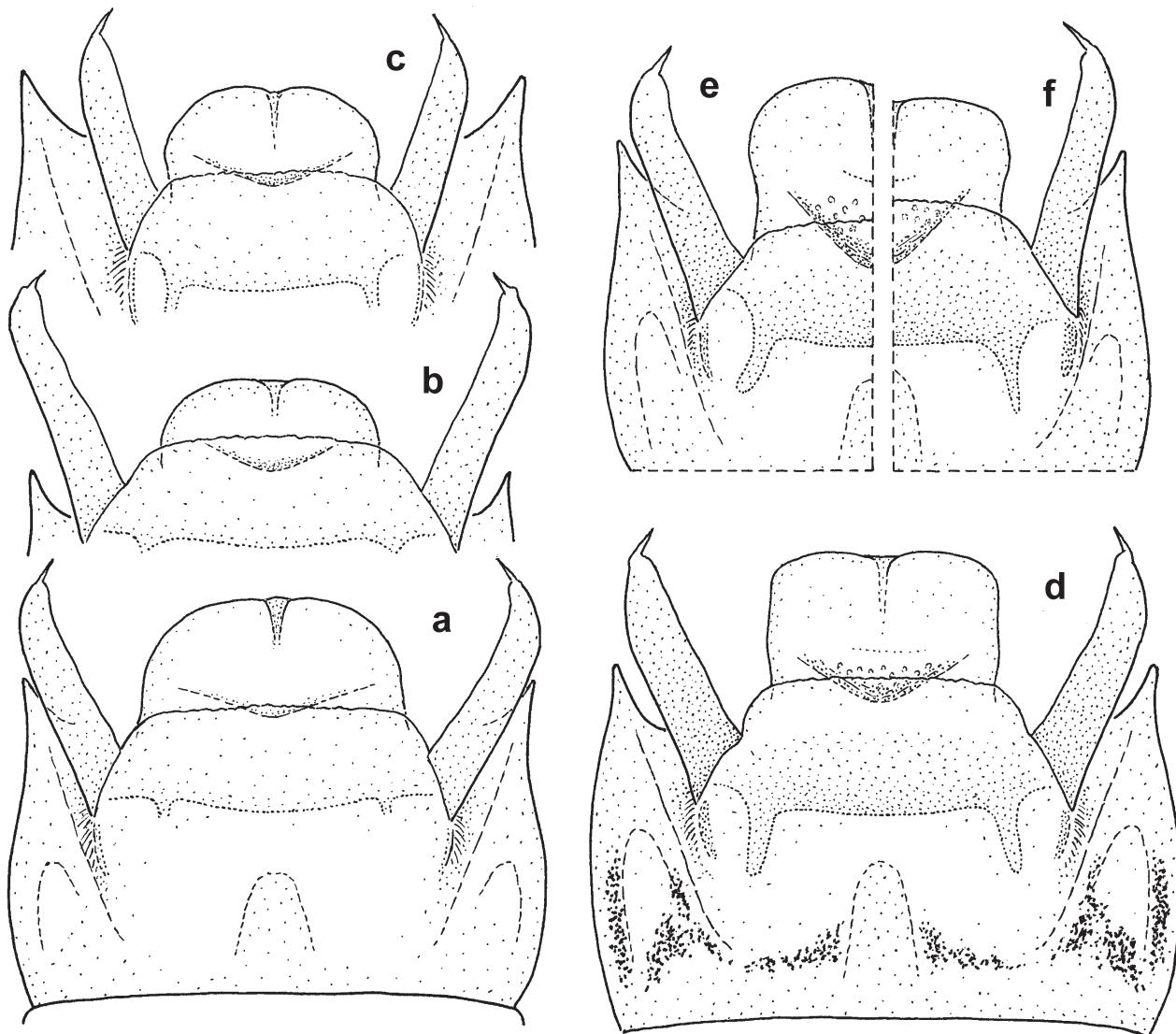


Fig. 5. *Caenis nigricola* n. sp., ♂ genitalia. – a–c. Typical specimens. d–f. Population west of upper Niger.

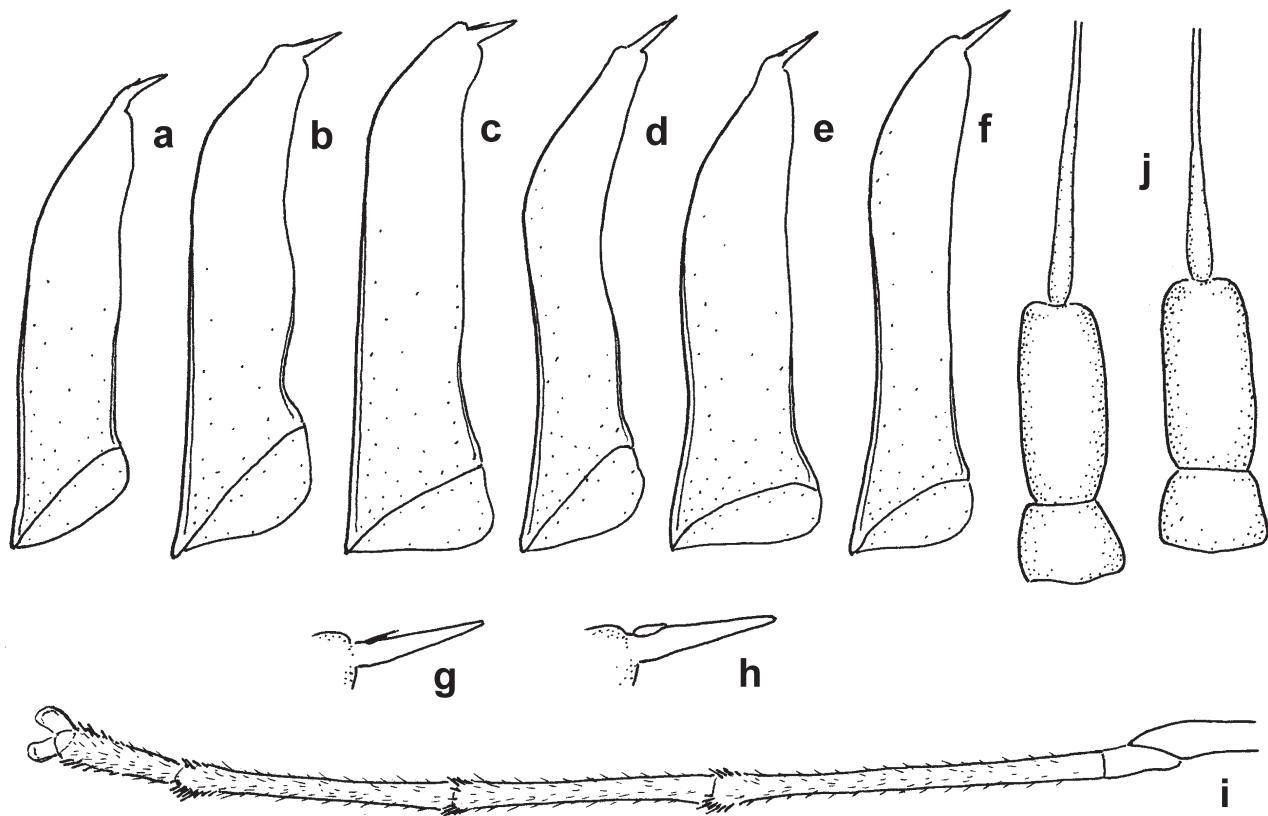


Fig. 6. *Caenis nigricola* n. sp., ♂, typical specimens (a–d, g, i–j), population west of upper Niger (e, f, h). – a–f. Different shapes of forceps. g, h. Tip of forceps. i. Tarsus of fore leg. j. Antennal scape, pedicel and base of flagellum.

Material examined

Guinea: River Kokoulou, road Pita–Madina, 25.I.1987, 26 ♂♂. – River Feredougouba [no locality] 4.III.1985, 6 %. – River Bafing, Timbo, 9.I.1986, several ♂♂; 31.I.1987, 10 %. – River Tomine (Rio Corubal), Télimélé, 27.I.1986, 3 ♂♂. – River Kaba (= Little Scarcies), road Faranah–Mamaou, 7.II.1986, 6 %. – River Kaba (= Little Scarcies), Tene, 24.I.1987, 4 %. – River Kolente, south of Kora, 10.II.1986, 1 %. – River Kakrima, Kouri, 15.II.1986, 30 %. – River Konkouré, Linsan near Mourou, 28.I.1987, 1 ♂; 29.I.1987, 5 ♂♂.

Morphological differences

Genitalia and sternum IX as in Fig. 5d–f. Penis longer and more or less quadrate, V-shaped sclerite more pronounced, with a more acute angle. Apophyses of styliger sclerite longer. Forceps longer on average, but variable in shape (Fig. 6e, f); accompanying spine basally broadened or drop-shaped (Fig. 6h).

Distribution

Guinea and western Mali, in the River Niger and its larger tributaries.

3.6 *Caenis jinjana* Kimmins, 1956

(Figs. 25–27)

KIMMINS (1956: 84) (sub *Caenodes jinjana*); THEW (1960: 199) (sub *Caenodes jinjana*); DEMOULIN (1970: 157) (sub *Caenodes jinjana*); MALZACHER (1993: 398).

Material examined

Togo: River Mono, Kpessi, 30.XI.1985, 1 ♂.

Ivory Coast: River Bagoé-Bani; Kouto, 10.III.1976, several ♂♂. – River Bandama, Badikaha, 18.IX.1985, several ♂♂. – River Cavally, Grié (Toulepleu region), 1.II.1988, several ♂♂. – River Cavally, Lieuplé, 3.II.1988, 3 ♂♂. – River Cavally, Tai, 10.II.1988, several ♂♂. – River Cavally + N'ze, Tai, 10.II.1988, several ♂♂. – River Maraoué, Entomokro, 13.II.1988, several ♂♂.

Guinea: River Milo, Boussoulé, 28.III.1984, several ♂♂; 22.XII.1984, several ♂♂; 24.I.1985, 22 ♂♂, 2 ♀♀; 28.III.1985, 6%; 26.IV.1985, 5 ♂♂; 15.V.1985, several ♂♂; 31.VI.1985, 1 ♂; 22.III.1986, 80%; 2.IV.1986, several ♂♂; 10.XII.1986, several ♂♂; 22.I.1987, 20%; 17.II.1987, several ♂♂; 17.III.1987, 24%; 18.III.1987, 1%; 7.V.1987, 1 ♂. – River Milo, Konsankoro, 27.IV.1985, 12 ♂♂, several ♀♀. – River Niandan, Sassambaya, 23.XII.1984, 3 ♂♂; 2.III.1985, several ♂♂; 25.IV.1985, several ♂♂; 29.V.1985, 1 ♂, 1 ♀; 21.III.1986, 40 ♂♂, 3 ♀♀; 19.IV.1986, 9 ♂♂; 20.IV.1986, several ♂♂; 14.V.1986, several ♂♂; 15.V.1986,

4%; 17.VI.1986, 1♂; 9.XII.1986, several ♂♂; 10.XII.1986, 13♂♂; 19.II.1987, several ♂♂; 18.III.1987, 92%; 19.III.1987, 12%; 17.–18.VI.1987, 2–5%; 27.XI.1987, 1%; 7.IV.1988, several ♂♂; 12.IV.1988, 10%; 8.II.1988, 6%; 5.IV.1988, several ♂♂. – River Niandan, Kissidougou, 22.I.1987, 2♂♂. – River Niger, Kouroussa, 27.I.1985, 7♂♂. – River Feredougouba, Badala, 4.III.1985, 28%; 30.III.1985, 3♂♂; 13.V.1985, several ♂♂. – River Kaba, Faranah–Mamaou, 7.II.1986, 45%. – River Kaba, Kaba, 23.I.1987, 20♂♂ and 4♂♂SI. – River Koumba, near Sita, 26.I.1987, 9%. – River Konkouré, Linsan near Mourou, 29.I.1987, several ♂♂. – River Konkouré, Acondea, 28.I.1987, 10♂♂. – River Bafing, Timbo, 31.I.1987, 4♂♂. – River Tinkisso, Dabola, 1.II.1987, several ♂♂. – River Loffa, Mancata, 20.II.1987, several ♂♂; 30.I.1988, several ♂♂. – River Diani, N’zébela, 31.I.1988, several ♂♂. – River Makona, Bofossou, 29.I.1988, several ♂♂.

Mali: River Marigot, Kaviebo-Kayes, 12.I.1986, several ♂♂. – River Bakoye, Kokofata, 24.X.1986, 3%.

Redescription

Male imago

Measurements, ratios and colouration

Body length 2.1–2.7 mm; wing length 1.7–2.0 mm; length of fore leg 0.9–1.2 mm; fore femur to fore tibia length = 1.07–1.37; fore tibia to fore tarsus length = 0.91–1.20; fore leg to hind leg length = 0.88–1.03 (1.06 Sassambaya); 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 1.3–1.5 (1.8 Sassambaya) : 0.6–0.9 (1.5 Sassambaya) : 0.7–1.1 (1.4 Sassambaya) : 0.8 : 1.3; body length to length of cercus to length of terminal filum = 1 : 1.5–1.6 : 2. 5–2.6.; terminal filum to cercus length = 1.65–1.75.

Colouration of cuticle: Meso- and metathorax yellowish-brown, head and prothorax lighter, abdomen yellowish-white, cerci white, median notal suture conspicuously brown.

Epidermal pigmentation: Frons and vertex more or less brown, posterior vertex with a dark brown transverse band. Pronotum with a transverse band and a more or less pronounced pattern of brown spots. Additional greyish to blackish-brown pigmentation on prealar bridges, metapleura and hind margin of metanotum, scutellum, prosternum and surrounding of coxae. Abdominal terga I–III with greyish-brown transverse bands, segments IV–VI only with sublateral marks, VII–IX also with the median parts pigmented, sometimes with paramedian longitudinal blackish-brown bands. Paratergal dashes or spots more or less pronounced; if conspicuous, mainly present on segments III–VI. Most populations from Mali, Guinea and Ivory Coast have a reduced pigmentation.

Morphology

Head: Eyes relatively small. Base of antennal flagellum strongly dilated; dilated part usually a little longer than pedicel (MALZACHER 1993: fig. 8d).

Thorax: Prosternal triangle isosceles, apically pointed. Segments II–IV of fore tarsus more or less fused.

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in MALZACHER (1993: figs. 8b; 9a, b). Penis basally more or less distended, lobes narrow and pointed. Styliger sclerite with thin straight apophyses varying in length. Forceps long and straight (MALZACHER 1993: fig. 9d), apically with a long tuft of spines.

Female imago

Measurements and colouration

Body length 2.7–3.4 mm; wing length 2.3–2.7 mm.

Same colouration as in males. Females are characterized by the arrangement of paratergal dashes in strongly coloured specimens (see above: epidermal pigmentation in male imago).

Morphology

Prosternal triangle wider than in males, trapezoid-shaped or broadly rounded anteriorly.

Egg

Chorion inconspicuously pored, even in SEM pictures, often nearly smooth but with irregularly arranged, very small tubercles (Fig. 27). Two voluminous epithemata (Fig. 25), cap- or turban-shaped; very fine threads with small terminal knobs leading from margins of epithemata, spreading out all over egg-surface, a little sunken in (Figs. 26, 27). One or two micropyles moderate in length, sometimes slightly bent, situated between equator and epithemata; mouth broadened; a nearly circular and relatively deep sperm guide with a smooth surface (Figs. 25–27).

Larva unknown.

Distribution

Widely distributed and abundant in West Africa (included in 85 samples from 23 localities). In East Africa, *Caenis jinjana* is found in lakes and large rivers of Uganda and Abyssinia.

3.7 *Caenis antelucana* Malzacher, 1990 (Fig. 7a–i)

MALZACHER (1990: 12).

Material examined

Ivory Coast: River Maraoué, Entomokro, 17.VI.1974, several ♂♂.

Guinea: River Tomine, Télimélé, 27.I.1986, 10♂♂, 6♀♀. – River Koumba, near Sita, 26.I.1987, 52%. – River Milo, Bousoulé, 2.IV.1986, several ♂♂; 19.IV.1986, several ♂♂; 18.III.1987, 7%. – River Niandan, Sassambaya, 15.V.1986, 30%; 18.III.1987, 2%; 19.III.1987, 27%; 17.–18.VI.1987, 4%; 27.XI.1987, 4%;

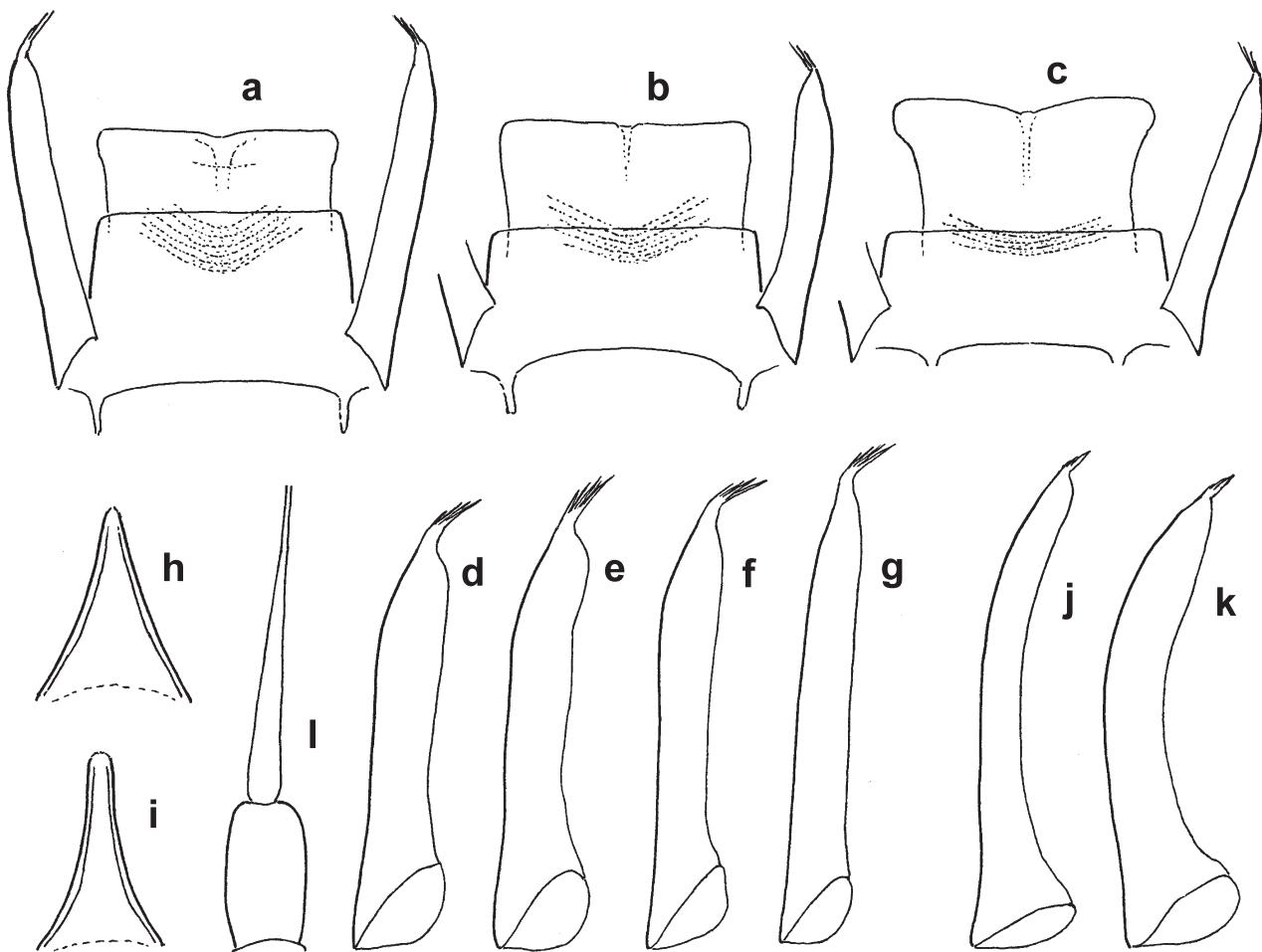


Fig. 7. *Caenis antelucana*, ♂ (a–i), *C. gilliesi*, ♂ (j, k), *C. kohli* n. sp., ♂ (l). – a–c. Genitalia, different shapes of styliger. d–g, j, k. Different shapes of forceips (j and k from the same sample). h, i. Prosternal triangle. l. Antennal pedicel and base of flagellum.

8.II.1988, 10 %. – River Konkouré, Linsan near Mourou, 29.I.1987, 2♂♂. – River Bafing, Timbo, 31.I.1987, 58 %. – River Loffa, Macenta, 30.I.1988, several ♂♂. – River Diani, N'zébélá, 31.I.1988, 14♂♂ and 4♂♂ SI.

Mali: River Niger, Tienfala, 23.V.1986, 1♂. – River Bakoye, Kokofata, 22.VIII.1986, 36%; 6.X.1986, 2%; 24.X.1986, 20%; 7.XI.1986, several ♂♂; 4.VIII.1987, 1%; 20.11.1987, 1%.

Redescription

Male imago

Measurements, ratios and colouration

Body size and ratios highly variable in populations from different regions: Body length 1.7–2.0 mm (Gambia, Senegal), 2.3–2.8 mm (Guinea: Boussoulé, Nzebelá); wing length 1.5–1.6 mm (Gambia, Senegal), 1.8–2.3 mm (Guinea: Boussoulé, Nzebelá, Sita); length of fore leg 0.8 mm (Gambia, Senegal), 1.0–1.2 mm (Guinea: Boussoulé, Nzebelá); fore femur to fore tibia length = 0.89–

0.97 (Gambia, Senegal), 0.82–0.90 (Guinea: Boussoulé), 0.55–0.63 (Guinea: Nzebelá); fore tibia to fore tarsus length = 1.15–1.28 (Gambia, Senegal), 1.28–1.46 (Guinea: Boussoulé, Nzebelá); fore leg to hind leg length = 1.02–1.15 (Gambia, Senegal), 1.11–1.22 (Guinea: Boussoulé), 1.51–1.55 (Guinea: Nzebelá); 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 1.2–1.7 : 1.0–1.3 : 1.0–1.2 : 1.0–1.3; body length to length of cercus to length of terminal filum = 1 : 1.6 : 2.5; terminal filum to cercus length = 1.6.

Colouration of cuticle: Very light, thorax yellow to yellowish-orange, other parts white.

Epidermal pigmentation: Frons, vertex and fore margin of pronotum more or less greyish-brown. Metanotum and abdominal terga with greyish-brown transverse bands, often more or less interrupted medially. Prosternal triangle often with blackish-brown pigment. Sutures of metasternum often strongly pigmented, forming an H-shaped figure. Pigmentation more or less reduced in most populations.

Morphology

Head: Base of antennal flagellum strongly dilated; dilated part 1.5–2 times pedicel length (MALZACHER 1990: fig. 7d).

Thorax: Prosternal triangle equilateral or isosceles, apically pointed or with rounded or cut tip (Fig. 7h, i).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in MALZACHER (1990: fig. 7a, b). Penis lobes short and broadly triangular, or nearly absent, penis shape rarely rectangular or quadrate; ventrally with about 4–6 slightly sclerotized transverse folds (Fig. 7a–c). Stylinger sclerite variable in length; apophyses very thin, also variable in length, sometimes absent. Forceps long and straight, sides more or less parallel (Fig. 7d–g, MALZACHER 1990: fig. 7e), apically with a short tuft of spines.

Female imago and larva unknown.

Distribution

Caenis antelucana and *C. cibaria kunda* have a similar distribution range. Each of them are included in 28 samples, in 17 samples from 7 localities they are accompanied by each other. Other species can also often be found together with *C. antelucana*: *C. brevipes* in 20 samples from 7 localities, *C. berneri* in 23 samples from 9 localities and *C. jinjana* in 18 samples from 8 localities. *C. antelucana* is recorded for the first time from Gambia and Senegal.

3.8 *Caenis jinjanoides* n.sp.

(Figs. 8a, b; 9e–j, 28, 29)

Holotype, ♂ (on microslide): **Guinea**, River Bafing, Timbo, 31.I.1987.

Paratypes: Same data as holotype, 70♂♂, 4♀♀.

Other material: **Guinea**: River Milo, Boussoulé, 24.I.1985, 18♂♂, 6♀♀; 28.III.1985, 16%, 31.VI.1985, 62%; 22.I.1987, 14%. – River Feredougouba, Badala, 4.III.1985, 14%. – River Kaba, Faranah–Mamaou, 7.II.1986, 2♂♂. – River Kolente, Kolente, 9.II.1986, 1%. – River Kolente, Kora, 10.II.1986, 6%. – River Kakrima, Kouri, 15.II.1986, 16% incl. 8♀♀. – River Kokoulou, road Pita–Madina, 25.I.1987, 15%. – River Nian-dan, Sassambaya, 5.VI.1987, 5♂♂. – River Koumba, near Sita, 26.I.1987, 4%. – River Tinkisso, Dabola, 30.I.1987, 35♂♂, 4♀♀; 1.II.1987, 3♂♂. – River Diani, N’zébéla, 31.I.1988, 1♂. – **Ivory Coast**: River Cavally, Tiboto–Grabo, 11.II.1988, 16♂♂.

Etymology

The species was named ‘jinjanoides’ because of its similarities with *Caenis jinjana*, e.g. very short fore tibiae.

Description

Male imago

Measurements, ratios and colouration

Body length 1.8–2.3 mm (Guinea, Milo), 2.2–2.9 mm (Guinea, Kokoulou); wing length 1.6–1.8 mm (Guinea, Milo), 2.0–2.3 mm (Guinea, Kokoulou); length of fore leg 1.0–1.2 mm (Guinea, Milo), 1.2–1.4 mm (Guinea, Kokoulou); fore femur to fore tibia length = 1.19–1.32 (Guinea, Milo), 0.94–1.09 (Guinea, Kokoulou); fore tibia to fore tarsus length = 0.95–1.12 (Guinea, Milo), 1.00–1.17 (Guinea, Kokoulou); fore leg to hind leg length = 1.03–1.18 (Guinea, Milo), 1.19–1.23 (Guinea, Kokoulou); 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 1.2–2.1 : 0.9–1.6 : 1.0–1.6 : 1.0–1.7; body length to length of cercus to length of terminal filum = 1 : ±1.9 : ±2.7; terminal filum to cercus length = ±1.45.

Colouration of cuticle: Meso- and metathorax yellowish-brown, median notal suture often brown, head and prothorax lighter, abdomen yellowish-white, cerci white.

Epidermal pigmentation: Frons and vertex greyish-brown. Pronotum grey, with blackish-brown margins and a median transverse line. Pleura with spots and dashes. Sutures and medio-longitudinal line of mesosternum often pigmented. Abdominal terga with blackish grey transverse bands, centrally lighter on posterior terga; lateral marks often with central brighter areas. In strongly coloured specimens (e.g. from River Bafing) transverse bands or lateral marks, as well as blackish lateral dashes, are also observed on abdominal sterna.

Morphology

Head: In populations with strongly coloured specimens (River Bafing) eyes often a little smaller than in populations with lighter specimens (River Milo). Base of antennal flagellum strongly dilated; dilated part about half as wide as pedicel.

Thorax: Prosternal ridges narrow, forming a broad, apically rounded triangle or a trapezoid structure with straight or concave sides (Fig. 9j).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments very short or absent.

Genitalia and sternum IX as in Fig. 8a, b. Base of penis broadened, lobes short, more or less triangular and apically rounded. Stylinger sclerite with short or very short apophyses. Forceps of moderate length (variable), in most cases medially more or less abruptly bent (Fig. 9e–i), apically with a long tuft of spines. Forceps and genital sclerites slightly brownish. Sternite IX in strongly pigmented specimens with blackish deposits as in Fig. 8a.

Female imago

Measurements and colouration

Body length 3.4–3.8 mm; wing length 2.5–2.7 mm.

Same colouration as in males. Females are characterized by the colouration of the mesosternum in strongly coloured specimens.

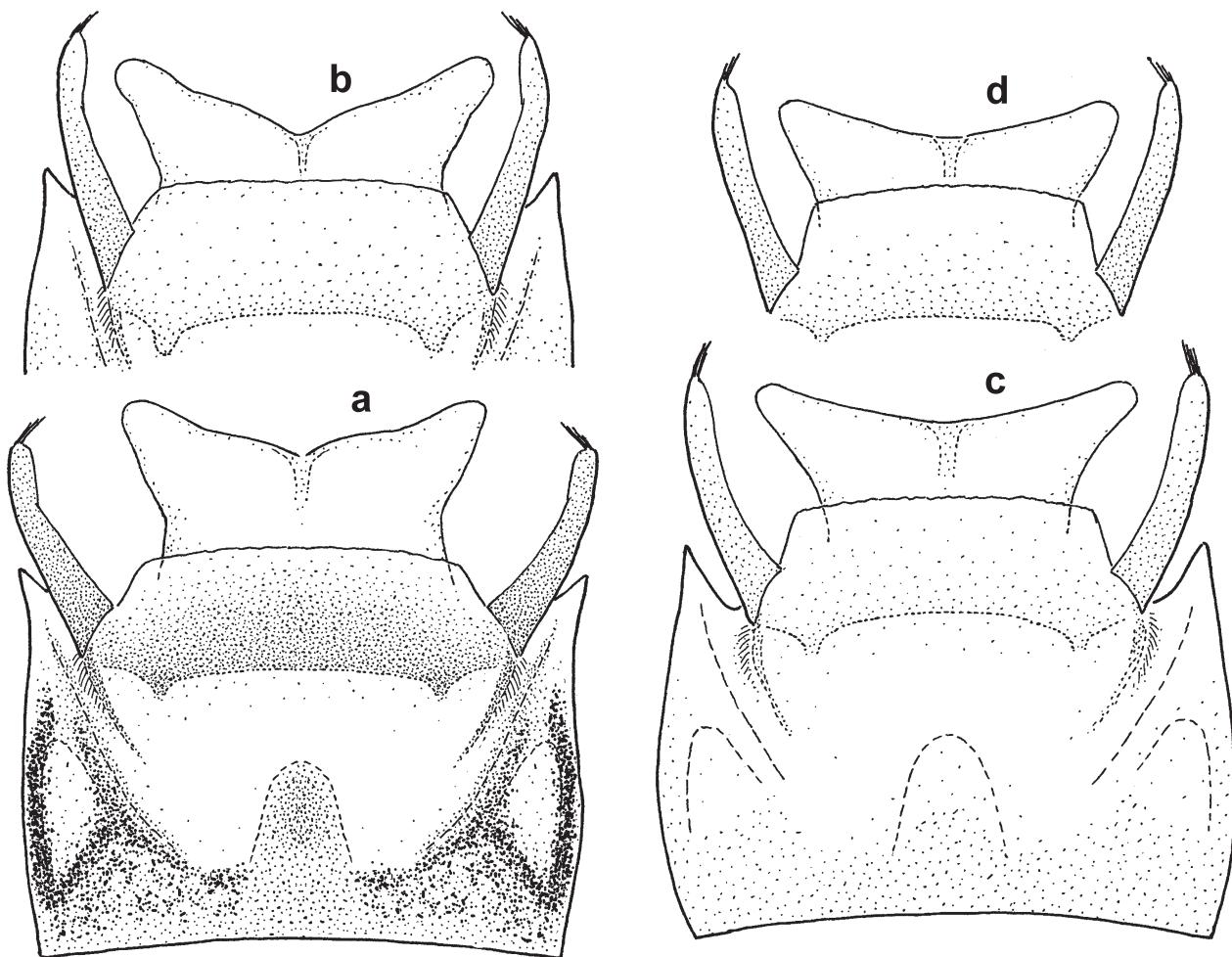


Fig. 8. *Caenis* spp., ♂ genitalia. – **a, b.** *C. jinjanoides* n. sp. **c, d.** *C. kohli* n. sp.

Morphology

Prosternal triangle very broad, trapezoid-shaped.

Egg

Epithemata absent (Fig. 28). Chorion conspicuously structured, with circular, penta- or hexagonal fields, their elevated margins broadly bulged (Fig. 29). One or two micropyles of moderate length situated in the equatorial plane; mouth region narrowed, bordered by small pores; sperm guide small and circular with a diminished chorion structure (Fig. 29).

Larva unknown.

Differential diagnosis

Caenis jinjanoides n. sp. is similar to the species of the *C. brevipes* group and to *C. jinjana* (see discussion, chapter 5). For the differences see couplets 10 and 11 in the key below (chapter 4).

Distribution

C. jinjanoides seems to be restricted to Guinea and the south-western Ivory Coast. The species is accompanied by *C. gilliesi* in 14 of 17 samples from 13 localities.

3.9 *Caenis brevipes* Kimmins, 1956 (Figs. 30–33)

KIMMINS (1956: 84); THEW (1960: 199) (sub *Caenomedea brevipes*); DEMOULIN (1970: 159) (sub *Caenomedea brevipes*); MALZACHER (1993: 406). – Including *Caenis brevipes occidentalis* Malzacher, 1993 (see discussion, chapter 5).

Material examined

Ivory Coast: River Maraoué, Entomokro, 17.VI.1974, several ♂♂.

Guinea: River Bafing, Timbo, 31.I.1987, 6%. – River Milo, Boussoulé, 17.II.1987, several ♂♂; 18.III.1987, 14%. – River Niandan, Sassambaya, 20.IV.1986, several ♂♂; 15.V.1986, 30%; 17.–18.VI.1986, 26–42%; 19.III.1987, 8%; 26.XI.1987,

several ♂♂; 27.XI.1987, 80%; 12.IV.1988, 3 ♂♂; 8.II.1988, 4%; 7.IV.1988, several ♂♂; 16.V.1988, several ♂♂. – River Koumba, near Sita, 26.I.1987, 11%.

Mali: River Niger, Tienfala, 21.V.1986, 80%; 23.V.1986, 86%; 27.V.1986, 97%; 28.VIII.1986, 84%. – River Senegal, Chutes du Felou, 13.I.1986, 6 ♂♂. – River Bakoye, Kokofata, 24.X.1986, 24%; 8.VII.1986, several ♂♂; 6.VIII.1986, 4 ♂♂; 9.II.1987, 1 ♂; 2.VII.1987, several ♂♂; 23.VIII.1987, 46%; 6.X.1987, 97%; 4.VIII.1987, 45%; 20.XI.1987, 80%.

Redescription

Male imago

Measurements, ratios and colouration

Body size and ratios between populations from different regions are highly variable: Body length 2.2–3.7 mm (Sudan: 2.2–2.8 mm; Guinea, Niandan: 2.5–3.3 mm; Abyssinia: 2.8–3.7 mm); wing length 1.8–3.3 mm (Gambia: 1.8–2.0 mm; Guinea, Niandan: 1.9–2.6 mm; Abyssinia: 2.6–3.3 mm); length of fore leg 1.3–2.3 mm (West Africa: 1.3–1.7 mm, Abyssinia: 1.7–2.3 mm); fore femur to fore tibia length = 0.47–0.95 (Kenya: 0.47–0.63; Guinea, Niandan: 6.2–7.8; Tanzania: 0.72–0.74; Mali: 6.4–8.8; Gambia: 7.1–9.5); fore tibia to fore tarsus length = 1.32 (Tanzania) – 1.92 (Gambia); fore leg to hind leg length = 1.18–1.85 (Gambia: 1.18–1.30; Guinea, Niandan: 1.26–1.50; Abyssinia: 1.53–1.85); 1st: 2nd: 3rd: 4th: 5th fore tarsal segments length = 1 : 1.4–3.0 : 1.0–1.7 : 0.6–1.4 : 1.0–1.8; body length to length of cercus to length of terminal filum = 1 : ±2.3 : ±3.3; terminal filum to cercus length = ±1.45.

Colouration of cuticle: Meso- and metathorax yellowish-brown or reddish-brown, head and prothorax distinctly lighter, abdomen yellowish-white or white.

Epidermal pigmentation: Head more or less brown dorsally, vertex with a dark brown transverse band. Pronotum with two paramedian spots and different marks on its lateral parts, sometimes only with two marks at the fore corners. Additional greyish to blackish-brown pigmentation is found on prealar bridges, metapleura and hind margin of metanotum, scutellum, prosternum, and surroundings of coxae. Abdominal terga with greyish-brown transverse bands which are more or less interrupted in the middle. Paratergal and parasternal blackish-brown dashes or spots present. On segments III–VI the parasternal dashes or spots are more pronounced, on segments VII–IX both are of similar intensity, forming more or less parallel bands in lateral view. Margins of fore femora and fore tibiae greyish. Many populations from West Africa show a more or less reduced pigmentation.

Morphology

Head: Base of antennal flagellum dilated; dilated part as long as or a little longer than pedicel and at least as wide as half of the pedicel width (MALZACHER 1993: fig. 14e, f).

Thorax: Prosternal triangle isosceles, with slightly concave sides, apically pointed or rounded. Fore tarsus

apically with small bristles beginning at the apical end of segment III.

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments short or slightly elongated.

Genitalia and sternum IX as in MALZACHER (1993: fig. 14a, b). Penis lobes very long and of different shape. Apophyses of styliger sclerite short and inconspicuous, sometimes a little longer. Forcipes long and more or less regularly bent, apically with a tuft of spines of moderate length (MALZACHER 1993: fig. 14c). Forcipes and genital sclerites more or less brownish tinted.

Female imago

Measurements and colouration

Body length 3.8–5.0 mm; wing length 3.8–4.3 mm.

Same colouration as in males. Females are characterized by the shape and the arrangement of paratergal and parasternal dashes in combination with the body size.

Morphology

Prosternal triangle wider than in males.

Egg

Chorion, even in SEM pictures, inconspicuously pored, often nearly smooth. Two broad epithemata, cap-shaped with small knobs, often covering a large and irregular area around the poles (Figs. 30, 31). Two elongated micropyles (Fig. 30), occasionally a little bent towards the equatorial plane, with broadened mouth and a flat round sperm guide (Fig. 33). In the specimen shown in Fig. 32 a part of the epithelial threads have become uncoiled by attaching their knobs to another egg.

Larva unknown.

Distribution

Senegal, Gambia, Guinea, Mali and Ivory Coast, with some distribution gaps. In big rivers the species is often abundant. *C. brevipes* was often collected together with *Caenis berneri*, *C. cibaria* and *C. antelucana*. It also occurs in Sudan, Abyssinia, Kenya, Uganda, and Tanzania.

3.10 *Caenis kohli* n.sp.

(Figs. 7l; 8c,d; 9a–d, 34–36)

Holotype, ♂ (on microslide): **Guinea**, River Tomine (Rio Corubal), Télimélé, 27.I.1986.

Paratypes: Same data as holotype, 4 ♂♂ and 1 ♂ SI, 16 ♀♀.

Other material: **Guinea**, River Konkouré, Linsan near Mourou, 29.I.1987, 5 ♂♂ and 5 ♂♂ SI, 10 ♀♀.

Etymology

The new species is dedicated to Dr. HELMUT KOHL, former chancellor of the Federal Republic of Germany, for his merits in the reunification of Germany.

Description

Male imago

Measurements, ratios and colouration

Body length 3.6–4.2 mm; wing length 2.7–3.1 mm; length of fore leg 2.0–2.4 mm; fore femur to fore tibia length = 0.83–0.94; fore tibia to fore tarsus length = 1.19–1.35; fore leg to hind leg length = 1.16–1.33; 1st:2nd:3rd:4th:5th fore tarsal segments length = 1:2.0–2.3:1.5–1.8:1.3–1.7:1.3–1.7; body length to length of cercus to length of terminal filum = 1:±1.8:±2.6; terminal filum to cercus length = ±1.44.

Colouration of cuticle: Meso- and metathorax yellowish-brown, head, prothorax and abdomen light brownish.

Epidermal pigmentation: Head grey dorsally, vertex with two transverse blackish bands, base of eye black; bases of antennae grey, and rudiments of maxillae apically with intense black spots (Fig. 9d). Pronotum grey, anterolateral with two transverse blackish dashes; fore coxae and pleura with grey marks, blackish lines running from the base of the strongly pigmented prosternal triangle towards the lateral margins. Besides diffuse greyish areas, blackish pigment on mesothorax are concentrated along the sutures and on the middle and hind coxae. Abdominal terga with greyish transverse bands which more or less interrupted in the middle. Anterior sterna often also with greyish pigment. Parasternal dashes mainly on segments II–VI, other marginal pigmentation inconspicuous or absent.

Morphology

Head: Base of antennal flagellum dilated; dilated part distinctly longer and about half as wide as pedicel (Fig. 7l).

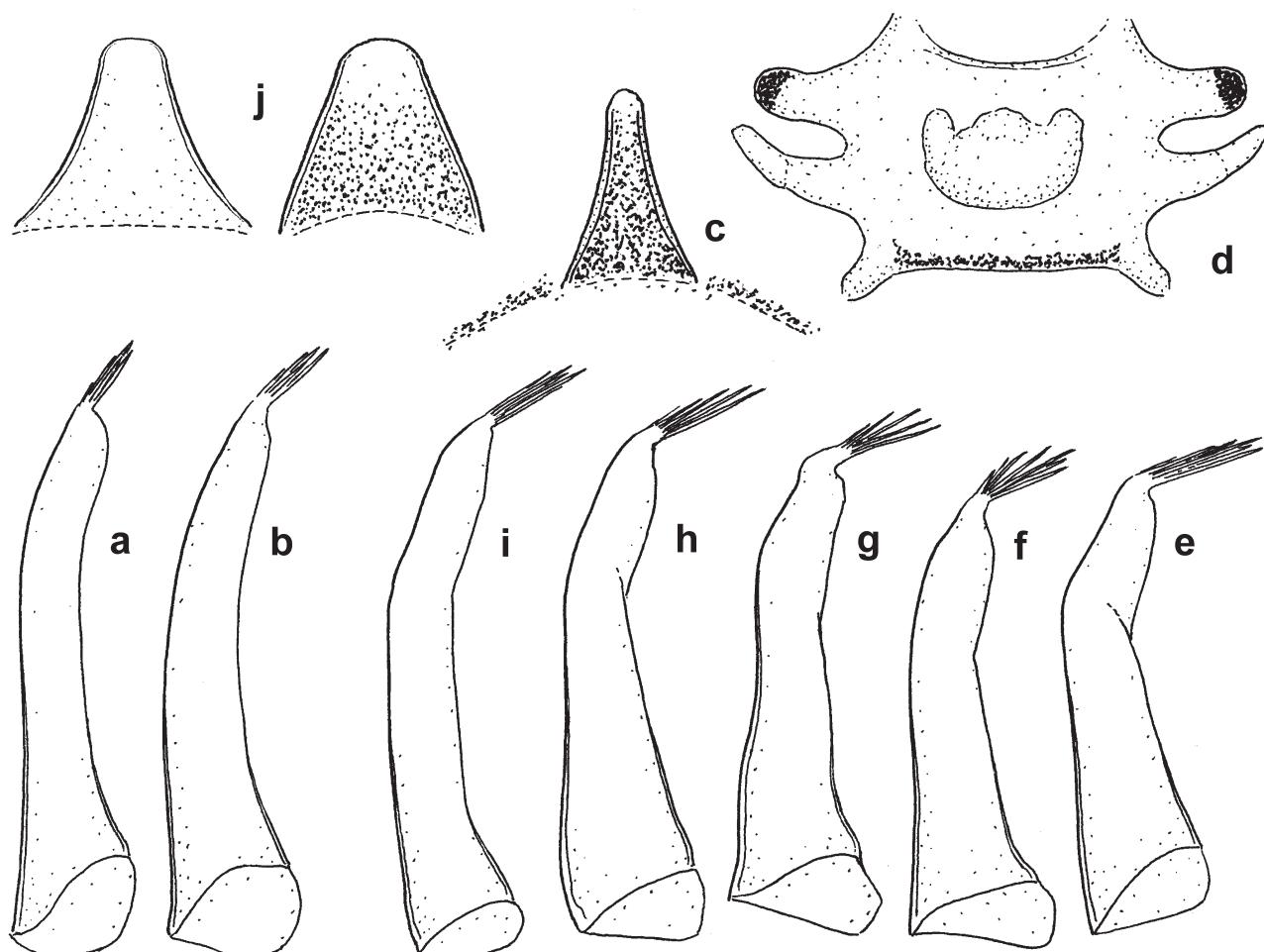


Fig. 9. *Caenis kohli* n. sp., ♂ (a–d), *C. jinjanoides* n. sp., ♂ (e–j). – a, b, e–i. Different shapes of forceps. c. Prosternal triangle. d. Rudiments of mouthparts. j. Prosternal triangle.

Thorax: Prosternal triangle more or less elongated and narrow, with slightly concave sides and a rounded tip (Fig. 9c). Fore tarsus apically with small bristles, beginning at the apical end of segment IV.

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments short.

Genitalia and sternum IX as in Fig. 8c, d. Sides of penis slightly concave, lobes slender and apically rounded. Apophyses of styliger sclerite short and inconspicuous. Forceps moderate in length and more or less regularly bent, apically with a tuft of spines also moderate in length (Fig. 9a, b). Forceps slightly brownish tinted.

F e m a l e i m a g o

Measurements and colouration

Body length 4.5–5.7 mm; wing length 3.5–4.2 mm.

Colour pattern as in males, but dorsally with stronger pigmentation, e.g. abdominal terga totally pigmented. Females are characterized by black spots on the maxillary rudiments in combination with body size in West African specimens.

Morphology

Prosternal triangle wider than in males.

E g g

Chorion with a very fine plush-like structure (Figs. 35, 36). One very flat epithema, often with an eccentric position towards the pole (Fig. 34). Epithema of coiled-rope-type (Fig. 35), i.e. a number of threads are rolled up like ropes, their large terminal knobs (4–6) situated in the centre of the coil. Threads form loops by turning about (Fig. 35, right) (see discussion, chapter 5). One micropyle, situated in the equatorial plane; mouth not broadened; sperm guide small, without any surface structure (Fig. 36).

Larva unknown.

Differential diagnosis

Caenis kohli n. sp. is similar to *C. brevipes* and *C. bernieri*. For the differences see couplets 12 and 13 in the key below (chapter 4).

Distribution

Only a few records from western Guinea.

3.11 *Caenis bernieri* Kimmins, 1955 (Fig. 10)

KIMMINS (1955: 879); THEW (1960: 201); DEMOULIN (1970: 150); MALZACHER (1993: 408).

Material examined

Ivory Coast: River Cavally, Tiboto-Grabo, 22.II.1978, 12♂♂.
Guinea: River Bafing, Timbo, 31.V.1983, 4♂♂; 31.I.1987, several ♂♂. – River Tomine, Télimélé, 27.I.1986, 7♂♂ SI. – River Dubreka, Dubreka, 10.II.1986, several ♂♂. – River Milo, Boussoulé, 2.IV.1986, several ♂♂; 21.IV.1986, 2♂♂; 22.I.1987, several ♂♂; 18.III.1987, 76 %. – River Niandan, Sassambaya, 15.V.1986, 20%; 17.–18.VI.1986, 34–46%; 10.XII.1986, 2♂♂; 19.III.1987, 51%; 27.XI.1987, 15%; 12.IV.1988, 85%; 8.II.1988, 76%; 16.V.1988, several ♂♂. – River Niandan, Kissidougou, 22.I.1987, 1♂. – River Konkouré, Linsan near Mourou, 29.I.1987, several ♂♂. – River Kaba, Kaba, 23.I.1987, 3♂♂. – River Kaba, Tene, 24.I.1987, 1♂. – River Makona, Nangoa, 19.II.1987, 1♂. – River Diani, N'zébéla, 31.I.1988, several ♂♂.

Mali: River Niger, Tienfala, 21.V.1986, 20%; 23.V.1986, 32% (very pale); 27.V.1986, 3%. – River Bakoye, Kokofata, 22.VIII.1986, 3♂♂; 28.VIII.1986, 10%; 24.X.1986, 25%; 23.VIII.1987, 10%; 6.X.1987, several ♂♂; 20.XI.1987, several ♂♂.

Redescription

M a l e i m a g o

Measurements, ratios and colouration

Body length 1.8–2.9 mm; wing length 1.4–2.6 mm (Guinea, Niandan and Mali, Niger: 1.4–1.9 mm; East Africa and Guinea, Kaba: 2.1–2.6 mm); length of fore leg 1.0–1.7 mm (Guinea, Niandan and Mali, Niger: 1.0–1.3 mm; East Africa and Guinea, Kaba: 1.4–1.7 mm); fore femur to fore tibia length = 0.48–0.76 (Guinea, Niandan and Mali, Niger: 0.57–0.76; East Africa and Guinea, Kaba: 0.48–0.59); fore tibia to fore tarsus length = (1.36) 1.45–1.79 (1.98); fore leg to hind leg length = 1.38–1.81 (Guinea, Niandan and Mali, Niger: 1.38–1.58; East Africa and Guinea, Kaba: 1.65–1.81); 1st: 2nd: 3rd: 4th: 5th fore tarsal segments length = 1 : 1.7–2.8 : 0.8–1.9 : 0.8–1.6 : 0.8–1.7; body length to length of cercus to length of terminal filum = 1 : ±2.1 : ±3.3; terminal filum to cercus length = ±1.60.

Colouration of cuticle: Meso- and metathorax reddish or chocolate brown, head and prothorax light-brown, abdomen yellowish-white or white, tergite X with conspicuous brown sclerites.

Epidermal pigmentation: Head more or less grey dorsally, vertex occasionally with a dark transverse band. Pronotum with two paramedian spots and anterolateral marks which differ in shape and intensity. Additional greyish pigmentation on mesonotal sutures, scutellum, prealar bridges and metapleura. Metanotum sometimes with a longitudinal median blackish-grey line. Abdominal terga with greyish transverse bands, on terga VI–IX more or less interrupted medially. Usually no conspicuous paratergal dashes or spots. Pigmentation strongly reduced in many populations.

Morphology

Head: Base of antennal flagellum only slightly dilated; dilated part shorter than pedicel and about one-fourth as

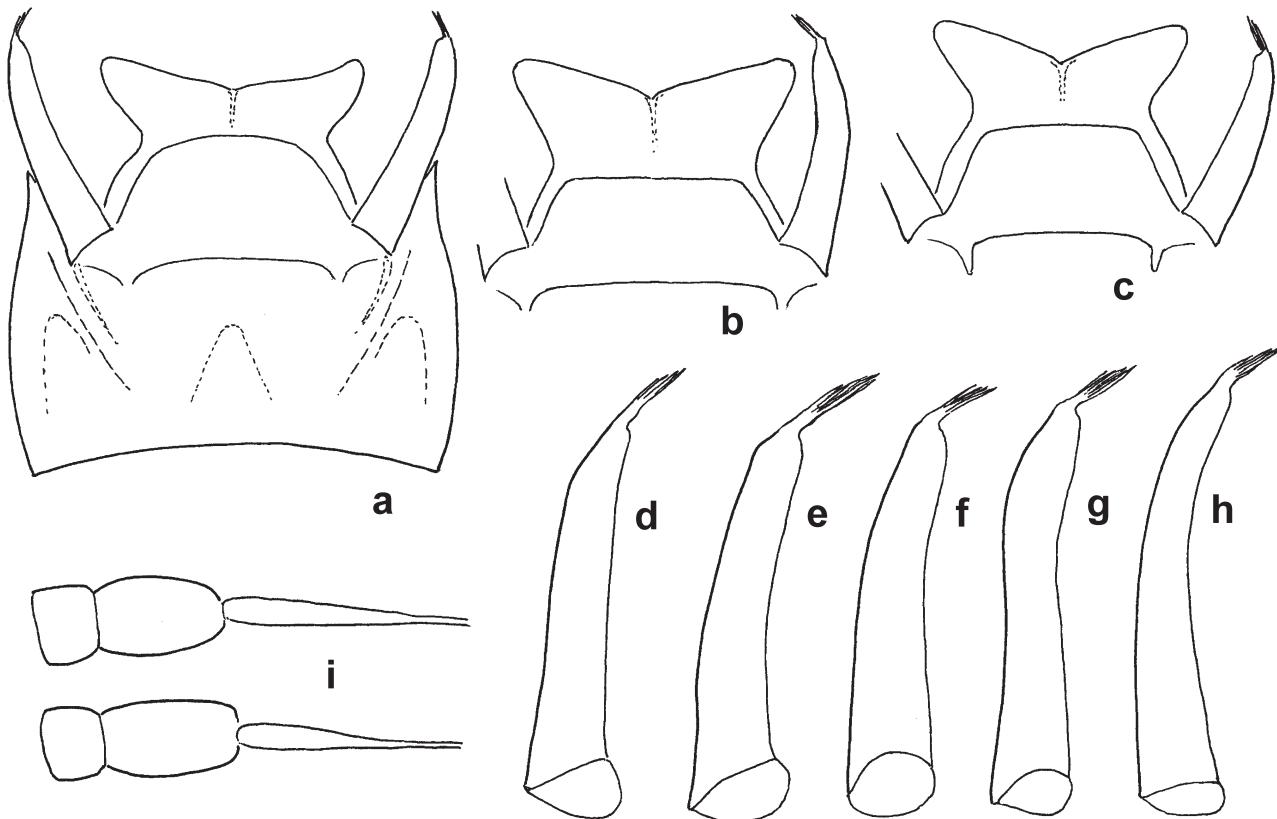


Fig. 10. *Caenis berneri*, ♂. – a–c. Genitalia, different shapes of styliger. d–h. Different shapes of forceps. i. Antennal scape, pedicel and base of flagellum.

wide (MALZACHER 1993: fig. 15c); the dilated part is longer and about one-third as wide as pedicel in populations of West Africa (Fig. 10i).

Thorax: Prosternal triangle apically broadly rounded or cut.

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments short.

Genitalia and sternum IX as in Fig. 10a–c and MALZACHER (1993: fig. 15a, b). Penis lobes triangular, variable, distinctly shorter than in *Caenis brevipes*. Styler with rounded hind margin (East Africa) or more or less trapezoid with rounded corners (most specimens from West Africa). Apophyses of styliger sclerite short or absent, longer in some populations of West Africa. Forceps relatively short, straight or only slightly bent, apically with a tuft of spines of moderate length, occasionally longer (Fig. 10d–h and MALZACHER 1993: fig. 14c). Forceps and genital sclerites more or less brownish. A broadly triangular shape of central sclerite is observed in strongly coloured specimens. The regularly rounded sides of segment IX are converging posteriorly in most East African specimens, forming medially bent posterolateral spines; this characteristic shape is not found in West African populations.

No female imago was available for this study; according to KIMMINS (1955) it has a wing length of 2.6–3.2 mm. Larva unknown.

Distribution

Similar to that of *Caenis brevipes* but more records. Furthermore known from Kenya and Tanzania.

3.12 *Caenis pallida* Malzacher, 1990 (Fig. 11a–g)

MALZACHER (1990: 16).

Material examined

Guinea: River Milo, Boussoulé, 19.IV.1986, 3♂♂.

Redescription

Male imago

Measurements, ratios and colouration

Body length 3.7–4.2 mm; wing length 2.8–3.7 mm; length of fore leg 2.5–3.0 mm; fore femur to fore tibia

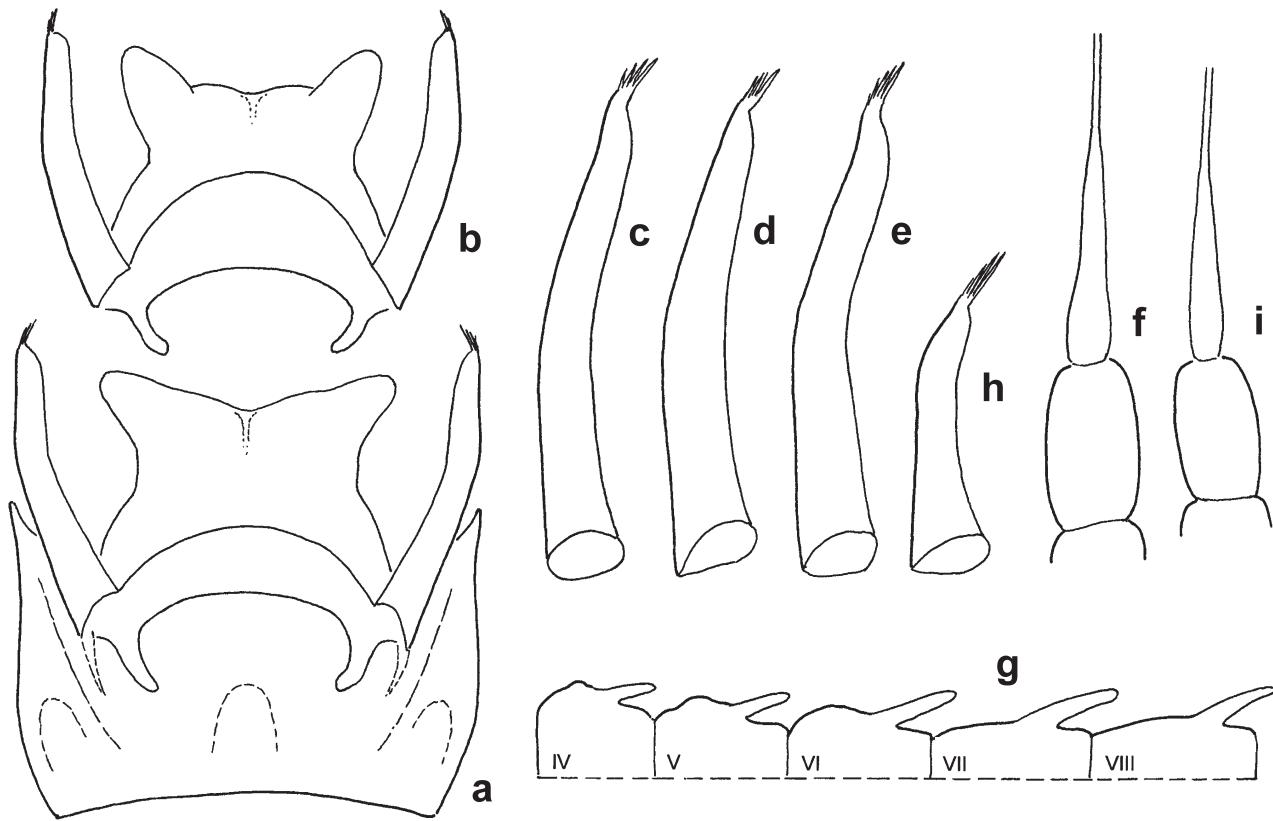


Fig. 11. *Caenis pallida*, ♂ (a–g), *C. orthostilata* n. sp., ♂ (h, i). – a, b. Genitalia, different shapes of styliger. c–e, h. Different shapes of forcipes. f, i. Antennal scape, pedicel and base of flagellum. g. Margins of abdominal segments IV–VIII with lateral processes.

length = 0.56–0.65 (East Africa), 0.70–0.72 (Guinea: River Milo); fore tibia to fore tarsus length = 1.45–1.83; fore leg to hind leg length = 1.56–1.68 (East Africa), 1.41–1.43 (Guinea: River Milo); 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 1.6–2.8 : 1.2–1.8 : 1.3–1.7 : 1.4–2.1; body length to length of cercus to length of terminal filum = 1 : ±2.3 : ±3.0; terminal filum to cercus length = ±1.38.

Colouration of cuticle: Meso- and metathorax yellowish-brown or orange, other parts yellowish-white or white.

Epidermal pigmentation: Head more or less grey dorsally, vertex sometimes with a greyish transverse band. Pronotum with diffuse anterolateral marks, occasionally with two paramedian spots. Abdominal terga III–VII with more or less visible greyish transverse bands, terga I, II, VIII and IX only with lateral marks. Usually no conspicuous paratergal dashes or spots.

Morphology

Head: Base of antennal flagellum dilated; dilated part longer than pedicel and nearly half as wide; dilatation a little narrowed in its middle part (Fig. 11f and MALZACHER 1990: fig. 10c).

Thorax: Prosternal triangle isosceles, with straight or slightly concave sides; inconspicuous in East African specimens but with strong and broad ridges in specimens from Guinea. Segments II–IV of fore tarsus nearly totally fused (MALZACHER 1990: fig. 10d).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments IV–VIII elongated (Fig. 11g).

Genitalia and sternum IX as in Fig. 11a, b and MALZACHER (1990: fig. 10a). Penis lobes triangular and variable in width; dorsal side of penis medially with a small brown sclerite. Hind margin of styliger semi-elliptical. Styliger sclerite with a concave anterior margin, apophyses long and bent medially. Forceps long, more or less abruptly bent medially, apical part slightly S-shaped, with a tuft of 5–6 short spines (Fig. 11c–e and MALZACHER 1990: fig. 10b). Forceps and apophyses of styliger sclerite brownish.

Female imago and larva unknown.

Distribution

Just a single West African record from eastern Guinea. Furthermore known from Abyssinia and Tschad, River Schari.

3.13 *Caenis orthostilata* n.sp.

(Figs. 11h–i, 12)

Holotype, ♂ (on microslide): **Mali**, River Bakoye, Kokofata, 23.VIII.1987.

Paratypes: Same data as holotype, 50 ♂♂ and 12 ♂♂ SI, 2 ♀♀ and 2 ♀♀ SI; same locality, but 4.VIII.1987, 50 ♂♂.

Other material: **Mali**, River Senegal, Chutes du Feiou, 13.I.1986, several ♂♂.

Etymology

The species name ‘orthostilata’ refers to the straight forceps, in contrary to that of *Caenis pallida*.

Description

Male imago

Measurements, ratios and colouration

Body length 3.2–3.6 mm; wing length 2.1–2.5 mm; length of fore leg 2.0–2.2 mm; fore femur to fore tibia length = 0.54–0.58; fore tibia to fore tarsus length = 1.75–1.94; fore leg to hind leg length = 1.42–1.55; 1st : 2nd : 3rd : 4th : 5th fore tarsal segments length = 1 : 2.6–2.7 : 1.4–1.7 : 1.1–1.5 : 1.9–2.1.

Colouration of cuticle: Meso- and metathorax yellowish-brown, other parts yellowish-white to white.

Epidermal pigmentation: Hind margin of head dark blackish-brown; rudiments of maxillae apically with black spots; vertex with a transverse band, fore margin of frons and clypeus and lateral parts of pronotum greyish-brown; sutures of mesonotum, metanotum and pleura more or less blackish-brown. Abdominal terga with transverse greyish bands which are more or less interrupted in the middle; with strong paratergal dashes.

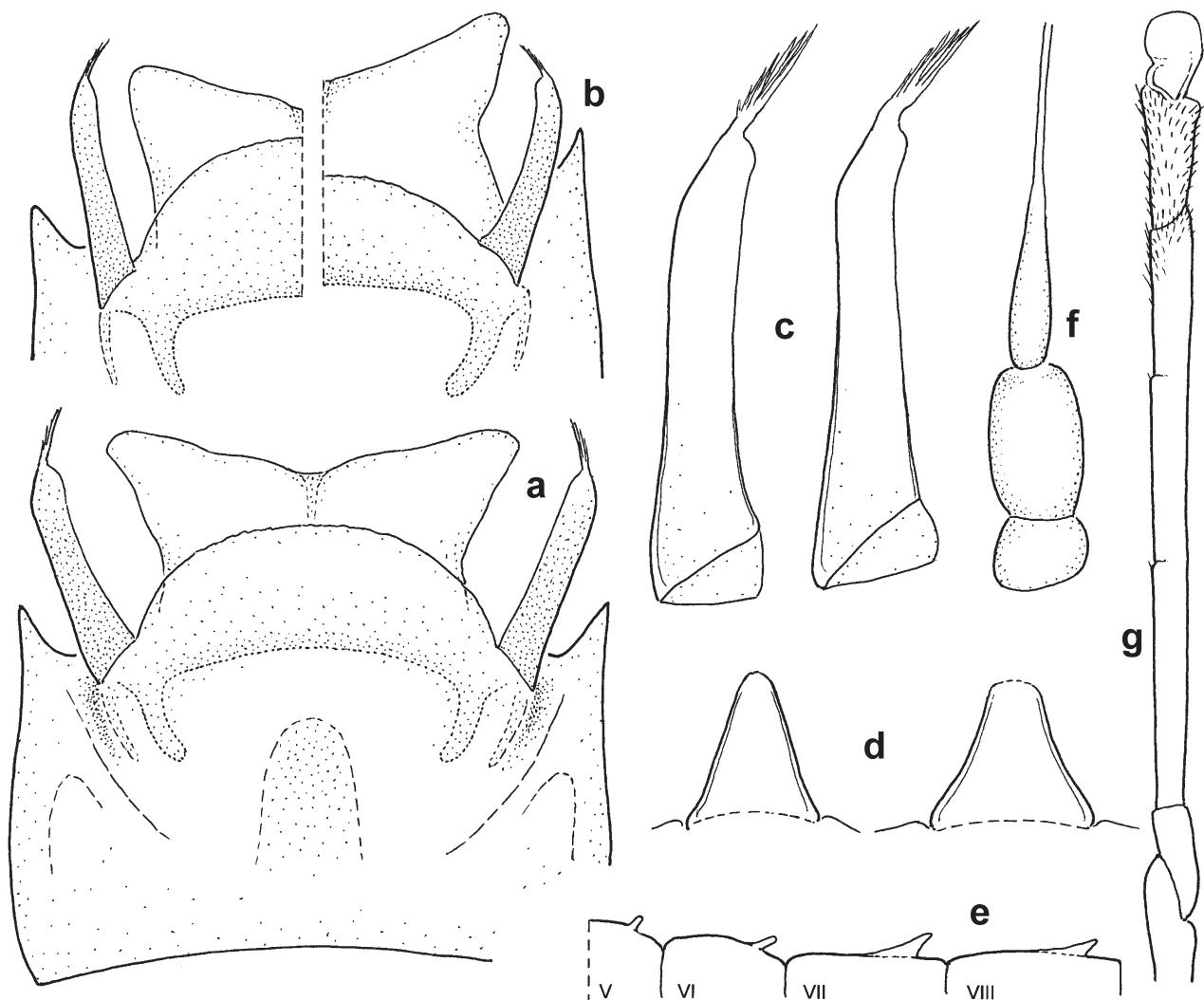


Fig. 12. *Caenis orthostilata* n.sp., ♂. – **a, b.** Genitalia, different shapes of styliger. **c.** Different shapes of forceps. **d.** Prosternal triangle. **e.** Margins of abdominal segments V–VIII with lateral processes. **f.** Antennal scape, pedicel and base of flagellum. **g.** Tarsus of fore leg.

Morphology

Head: Base of antennal flagellum strongly dilated; dilated part 1.5–2.0 times length of pedicel; pedicel relatively short with rounded sides, about twice as long as scape and about 1.7 times as long as wide (Fig. 12f).

Thorax: Prosternal triangle with a rounded tip or pointed, broader in specimens from Senegal (Fig. 12d). Segments II–IV of fore tarsus ventrally more or less fused (Fig. 12g).

Abdomen: Tergum II without a finger-like process. Lateral filaments of abdominal segments short, a little longer on segment VII, triangular on segments VII and VIII (Fig. 12e).

Genitalia and sternum IX as in Fig. 12a, b. Penis lobes triangular; dorsal side of penis medially with a small brown sclerite. Stylier sclerite with concave anterior margin, apophyses long and bent medially (stronger bent in specimens from Senegal, see Fig. 12b, right). Forceps apically with a tuft of long spines (Fig. 12c) and covered with trichomes sticking out of the surface.

Female imago

Measurements and colouration

Body length 4.4–4.7 mm; wing length 2.8–3.2 mm.

Same colouration as in males.

Morphology

Base of antennal flagellum weaker dilated than in males; prosternal triangle broader, abdominal segments V–VII with posterolateral processes distinctly longer than in males.

Egg

Chorion very inconspicuously pored. Two flat epithemata. One long and thin micropyle.

Larva unknown.

Differential diagnosis

Caenis orthostilata n. sp. is similar to *C. pallida* (see discussion, chapter 5). For differences see couplet 8 in the key below (chapter 4).

Distribution

Only two records known from southwestern Mali.

3.14 Caeninae gen. sp.
(Figs. 37–39)

Material examined

Guinea: River Tomine, Télimélé, 27.I.1986, 6 ♀♀. – River Bafing, Timbo, 31.I.1987, 23 ♀♀.

Description

Female imago

Measurements and colouration

Body length 3.5–3.7 mm; wing length 2.3–2.6 mm.

Colouration of cuticle: Mesothorax and basal part of cerci yellowish-brown, other parts yellowish-white to white.

Epidermal pigmentation: Head, pronotum and transverse bands on abdominal terga and sterna evenly blackish grey or greyish; sutures of mesonotum and ridges of prosternum with blackish-brown margins; mesosternum with conspicuous black sutures.

Morphology

Body and particularly abdomen thin and slender, segments VIII and IX more elongated than in other species. Prosternal ridges forming a trapezoid. Lateral filaments of abdomen very short.

Egg

Very elongated, in some specimens even more than shown in Fig. 37. One epithema with small knobs (Fig. 38) of variable shape, often pointed. Chorion with an irregular net of broad elevated bands; small fields in intermediate areas with marginal pores (Fig. 39). One long and thin micropyle situated in the middle of the egg; mouth somewhat broadened, sperm guide lacking; course of micropyle channel often disturbed and covered over by the elevations (Fig. 39).

4 Key to the male Caenidae of West Africa

- 1 Prosternum narrow, sclerotized margins forming a triangle or trapezoid. Coxae contiguous. **(Caeninae) 2**
- Prosternum broad. Coxae widely separated (MALZACHER & STANICZEK 2006: fig. 1e). **(Madecocercinae)** (for determination of West African Madecocercinae see MALZACHER & STANICZEK 2006)
- 2 Forceps short, apically rounded (Figs. 1f–n, 3c). **3**
- Forceps apically with spines or tufts of spines (e.g. Figs. 6a–f, 9e–i). **4**
- 3 Body length less than 2.5 mm. Forceps basally narrowed, apically often with a small bump (Fig. 3c). Basolateral sclerites of styliger clearly visible, often forming a shallow groove (Fig. 3a). Scutellum V-shaped and posteriorly pointed (Fig. 2k). Abdominal tergum II with a thin finger-like process. Subimago with a long vermiform process on mesonotum (Fig. 3f, g). ***Caenis vermifera* n. sp.**
- Body length more than 3.5 mm. Forceps basally broadened (Fig. 1f–n). Stylier nearly unsclerotized (Fig. 1a–e). Scutellum posteriorly rounded (Fig. 2j). Vermiform and finger-like processes lacking [subimago unknown]. ***Caenis elouardi***
- 4 Penis lobes short or absent, laterally rounded or with indistinct blunt corners (Figs. 4a–c, 5a–f). Segments II–IV of fore tarsus apically with lateral tufts of short and strong spines (Fig. 6i). **5**

- Penis lobes more or less elongated, triangular or with nearly rectangular corners (e.g. Figs. 7a–c, 8a–d). Segments II–IV of fore tarsus apically without tufts of spines..... 7
- 5 Forcipes apically with a tuft of long spines (Fig. 4d). Apophyses of styliger sclerite long and parallel (Fig. 4a–c)..... *Caenis cibaria kunda*
- Forcipes apically with one or a few short spines (Figs. 6a–h, 7j–k). Apophyses of styliger sclerite short or long and diverging anteriorly (Fig. 5a–f, MALZACHER 1990: fig. 6c)..... 6
- 6 Forcipes long and bowed, apically with three short spines (Fig. 7j, k). Apophyses of styliger sclerite very long and bent laterally (MALZACHER 1990: fig. 6c)..... *Caenis gilliesi*
- Forcipes short and more or less straight, apically with only one strong spine, sometimes a thin and very inconspicuous second one visible (Fig. 6a–h). Apophyses of styliger sclerite short or a little longer and slightly bent (Fig. 5a–f)..... *Caenis nigricola* n. sp.
- 7 Apophyses of styliger sclerite long, broad and more or less curved medially (Figs. 11a, b; 12a, b). Segments II–IV of fore tarsus fused on ventral side (Fig. 12g)..... 8
- Apophyses of styliger sclerite short; if longer then narrow and straight (Figs. 8a–d, 10a–c). Segments II–IV of fore tarsus not fused..... 9
- 8 Forcipes more or less abruptly bent medially, as long as the distance between the extreme lateral points of the forceps bases (Fig. 11a–e), about 10 times as long as apical spines (Fig. 11c–e). Dilated part of antennal flagellum slightly concave in its median part (Fig. 11f). Abdomen with lateral filaments about half as long as the segments (Fig. 11g)..... *Caenis pallida*
- Forcipes shorter, more or less straight, reaching about two-thirds of the distance between the extreme lateral points of the forceps bases (Figs. 12a–c, 11h). Apical spines long, forceps 4.5–5.0 times as long as apical spines (Fig. 12c). Dilated part of antennal flagellum slightly convex (Figs. 11i, 12f). Abdomen with short lateral filaments (Fig. 12e)..... *Caenis orthostilata* n. sp.
- 9 Penis with short or nearly lacking lobes, more or less rectangular, with 4–6 sclerotized cross folds ventrally (Fig. 7a–c)..... *Caenis antelucana*
- Penis with conspicuous triangular lobes (Figs. 8a–d, 10a–c), ventrally without sclerotized folds..... 10
- 10 Fore tibia as long as or shorter than fore femur..... 11
- Fore tibia longer than fore femur..... 12
- 11 Forcipes long and straight (MALZACHER 1993: fig. 9d). Penis base broadened and often a little distended, lobes long, thin and more or less pointed (MALZACHER 1993: fig. 9a–c)..... *Caenis jinjana*
- Forcipes shorter, apical third more or less abruptly bent (Fig. 9e–i). Penis base not distended, lobes broader, apically rounded (Fig. 8a, b)..... *Caenis jinjanoides* n. sp.
- 12 Penis medially narrowed, with long, relatively slender and more or less pointed lobes, often slightly sickle-shaped (MALZACHER 1993: fig. 14a, b). Strongly coloured specimens with paratergal and parasternal blackish-brown dashes on abdominal segments VII–IX and parasternal spots on segments II–VI..... *Caenis brevipes*
- Penis lobes shorter, broader triangular; if elongated not sickle-shaped but with concave lateral margins (Figs. 8c–d, 10a–c). Strongly coloured specimens with paratergal dashes or spots at most on segments II–VI..... 13
- 13 Body shorter than 3.0 mm. Lateral margins of penis distinctly and often abruptly bent (Fig. 10a–c). Forcipes more or less straight (Fig. 10d–h). Rudiments of maxillae apically not pigmented..... *Caenis berneri*
- Body longer than 3.5 mm. Lateral margins of penis only slightly, never abruptly bent (Fig. 8c, d). Forcipes more or less regularly curved (Fig. 9a, b). Rudiments of maxillae apically pigmented (Fig. 9d)..... *Caenis kohli* n. sp.

5 Discussion

The species *Caenis elouardi* and *C. vermicifera* share the following characters: Posterolateral corners of segment IX reduced; penis short and broad, with rounded corners (Figs. 1a–d; 3a, b); forcipes short and apically rounded (Figs. 1f–n, 3c). *C. ghibana* from Ethiopia also has similarities with *C. vermicifera*, such as a finger-like process on the second abdominal tergum, and the shape of sternum IX and genitalia. However, the forcipes of *C. ghibana*, although apically rounded as in *C. vermicifera*, are more developed and form sclerotized tips somewhat set off against the forceps shaft (MALZACHER 1990: fig. 5b). Therefore *C. ghibana* can not be included in the *Caenis* species groups with rounded forceps tip. Species which have such forcipes were subdivided into five groups by MALZACHER (2001), four from South America and one, the *C. elouardi* group, from West Africa. As the genitalia of *C. vermicifera* are clearly different and more advanced than in the *C. elouardi* group, the *C. vermicifera* group can be established as a sixth species group. Besides the length and shape of the forcipes there is another feature for characterizing the groups with rounded forceps tip: the ratio of the distance between the extreme lateral points of the forcipes bases to the forceps length. Concerning this character, the *C. vermicifera* group is close to the most plesiomorphic group from South America, the *C. reissi* group. The value of the given ratio is 2.2–2.8 in the *C. reissi* group and 2.2–2.5 in *C. vermicifera*, whereas it is 3.0–4.8(!) in *C. elouardi*, and 1.0–1.7 in the vast majority of the other *Caenis* species.

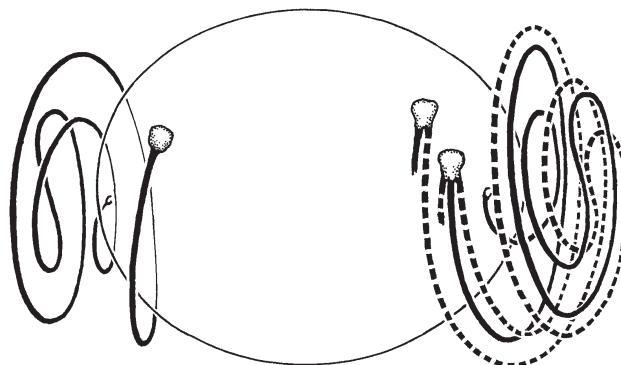
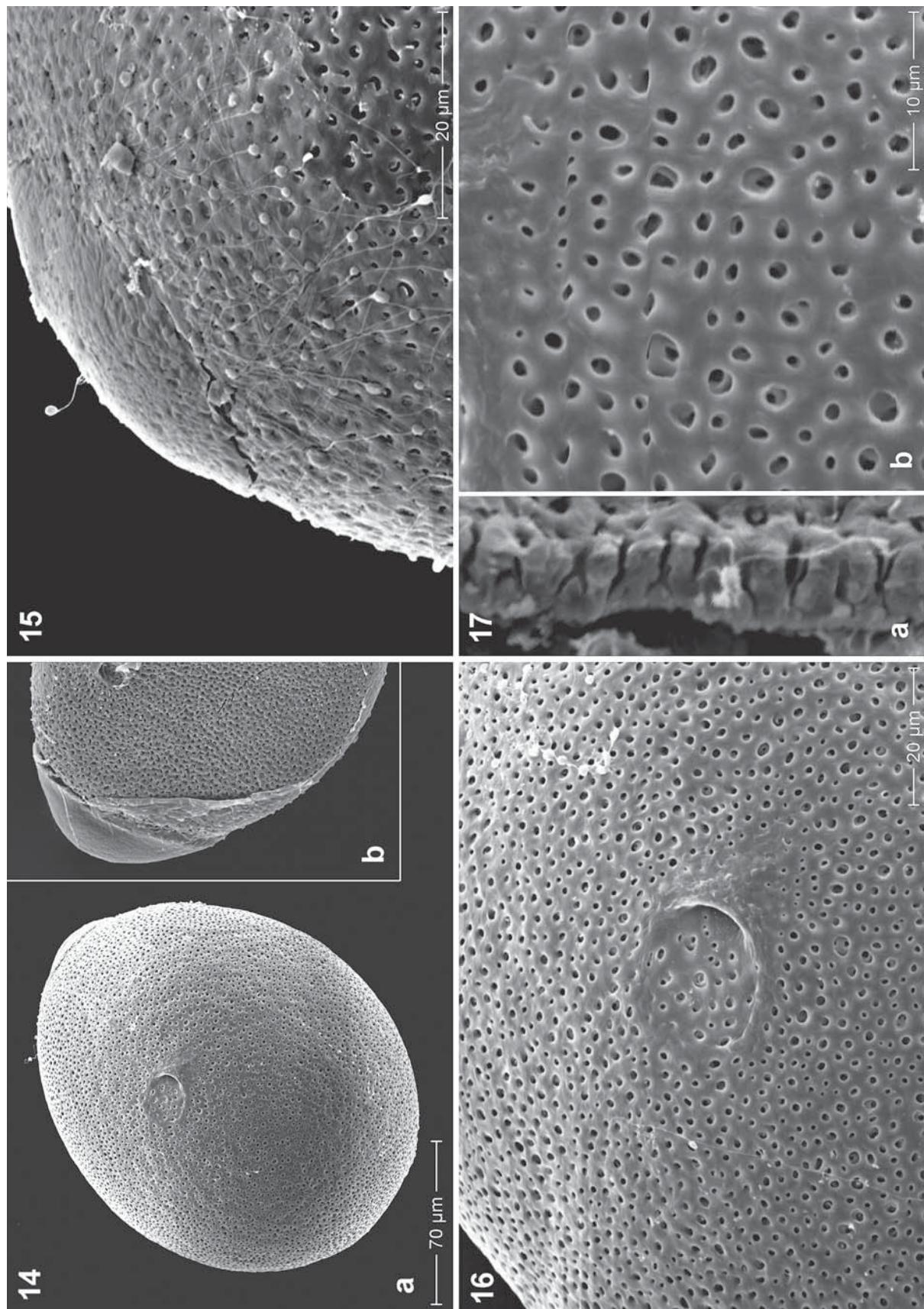
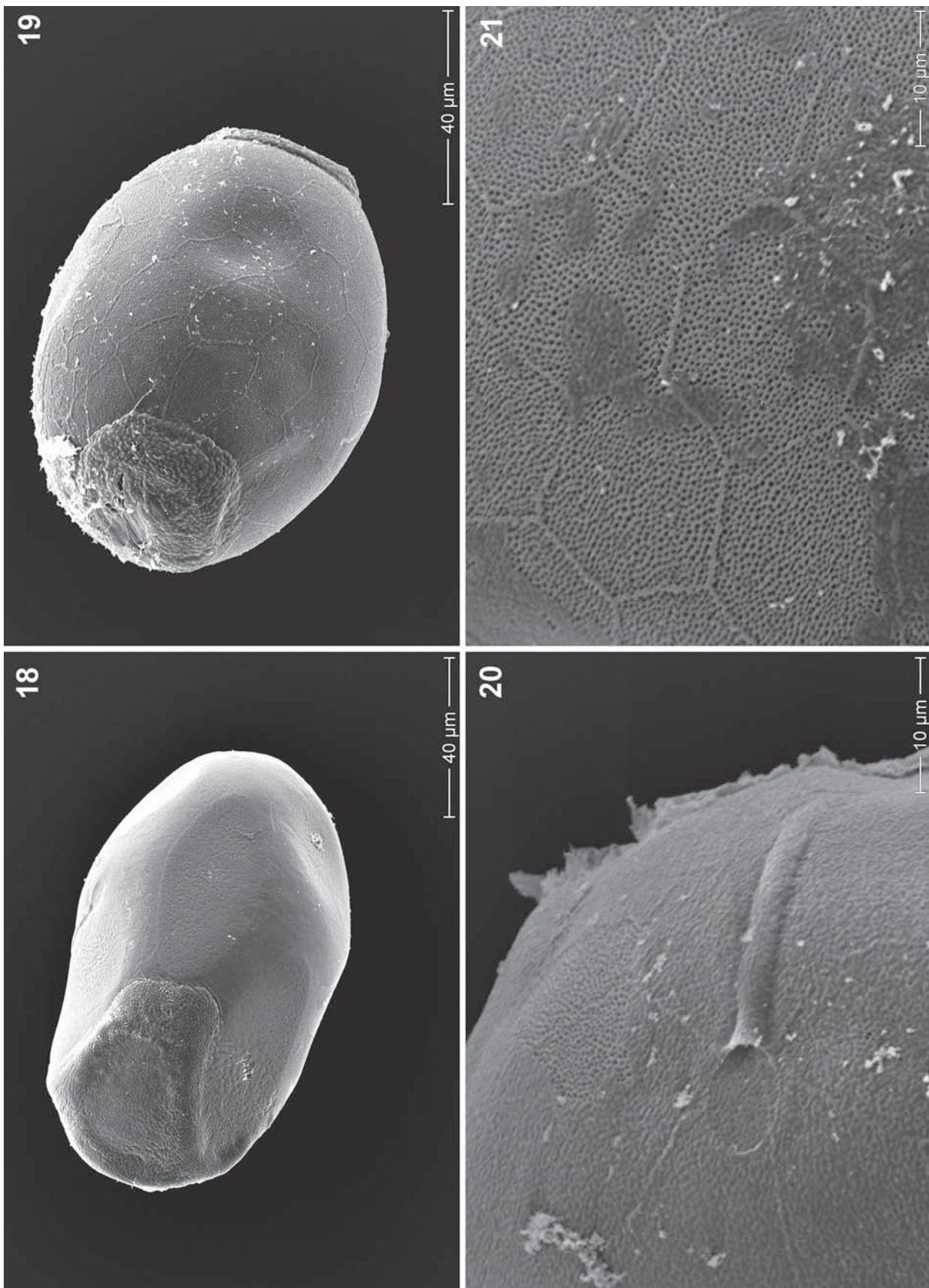


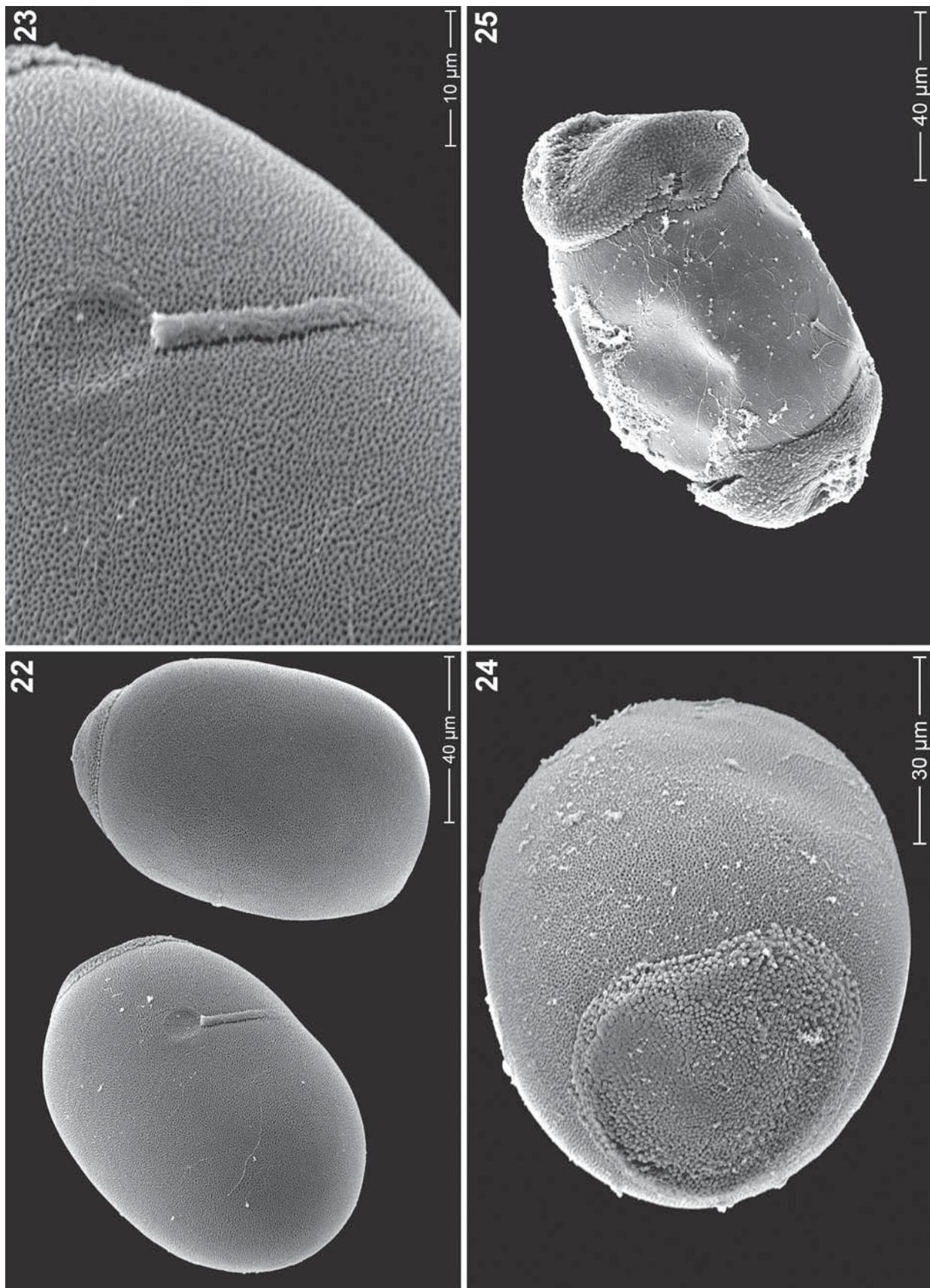
Fig. 13. Schematic view of the coiled-rope epithema-types, *C. perpusilla* subtype (left) and *C. robusta* subtype (right). – Slightly modified after MALZACHER (1982).



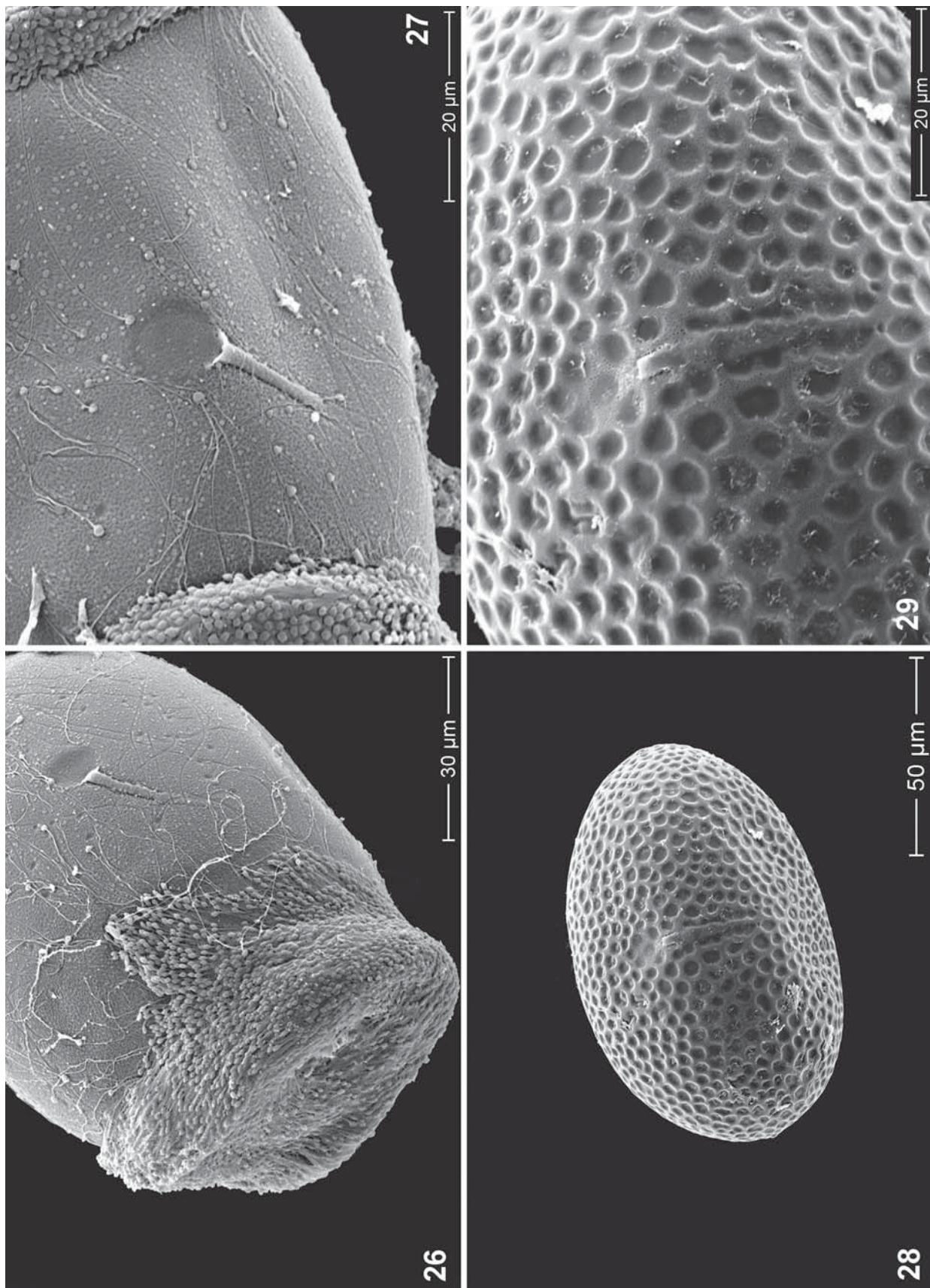
Figs. 14–17. *Caenid elouardi*, eggs. – **14.** Eggs with small (a) and large (b) epiphema. **15.** Epiphema with extraepithelial threads and terminal knobs. **16.** Micropyle. **17.** Surface of chorion (b), transverse section of chorion (a).



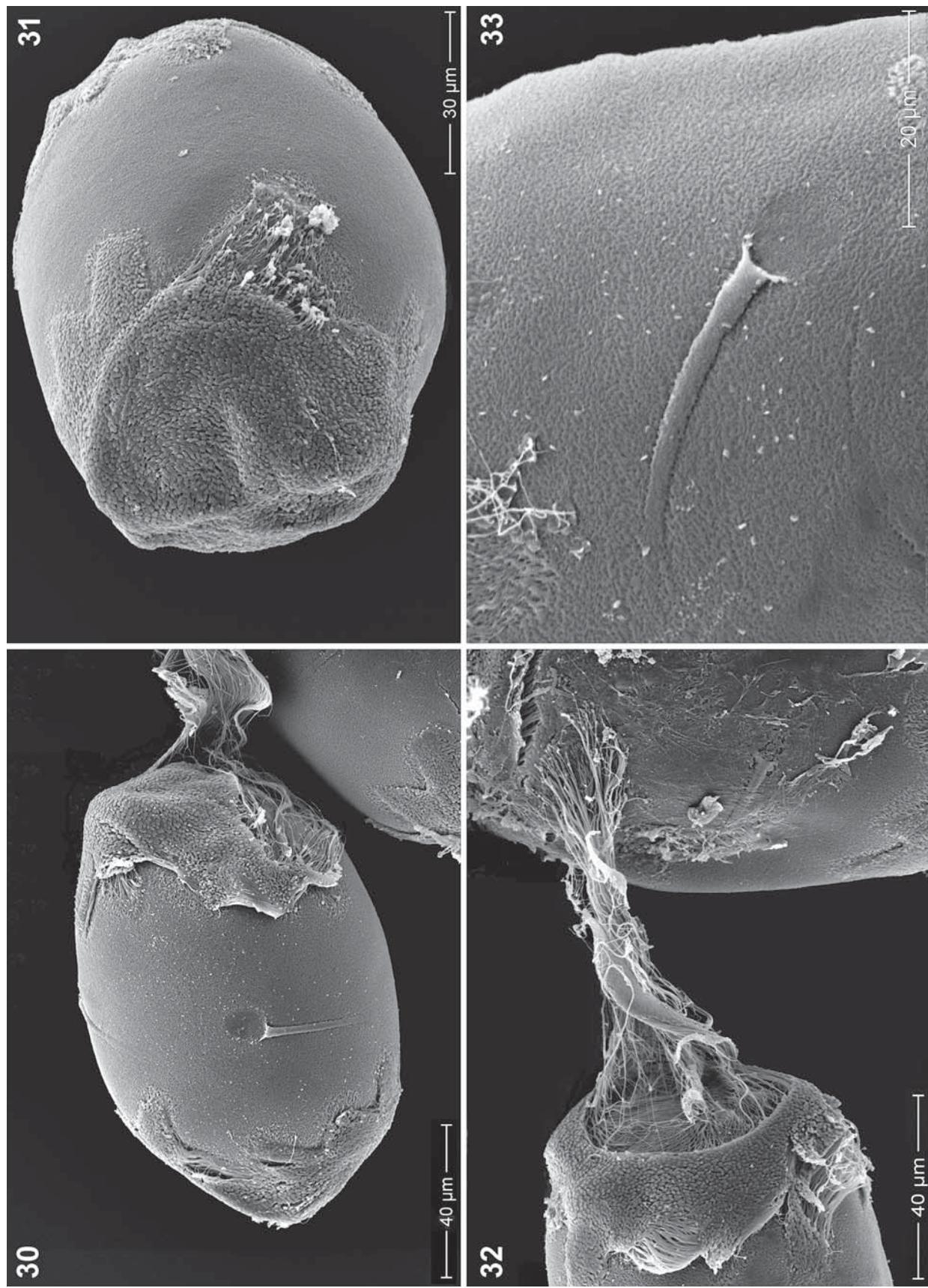
Figs. 18–21. *Caenis vernifera* n. sp. (18), *C. gilliævi* (19–21), eggs. – 18, 19. Eggs. – 20. Micropyle. – 21. Surface of chorion.



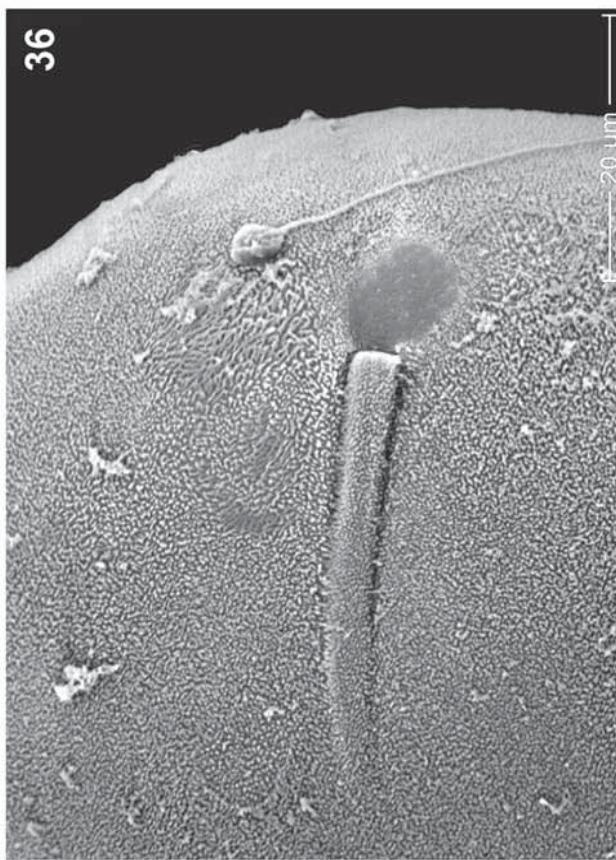
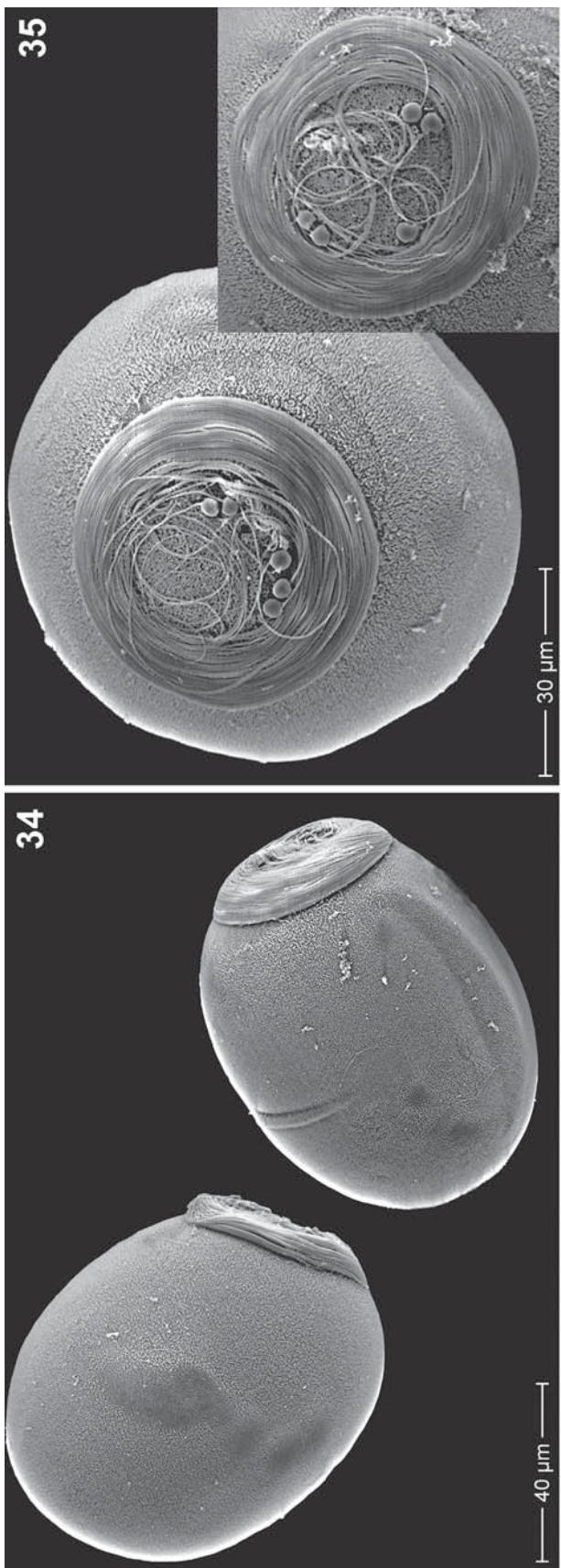
Figs. 22–25. *Caenis nigricola* n. sp. (22–24), *C. jinjana* (25), eggs. – 22, 25. Eggs. 23. Micropyle. 24. Epitheme.



Figs. 26–29. *Caenis jinjana* (26, 27), *C. jinjanoides* n. sp. (28, 29), eggs. – 26. Epithema. 27. Micropyle. 28. Egg. 29. Micropyle and surface of chorion.



Figs. 30–33. *Caenis brevipes*, eggs. – 30. Egg. 31. Epithema. 32. Epithema-threads uncoiled and attached to the surface of another egg. 33. Micropyle.



Figs. 34–36. *Caenis kohli* n. sp., eggs. – 34. Eggs. – 35. Epithemata. 36. Micropyle and surface of chorion.



Figs. 37–39. *Caeninae* gen. sp., eggs. – 37. Egg. – 38. Epithemata, different shapes. 39. Micropyle and surface of chorion.

After the splitting of Gondwana, these plesiomorphic forms developed in separate lineages, evolving to more differentiated genitalia of the *C. pflugfelderi* group and the *C. argentina* group in South America and the *C. ghibana* group in Africa, later on leading to other apomorphic *Caenis* genitalia in both continents.

The *Caenis cibaria* group was established by MALZACHER (1993), uniting species with apico-lateral tufts of stronger spines on segments II–IV of the fore tarsus (MALZACHER 1990: fig. 6a, i; MALZACHER 1993: fig. 6c), in combination with short or very short more or less rounded penis lobes, a V-shaped sclerite on the ventral side of the penis (Figs. 4a–c, 5a–e), and preapical spots on the femora. Besides *C. cibaria* and *C. gilliesi*, the here described *C. nigricola* also belongs to this group. The apical forceps spines are very long in *C. cibaria* (Fig. 4d), but shortened in the other species (Figs. 6a–f, 7j–k). In *C. gilliesi* there are three short spines and in *C. nigricola* only one (sometimes with another very thin and inconspicuous one, Fig. 6g–h). In the latter species the forcipes are short and broad and more or less straight, in contrast to the bent and longer ones in *C. cibaria* and *C. gilliesi*.

The other species covered in the present paper are characterized by triangular, more or less elongated and pointed penis lobes (Figs. 7a–c; 8a–d; 10a–c; 11a, b; 12a, b), in connection with forcipes with apical tufts of spines (Figs. 7d–g; 9a, b, e–i; 10d–h; 11c–e; 12c). They belong to three different species groups (MALZACHER 1993):

The *C. jinjana* group, consisting of *C. jinjana* and *C. antelucana*, has been characterized until now by short fore legs (about as long as hind legs) and by tibiae about as long as femora. Also the newly described *C. jinjanoides* shows these features, but concerning penis and forceps shape it seems to be closer to the *C. brevipes* group. Hence, its assignment remains uncertain, mainly because short fore legs and fore tibiae cannot be regarded as synapomorphies of the genus *Caenis*. These characters are present also in some populations of *C. brevipes* from Gambia (described as subspecies *C. brevipes occidentalis* by MALZACHER 1993). On the other hand, long and very long fore legs and tibiae can be observed in a population of *C. antelucana* (Guinea, Nzebelá). Finally, the new extensive material of *C. brevipes* shows fluid transitional stages of these features. *C. brevipes occidentalis*, which was characterized mainly by the short fore legs, can therefore no longer be maintained as a valid subspecies.

Another species of the *C. brevipes* group is *C. bernieri*, hitherto known from Tanzania and Kenya. As shown in the description in the present paper, most of the West African specimens are differing in a few characters from those of East Africa. In view of the above mentioned variability and existence of transitional stages, the description of a new subspecies of *C. bernieri* on the base of morphological characters would not be tenable. The same is true for

populations of *C. cibaria kunda* from the Fouta Djalon region and *C. nigricola* from Central and West Guinea, although, particularly in the latter, a geographical separation is obvious.

The morphological characters of the newly described species *C. kohli* are very similar to that of *C. brevipes*. Therefore it is surprising that the eggs possess a totally different epithema-type which I call the coiled-rope-type. It is characterized by the presence of a number of threads that are rolled up like ropes on the deck of a ship (Fig. 35).

C. orthostilata seems to be closely related to *C. pallida*, and will therefore be assigned to the *C. pallida* group. Common characters are the more or less fused segments II–IV of the fore tarsus (MALZACHER 1990: figs. 10d, 12g) and the sickle-shaped styliger sclerite with long and bent apophyses (Figs. 11a, b; 12a, b). Distinctive characters are the different shape and length of the forcipes (Fig. 11c–e, h), slightly differing proportions of the genitalia and the length of the lateral filaments on the abdomen (Figs. 11g, 12e). *C. corbetti* from Uganda, which was formerly assigned to the *C. pallida* group only based on the shape of the forcipes (MALZACHER 1993), however, neither has a sickle-shaped styliger sclerite nor long and bent apophyses. Segments II–IV of the fore tarsus are not fused. Therefore a separate species group is established for this species, the *C. corbetti* group.

The eggs of most of the West African species show specific characters. The epithemata of *Caenis kohli* seem to be most spectacular. This epithema-type is, however, not unique in the Caeninae because it can also be found in *C. perpusilla* from India (SMITH 1935, MALZACHER 1982), in the Palaearctic *C. robusta* (DEGRANGE 1957, MALZACHER 1982), in the South American *C. fitkaui* and *C. cuniana*, and in the species of *Brasilocaenis* (MALZACHER 1986: tab. 2, fig. 5). This type shows two subtypes: The *C. perpusilla* subtype (Fig. 13, left) consists of only a few threads (4–6) and the same number of large terminal knobs. Each thread is joined with the pole of the egg. In their middle part the threads are forming loops so that their running direction is reversed (Fig. 35). In the more complex *C. robusta* subtype (Fig. 13, right) a greater number of terminal knobs can be observed (from about 10 up to nearly 50). From each knob several (2–7) threads are leading off (MALZACHER 1986: tab. 2, fig. 6). All threads are forming loops, but only a small number is anchored on the egg surface. Each of the other ones joins two different terminal knobs which can be observed in uncoiled epithemata (Fig. 13, right). This subtype is realized in *C. robusta* and in the South American species, the other one in *C. perpusilla* and *C. kohli*. It is a peculiarity of *C. kohli* that its eggs have only one epithema. In all other species mentioned in this paragraph, the eggs show two epithemata.

The number of epithemata is also different in two closely related species of the *C. cibaria* group: *C. gilliesi* shows two epithemata, *C. nigricola* only one.

In two of the newly described species the chorion structure of the eggs differs strongly from the structure that can be found in the majority of the other Caeninae species. This applies to the eggs of *C. jinjanoides* which show small fields deeply sunken in (Figs. 28, 29), and the very elongated eggs of an unidentified species (gen. sp.) with irregular fields and broad elevated bands (Figs. 37–39). The latter belongs to the subfamily Caeninae because of the presence of prosternal ridges forming a trapezoid. The eggs of the unidentified species possess one epithema; epithemata are totally lacking in *C. jinjanoides*. As in the case *C. kohli/C. brevipes*, also in *C. jinjanoides* the egg structure is very different from that of the very similar *C. jinjana*.

In view of the rather random distribution of the features discussed herein, once again the question arises how the phylogenetic state of a certain character can be assessed in lower taxa. In the case of the highly differentiated coiled-rope epithemata, the sporadic appearance all over the world seems to be coincidental. A closer relationship between species with this epithema-type from different continents is not likely. In my opinion, this character distribution is best explained as parallelism (sensu HERRE 1961 and STURM 1994). This could be caused by temporarily suppressed gene effects produced e. g. by specific transcription mechanisms (MALZACHER 1997). Then the phenotypical appearance of the character may depend on selection pressure. In case of the coiled-rope epithemata this could be a low concentration of oxygen at the bottom of lentic water areas. Uncoiled and tangled threads (in *Caenis robusta* already realized in unlaid eggs in the oviduct) lead to large egg conglomerations that later become more easily attached to plants. So the eggs can develop in an area of higher oxygen concentration.

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