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Redescriptions of Indian species of *Nigrobaetis* Kazlauskas (in Novikova & Kluge) 1987 (Ephemeroptera, Baetidae)

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Abstract

The European species *Nigrobaetis gracilis* (Bogoescu & Tabacaru 1957) and more than 19 Asian and African species of *Nigrobaetis* Kazlauskas (in Novikova & Kluge) 1987 belong to the subgenus *Margobaetis* Kang & Yang 1994, which is characterized by peculiar asymmetric eggs and narrow paraglossa of larval labium. A new synonymy is established: *Nigrobaetis* (*Margobaetis*) *minutus* (Müller-Liebenau 1984) = *N. paramakalyani* Kubendran & Balasubramanian *in* Kubendran *et al*. 2015 = *N. sumbensis* Kaltenbach & Gattolliat 2023, **synn. n.**; winged stages (male and female imagines and subimagines) and eggs of this species are described for the first time. *N.* (*M.*) *minutus* is widely distributed on Oriental Region, being revealed in West Malaysia, Southern India, Sumba and Sulawesi islands in Indonesia. Winged stages (male and female imagines and subimagines) and eggs of *Nigrobaetis* (*Margobaetis*) *klugei* Sivaruban *et al*. 2022 are described for the first time.

Key words: mayflies, systematics, India, Western Ghats, Indonesia

Introduction

At present, two species of the genus *Nigrobaetis* Kazlauskas (in Novikova & Kluge) 1987 have been reported from Southern India: *N. paramakalyani* Kubendran & Balasubramanian (in Kubendran *et al*.) 2015 and *N. klugei* Sivaruban *et al*. 2022. Till now, both species were known as larvae only. The original description of *N. paramakalyani* contained significant errors, because it was based on a mix of larvae belonging to both these species (Sivaruban *et al*. 2022). Our new material from India and other countries allows to give additional descriptions of these species and to describe their winged stages and eggs.

Material and methods

Larvae, imagines and subimagines were associated by rearing. For this purpose, subimagines were reared from larvae in cages placed in natural current water or in containers with stagnant water; imagines were reared from subimagines in wide glass tubes closed with wet cotton and protected from direct sun light. Slides are made in Canadian balsam.

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Material reported in this paper is deposited in the following institutions: (1) **ZIN**: Zoological Institute of the Russian Academy of Sciences, Saint Petersburg, Russia; now this material is temporarily located in the Department of Entomology of Saint Petersburg State University; (2) **AMC**: American College (Department of Zoology), Madurai, India.

In the lists of material examined, the following arbitrary signs are used: **L**—larva; **S**—subimago; **I**—imago; **L-S-I**♂—male imago reared from larva, with larval and subimaginal exuviae; **L-S**♂—male subimago reared from larva, with larval exuviae; **L/S**♂—male subimago developed under larval cuticle; **S-I**♂—male subimago reared from subimago, with subimaginal exuviae.

The term «microlepides» is used according to Kluge (2022); the term «protopteron» according to Kluge (2005); other terms according to Kluge (2004). The noun «blank» is used to describe an unpigmented area of cuticle.

Genus *Nigrobaetis* Kazlauskas (in Novikova & Kluge) 1987

(Figs 1–89)

Genus *Nigrobaetis*: Kazlauskas 1972: 338 (imago, larva) (unavailable name, since type species was not reported in direct form).
Subgenus *Nigrobaetis* Kazlauskas: Novikova & Kluge 1987: 13.
Nigrobaetis/fg1: Kluge & Novikova 2014: 227.

Type species: *Ephemera nigra* Linnaeus 1761.

Comments. The genus *Nigrobaetis* is divided into three subgenera, *Nigrobaetis* s. str. (= *Diphetor* Waltz & McCafferty 1987), *Takobia* Novikova & Kluge 1987 (= *Alainites* Waltz & McCafferty in Waltz, McCafferty & Thomas 1994, = *Acerbaetis* Kang & Yang in Kang, Chang & Yang 1994) and *Margobaetis* Kang & Yang *in* Kang, Chang & Yang 1994 (Kluge 2022). In India, the genus *Nigrobaetis* is represented by two species belonging to the subgenus *Margobaetis*.

Subgenus *Margobaetis* Kang & Yang 1994

(Figs 1–89)

Group *gracilis*: Novikova & Kluge 1994: 634 (egg, larva).
Subgenus *Margobaetis* Kang & Yang (in Kang, Chang & Yang) 1994: 11 (partim).

Type species: *Baetis* (*Margobaetis*) *mundus* Chang & Yang (in Kang & Chang & Yang) 1994.

Diagnosis. Egg more or less asymmetric: in typical case one side bluntly cone-like pointed, with surface mostly smooth; opposite side hemispheric or hemi-ellipsoid, with regularly arranged papillae and/or other relief (Figs 39–43, 86–89). Paraglossa narrower than in other *Nigrobaetis*, with apical setae arranged mostly in 2 longitudinal rows (Figs 17–18, 54; Müller-Liebenau 1969: Abb. 140e; Kaltenbach & Gattolliat 2023: figs 4b, 12b, 18b, 24b–c, 31b–c, 37d).

Composition. Europe: *Nigrobaetis* (*Margobaetis*) *gracilis* (Bogoescu & Tabacaru 1957).

Jordan: probably *N.* (*M.*) *vuatazi* Gattolliat & Sartori *in* Gattolliat *et al*. 2012 (egg structure unknown).

Arabia: *N.* (*M.*) *arabiensis* Gattolliat & Sartori 2008.

Algeria: probably *N.* (*M.*) *numidicus* (Soldan & Thomas 1983) (egg structure unknown).

Afrotropical Region: probably *N.* (*M.*) *bethuneae* Lugo-Ortiz & de Moor 2000 (egg structure unknown). In subsequent publications, some other Afrotropical species will be described.

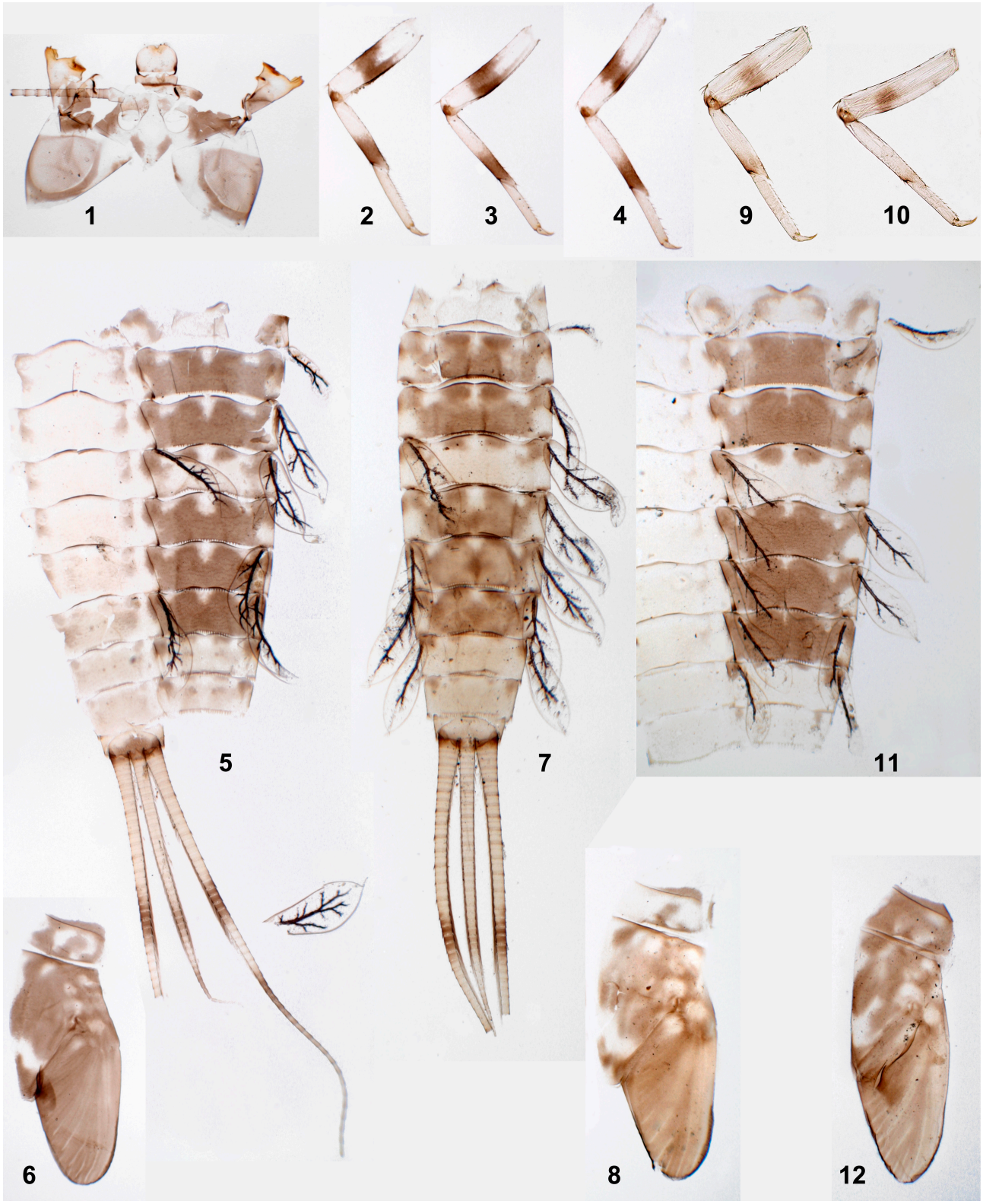
Siberia and Far East: *N.* (*M.*) *bacillus* (Kluge 1983).

Continental China: probably *N.* (*M.*) *trialbus* Li *et al*. 2023 (egg structure unknown).

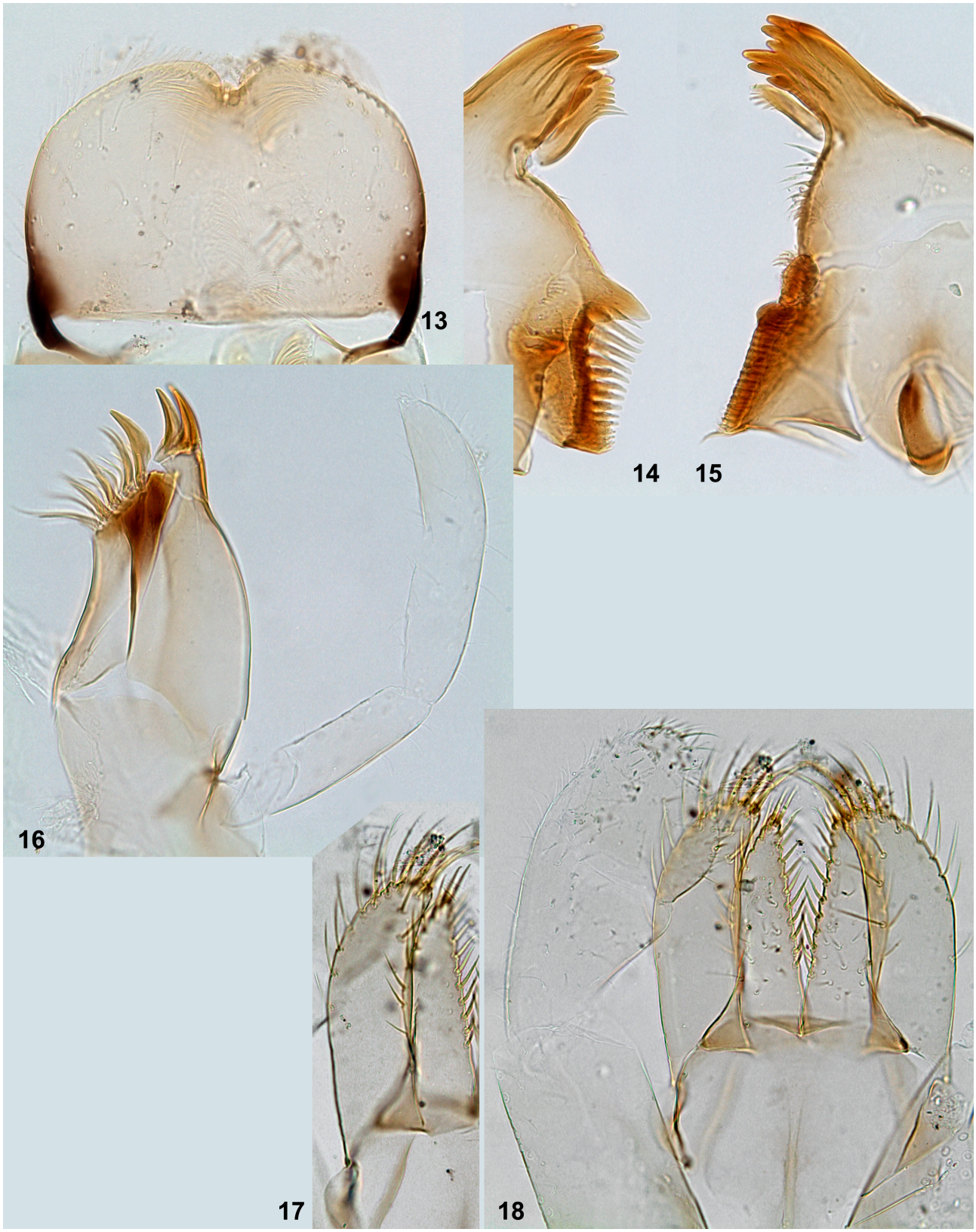
Taiwan: *N.* (*M.*) *tatuensis* (Müller-Liebenau 1985) (= «*Baetis taiwanensis*»: Kang *et al*. 1994), *N.* (*M.*) *mundus* (Chang & Yang *in* Kang *et al*. 1994). Probably also *N.* (*M.*) *facetus* (Chang & Yang *in* Kang *et al*. 1994), *N.* (*M.*) *terminus* (Chang & Yang *in* Kang *et al*. 1994) (egg structure unknown).

Oriental Region: *N.* (*M.*) *minutus* (Müller-Liebenau 1984) (= *N. paramakalyani* Kubendran & Balasubramanian *in* Kubendran *et al*. 2015 **syn. n.**; = *N. sumbensis* Kaltenbach & Gattolliat 2023 **syn. n.**), *N.* (*M.*) *klugei* Sivaruban *et al*. 2022. Probably also species with unknown egg structure—*N.* (*M.*) *mirabilis* (Müller-Liebenau 1984), *N.*

(*M.*) *gombaki* (Müller-Liebenau 1984), *N.* (*M.*) *plures* Kaltenbach & Gattolliat 2023, *N.* (*M.*) *palawus* Kaltenbach & Gattolliat 2023, *N.* (*M.*) *suma* Kaltenbach & Gattolliat 2023, *N.* (*M.*) *borneus* Kaltenbach & Gattolliat 2023, *N.* (*M.*) *kaliman* Kaltenbach & Gattolliat 2023. Described and figured eggs of *N. plures*, *N. suma* and *N. kaliman* (Kaltenbach & Gattolliat 2023: figs 7, 27, 40) are immature, have no definite shape and have no chorion structure. In subsequent publications, some other Oriental species will be described.

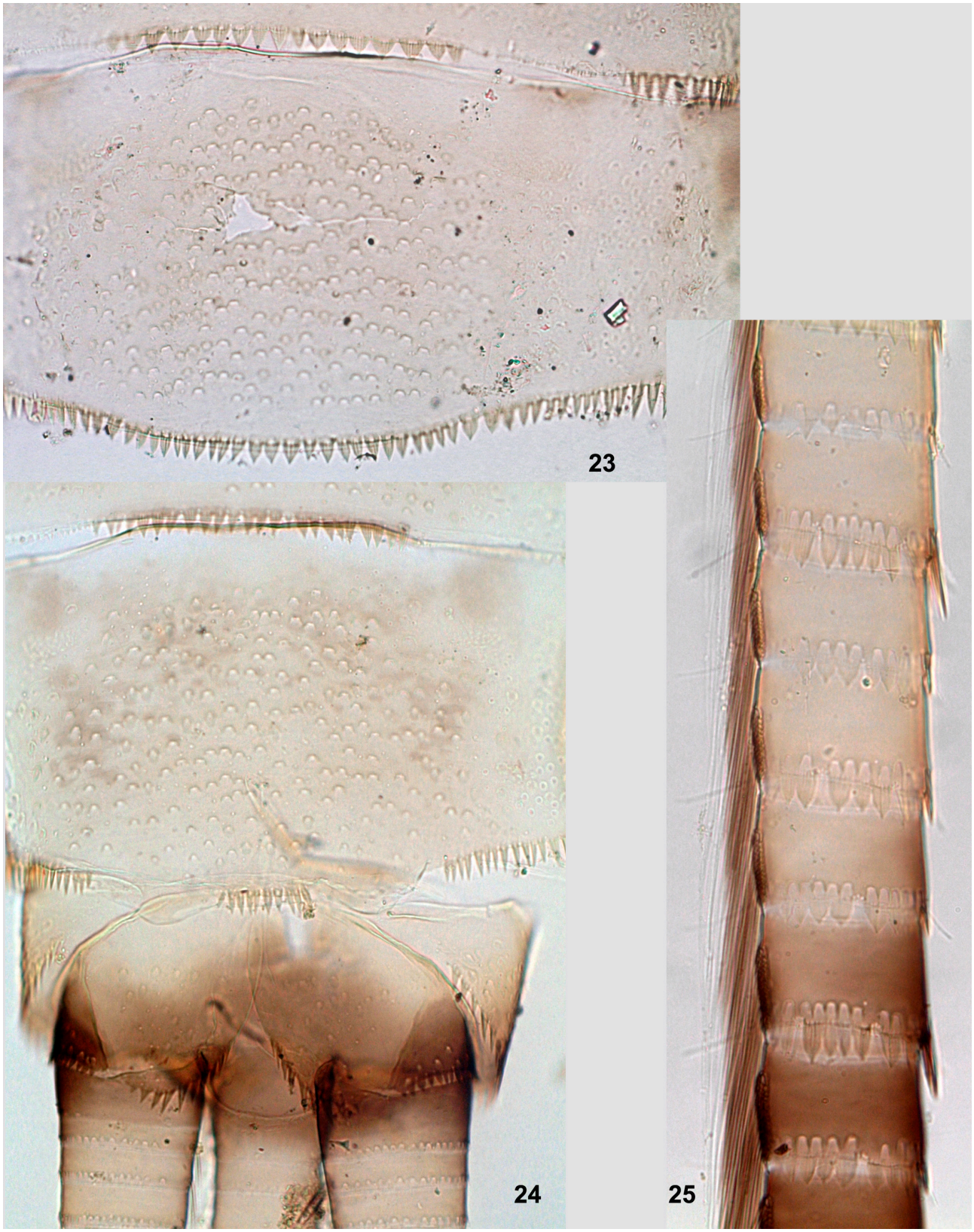


FIGURES 1–12. *Nigrobaetis* (*Margobaetis*) *minutus*, larvae. 1–6, specimen from Madurai; 7–8, specimen from Erumeli; 9–12, specimen from Pinrang (Sulawesi). 1, exuviae of head; 2–4, exuviae of fore, middle and hind legs; 5, 7, 11, exuviae of abdomen; 6, 8, 12, exuviae of pronotum and mesonotum; 9, 10, fore and hind legs.



FIGURES 13–18. *Nigrobaetis* (*Margobaetis*) *minutus*, larval mouthparts. 13, labrum; 14–15, left and right mandibles; 16, maxilla; 17, paraglossa (focus on dorsal side); 18, labium (focus on ventral side).

FIGURES 19–22. *Nigrobaetis* (*Margobaetis*) *minutus*, exuviae of larval tibia and tarsus. 19–21, fore, middle and hind legs; 22, hind leg of another specimen.



FIGURES 23–25. *Nigrobaetis* (*Margobaetis*) *minutus*, exuviae of larval abdomen. 23, sterna VIII–IX of female; 24, sterna VIII–X of male; 25, fragment of cercus.

***Nigrobaetis* (*Margobaetis*) *minutus* (Müller-Liebenau 1984)**
(Figs 1–43)

Baetis minutus Müller-Liebenau 1984: 255 (larva).
Baetis (*Nigrobaetis*) *minutus*: Novikova & Kluge 1994: 627.
Nigrobaetis (*Margobaetis*) *minutus*: Kluge 2022: 163 (subimago, misidentified).
Nigrobaetis paramakalyani Kubendran & Balasubramanian *in* Kubendran, Balasubramanian, Selvakumar, Gattolliat & Sivaramakrishnan 2015: 193 (larva, partim), **syn. n.**; Sivaruban, Srinivasan, Barathy & Isack 2022: 189 (corrections to larval description).
Nigrobaetis sumbensis Kaltenbach & Gattolliat 2023: 196 (larva), **syn. n.**

Material examined. INDIA: State Tamil Nadu: Tirunelveli district, Gadana river, 28.VI.2012, coll. C. Balasubramanian, T. Kubendran & C. Selvakumar: ♂ larva (holotype), 1♀ larva (paratype); Madurai district, river Vaigai, 10.II.2016, coll. N. Kluge & L. Sheyko: 1 L-S♂ (ZIN); the same locality, 23.IV.2022, coll. P. Srinivasan & R. Isack: 3 larvae (AMC). State Kerala, Kottayam District, Erumeli, 22.I.2016, coll. N. Kluge & L. Sheyko: 1 L-S-I♂, L-S♂, 3 S-I♂, 1 S-I♀, 2 I♂, 19 S♂, 9 L (ZIN). INDONESIA, Sulawesi, Pinrang, 28–31.VIII.2009, coll. N. Kluge & L. Sheyko: 1 L/S♂, 1 L-S-I♀, 1 L/S♀ (ZIN).

Additional description of larva. CUTICULAR COLORATION: With more or less contrasting brown and colorless or light areas (Figs 1–12). Pronotum and mesonotum with colorless median stripe of variable, composite shape and paired colorless blanks (Figs 6, 8, 12; Kaltenbach & Gattolliat 2023: fig. 15a). Leg of each pair mostly colorless, with more or less expressed brown transverse band on femur, brown femur-tibia articulation and brown apex of tibia (Figs 2–4, 9–10; Müller-Liebenau 1984: fig. 2i–j; Kaltenbach & Gattolliat 2023: fig. 19a); sometimes nearly entirely colorless. Abdominal tergum I mostly colorless; terga II–III mostly brown, with contrasting paired and unpaired blanks; tergum IV mostly colorless, with pair of contrasting brown spots near anterior margin; terga V–VII mostly brown, with contrasting paired and unpaired blanks; terga VIII–X mostly colorless, with brown posterior margin of tergum X (Figs 5, 7, 11; Müller-Liebenau 1984: fig. 17; Kaltenbach & Gattolliat 2023: fig. 15a). Caudalii mostly colorless, with brown band near middle and apically (Fig. 5; Müller-Liebenau 1984: fig. 2m).

HYPODERMAL COLORATION: Not expressed.

SHAPE AND SETATION: Labrum parallel-sided in proximal half (Fig. 13; Müller-Liebenau 1984: fig. 2a; Kaltenbach & Gattolliat 2023: figs 16a–b). Other mouthparts as in photos (Figs 14–18; Kaltenbach & Gattolliat 2023: figs 16–18).

Hind protoptera or their vestiges absent (Müller-Liebenau 1984: fig. 2h).

Each tibia with one stout, pointed seta on outer side near apex (subapical seta); middle and hind tibiae, besides subapical seta, with several (2–10) smaller, pointed setae forming irregular longitudinal row on outer side; outer side of fore tibia with no more than one stout seta other than subapical one (Figs 19–22; Müller-Liebenau 1984: figs 2i–j).

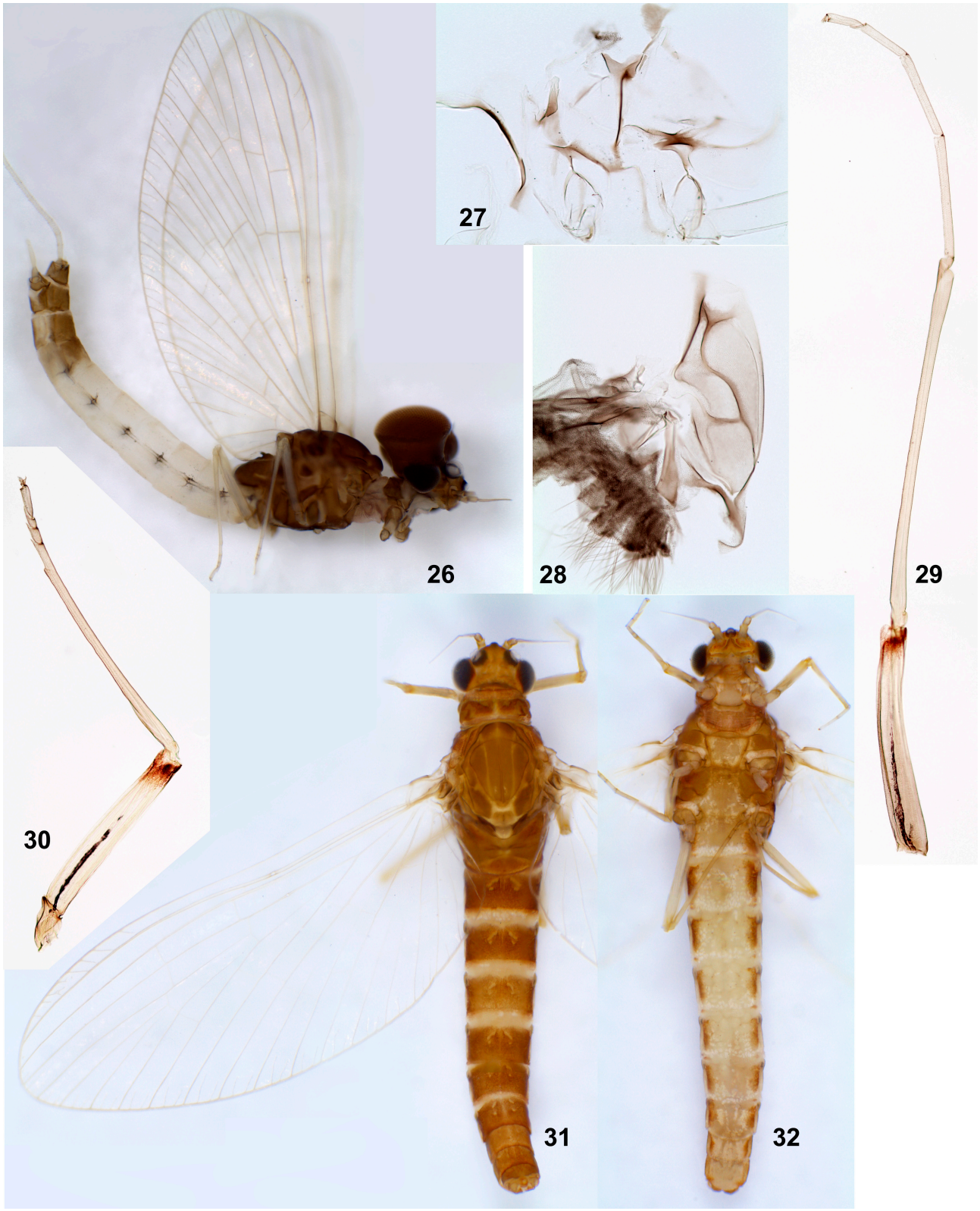
Posterior margins of abdominal terga II–X with triangular denticles, shorter and blunter on anterior segments, longer and pointer on posterior segments (Kaltenbach & Gattolliat 2023: fig. 2a). Posterior margins of abdominal sterna I–VI smooth; posterior margins of sterna VII–IX with sharply pointed, triangular denticles (Figs 23–24). Paraproct with many small denticles (Fig. 24; Müller-Liebenau 1984: fig. 2i; Sivaruban *et al*. 2022: fig. 4d; Kaltenbach & Gattolliat 2023: fig. 20b). All 7 pairs of tergalii present, relatively long and narrow (Figs 5, 7, 11; Sivaruban *et al*. 2022: figs 4B, E; Kaltenbach & Gattolliat 2023: figs 15a, 19d–e). In middle part of cercus, each 4th segment with several enlarged denticles on outer side (Fig. 25); paracercus without enlarged denticles.

Descriptions of winged stages

***Subimago*.** CUTICULAR COLORATION: Head colorless, antennal flagellum light brown. Pronotum colorless. Mesonotum light brownish, with brown sutures (Fig. 28). Thoracic pleura and sterna mostly colorless, with certain sclerites brown (Fig. 27). Legs colorless. Abdomen colorless, caudalii and gonostyli colorless.

HYPODERMAL COLORATION: As in imago.

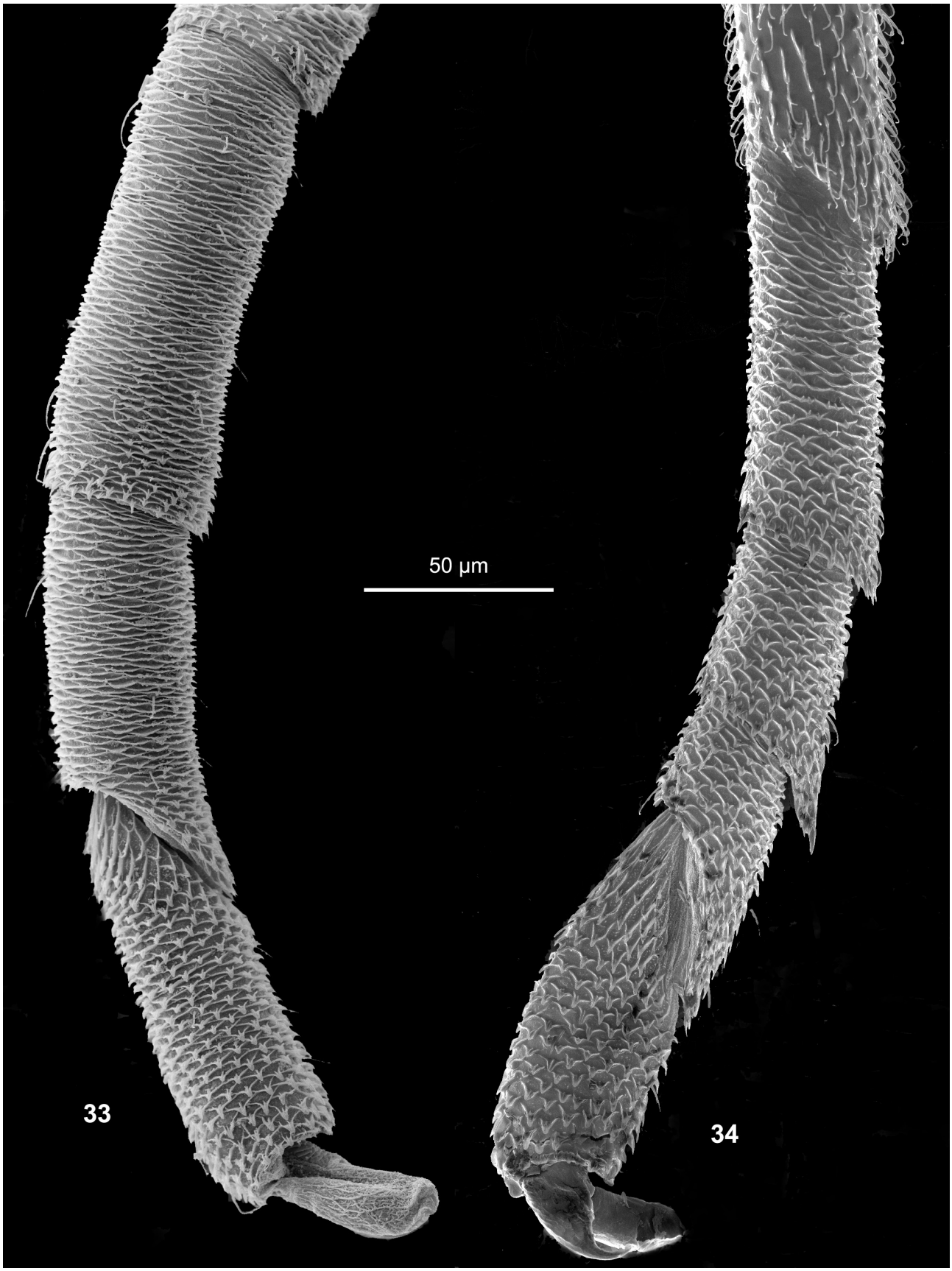
TEXTURE: On middle and hind legs of both sexes, proximal tarsal segment (corresponding to initial 1st+2nd tarsomeres) in proximal part covered with blunt microlepides, in distal part covered with pointed microlepides; other three segments entirely covered with pointed microlepides (Fig. 34). On fore leg of female, 1st tarsomere covered with pointed microlepides; 2nd tarsomere in proximal part covered with blunt microlepides, in distal part covered with pointed microlepides; 3rd–5th tarsomeres entirely covered with pointed microlepides (similar to Fig. 34). On fore leg of male, 1st–4th tarsal segments covered mostly with blunt microlepides, apically with pointed microlepides; 5th tarsomere entirely covered with pointed microlepides (Fig. 33).



FIGURES 26–32. *Nigrobaetis* (*Margobaetis*) *minutus*. 26, male imago; 27, subimaginal exuviae of meso- and metapleura; 28, subimaginal exuviae of mesonotum; 29–30, fore and middle legs of male imago; 31–32, female imago.

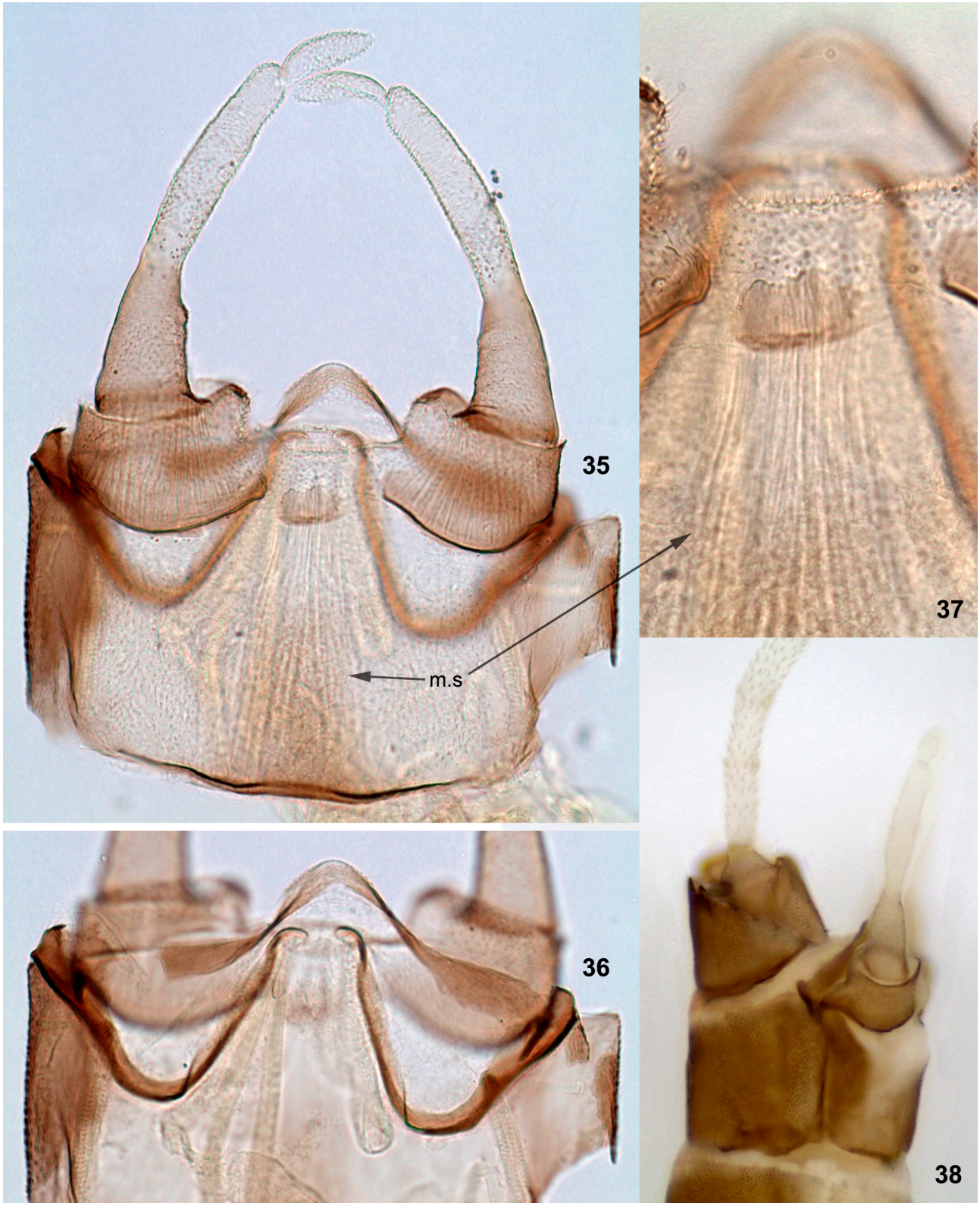
Imago, male (Fig. 26). Head brown. Turbinate eyes dark reddish-brown. Thorax brown with ochre, equally dark dorsally, laterally and ventrally. Wings colorless, veins ochre-brownish, C and Sc+R proximad of costal brace brown. Pterostigma with simple, oblique crossveins. Hind wings absent. Legs of all pairs light ochre, either unicolor (Fig. 26), or with apex of femur brown (Figs 29–30). On middle and hind legs, tarsus with 2 apical spines, on

1st+2nd and 3rd tarsomeres. Abdominal terga and sterna I–VI colorless, translucent, with brown spots on spiracles; terga VII–X brown. Cerci ochre.



FIGURES 33–34. *Nigrobaetis* (*Margobaetis*) *minutus*, male subimago. 33, 3rd–5th tarsomeres of fore leg, 34, apex of tibia and tarsus of hind leg.

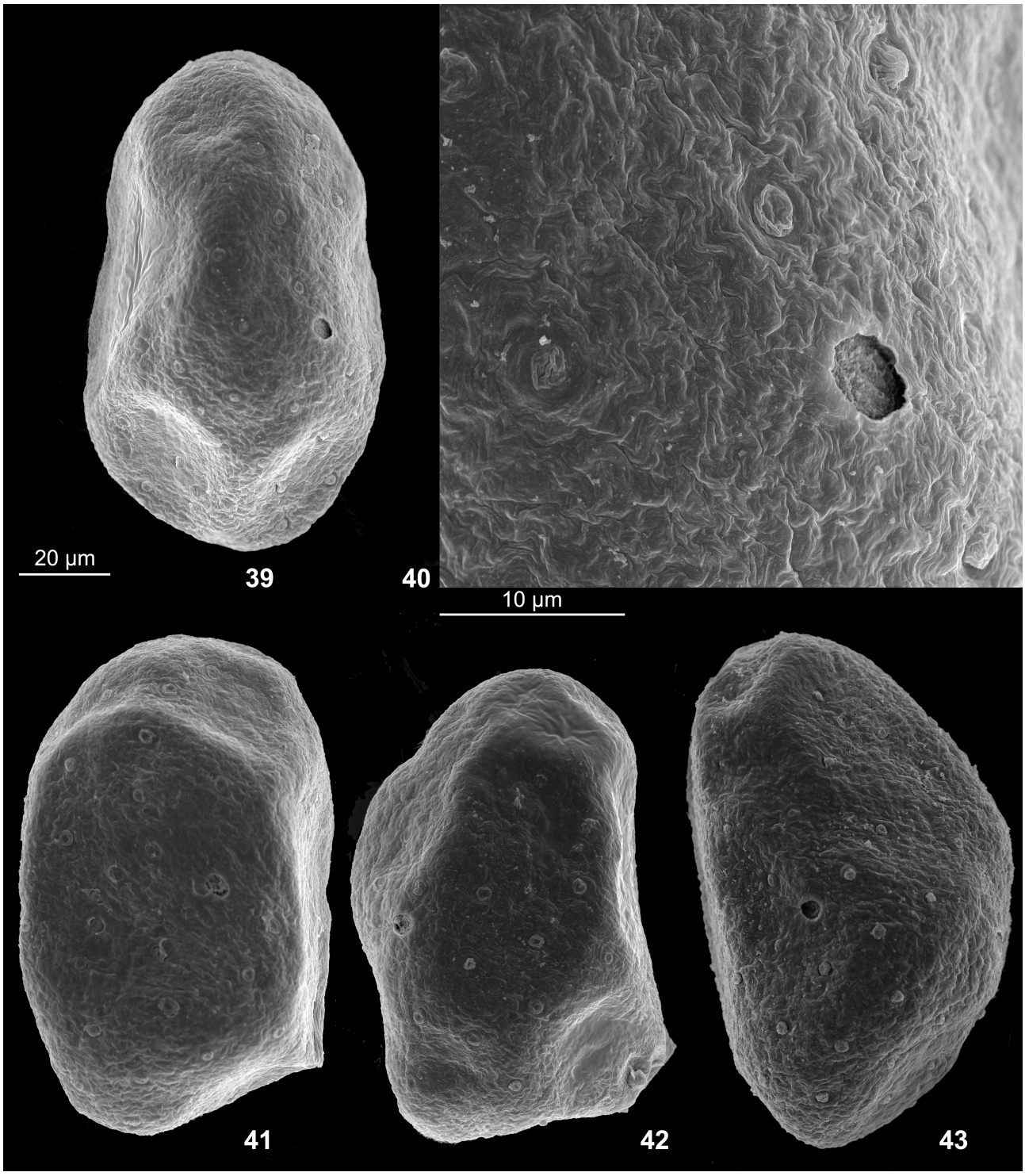
Male genitalia (Figs 33–38): Styliger with well-outlined, brown median sclerite, to which distal end of sterno-styligeral muscle is attached (Figs 35, 37). 1st segment of gonostylus narrowing from base to apex, angulate apically-medially. 3rd (terminal) segment of gonostylus elongate. Penial bridge with prominent, cone-like, sclerotized median projection. Gonovectes sharply bent, with narrow apices.



FIGURES 35–38. *Nigrobaetis* (*Margobaetis*) *minutus*, genitalia of male imago. 35, ventral view; 36, view with focus on gonovectes and penial bridge; 37, ventral view with focus on sterno-styligeral muscle and median sclerite; 38, lateral view. Abbreviation: m.s, median sterno-styligeral muscle.

Imago, female. All abdominal terga brown, sterna ochre with pair of brown stripes laterally (Figs 31–32). On fore leg, tarsus with 2 apical spines, on 2nd and 3rd tarsomeres.

Egg (Figs 39–43). Asymmetric, generally irregularly-oval, with one side more or less stretched. Surface with evenly dispersed small round papillae and irregular folds. Micropile wide.



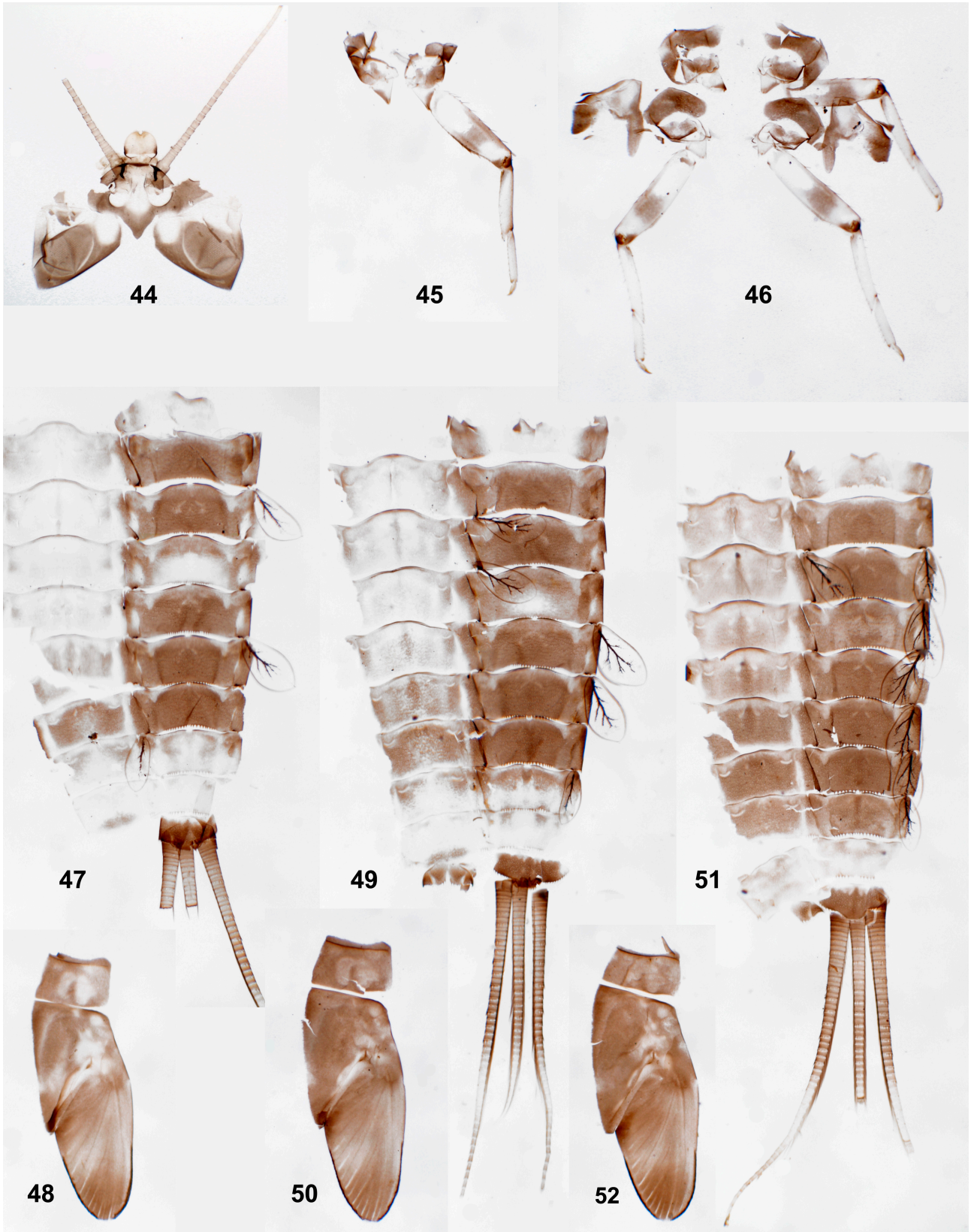
FIGURES 39–43. *Nigrobaetis* (*Margobaetis*) *minutus*, eggs.

Dimension. Fore wing length (and approximate body length): male 3.5 mm, female 4 mm.

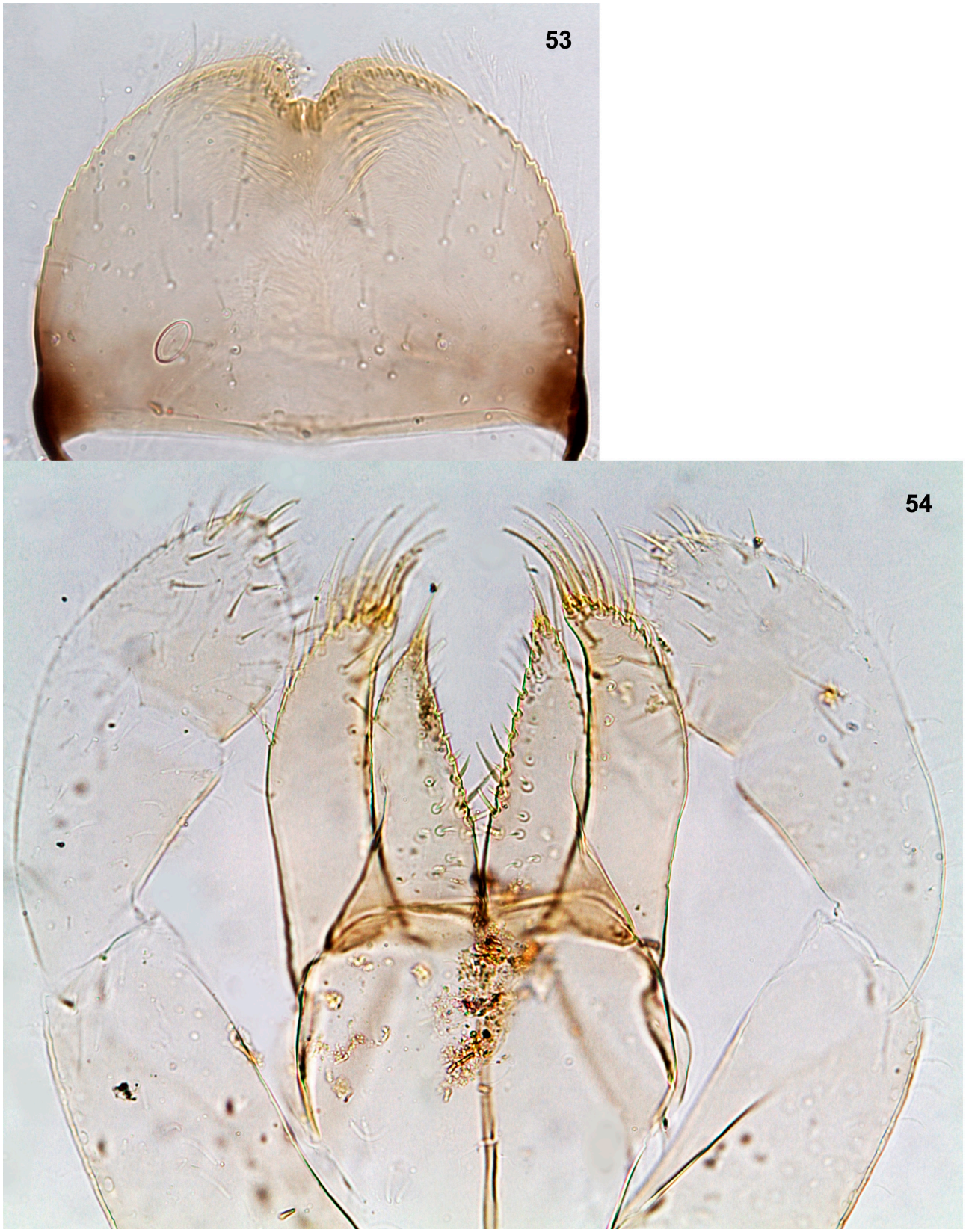
Distribution. Oriental Region. Described from West Malaysia (as *B. minutus*), from Southern India (as *N. paramakalyani*) and from Sumba Island in Indonesia (as *N. sumbensis*); reported here from Sulawesi island in Indonesia.

Errors in original description of *N. paramakalyani*. Originally (Kubendran *et al*. 2015), *Nigrobaetis paramakalyani*

was described based on 14 larvae collected in Gadana River in Southern India. Actually, these larvae represented a mixture of two different species, the second one of which was subsequently described as *Nigrobaetis klugei* Sivaruban *et al*. 2022. Holotype of *N. paramakalyani* is the mature male larva (Sivaruban *et al*. 2022: figs 4A–E).



FIGURES 44–52. *Nigrobaetis* (*Margobaetis*) *klugei*, larval exuviae. 44, head; 45, prosternum with fore leg; 46, mesosternum, metasternum and metanotum with hind protoptera, middle and hind legs; 47, 49, 51, abdomen; 48, 50, 52, half of pronotum and mesonotum.



FIGURES 53–54. *Nigrobaetis* (*Margobaetis*) *klugei*, larval exuviae. 53, labrum; 54, labium.

The original description and illustrations of *Nigrobaetis paramakalyani* contain a mixture of characters belonging to both species. The photos of female larva (Kubendran *et al*. 2015: figs 22–23) belong to *N. paramakalyani* and demonstrate characteristic color pattern of thoracic and abdominal terga. In contrast to this, the drawing of paraproct

which bears a few long spines (ibid., fig. 36) belongs to *N. klugei*, while true paraproct of *N. paramakalyani* has a higher number of small spines (Sivaruban *et al*. 2022: 189 and fig. 4D). The original description of *N. paramakalyani* states that «Hind wing pads present» and contains the drawing of hind protopteron (Kubendran *et al*. 2015: 194 and fig. 33). However, the holotype of *N. paramakalyani* has no hind protoptera, and the drawing belongs to *N. klugei*.

FIGURES 55–57. *Nigrobaetis* (*Margobaetis*) *klugei*, larval exuviae of tibia and tarsus. 55, fore leg; 56, middle leg; 57, hind leg.

Synonymy of *N. sumbensis*. *Nigrobaetis sumbensis* Kaltenbach & Gattolliat 2023 was described based on 3 larvae from Sumba Islan in Indonesia. This species was compared with other *Nigrobaetis* species from Indonesia, Philippines and Malaysia, but not with *N. paramakalyani* from India. Comparison of *N. sumbensis* with *N. paramakalyani* was impossible, because *N. paramakalyani* was wrongly characterized as having hind wings.

Comparison of *N. sumbensis* with *N. minutus* was given in the key (Kaltenbach & Gattolliat 2023: 228–229), according to which *N. sumbensis* differs from *N. minutus* and other species by «Fore femur very slender ..., dorsally slightly concave». Actually, the leg described and figures as «foreleg» is actually middle or hind leg, that is testified by the 4-segmented subimaginal tarsus developing inside (Kaltenbach & Gattolliat 2023: fig. 19a). As well in many other species, in *N. minutus* femur of the foreleg is thicker, with straight outer margin (Figs 2, 9), and femora of middle and hind legs are thinner, with concave outer margin (Figs 3–4, 10).

Another characters of *N. sumbensis* reported in this key, is the number of denticles on claws; variability of their number has not been reported for *N. minutus*. The third reported character is a tuft of setae-like processes between prostheca and mola of left mandible; the same tuft is figured for *N. minutus* (Müller-Liebenau 1984: fig. 2).

Comparison of the larval description of *N. sumbensis* with our material from India and Sulawesi does not reveal differences. Comparison of egg structure of specimens from India and Sulawesi confirms the wide distribution of this species.

Nigrobaetis (*Margobaetis*) *klugei* Sivaruban *et al*. 2022

(Figs 44–89)

Nigrobaetis klugei Sivaruban, Srinivasan, Barathy & Isack 2022: 183 (larva).
Nigrobaetis (*Margobaetis*) *klugei*: Kluge 2022: 163, 164 (subimago).

Material examined. INDIA: state Tamil Nadu: Rajapalayam district, Sastha falls, 9°41′50″N & 77°40′15″E; 195 m a.s.l., 24.I.2021, coll. P. Srinivasan & R. Isack.: 13 larvae (holotype and paratypes); Theni district, Suruli Falls, 24–26.I.2016, coll. L. Sheyko & N. Kluge: 10 L-S-I♂, 9 L-S-I♀, 1 L-S♀, 13 larvae (ZIN); Theni district, Veerapandi river, 31.VIII.2022, coll. P. Srinivasan & R. Isack: 1 I♂ (AMC); Madurai district, Vaigai river, 14.XII.2022, coll. P. Srinivasan & R. Isack: 3 L-S-I♂ (AMC); Tirunelveli district, Courtallam, Chittar river near Peraruvi (= Main Falls), 3–7.II.2013, coll. N. Kluge & L. Sheyko: L-S-I♀, 4 larvae (ZIN); state Karnataka: border of Shivamogga and Udupi districts near Agumbe and Someswar, 11.I–1.II.2013, coll. N. Kluge & L. Sheyko: 3 larvae (ZIN).

Additional descriptions

***Larva*.** CUTICULAR COLORATION: Pronotum and mesonotum mostly brown, with variable paired blanks (Figs 48, 50, 52). Leg of each pair mostly colorless, with more or less expressed brown transverse band on femur and brown femur-tibia articulation (Figs 45–46); sometimes femur mostly brown, with two colorless blanks (Figs 58–60; Sivaruban *et al*. 2022: figs 3A–E). Abdominal terga II–III, V–VII and X mostly brown, sometimes with lighter submedian sigilla; terga I, IV and VIII–IX more or less lighter (Figs 47, 49, 51; Sivaruban *et al*. 2022: figs 1A–B, 3H). Caudalii proximally brown, distally colorless (Figs 49, 51).

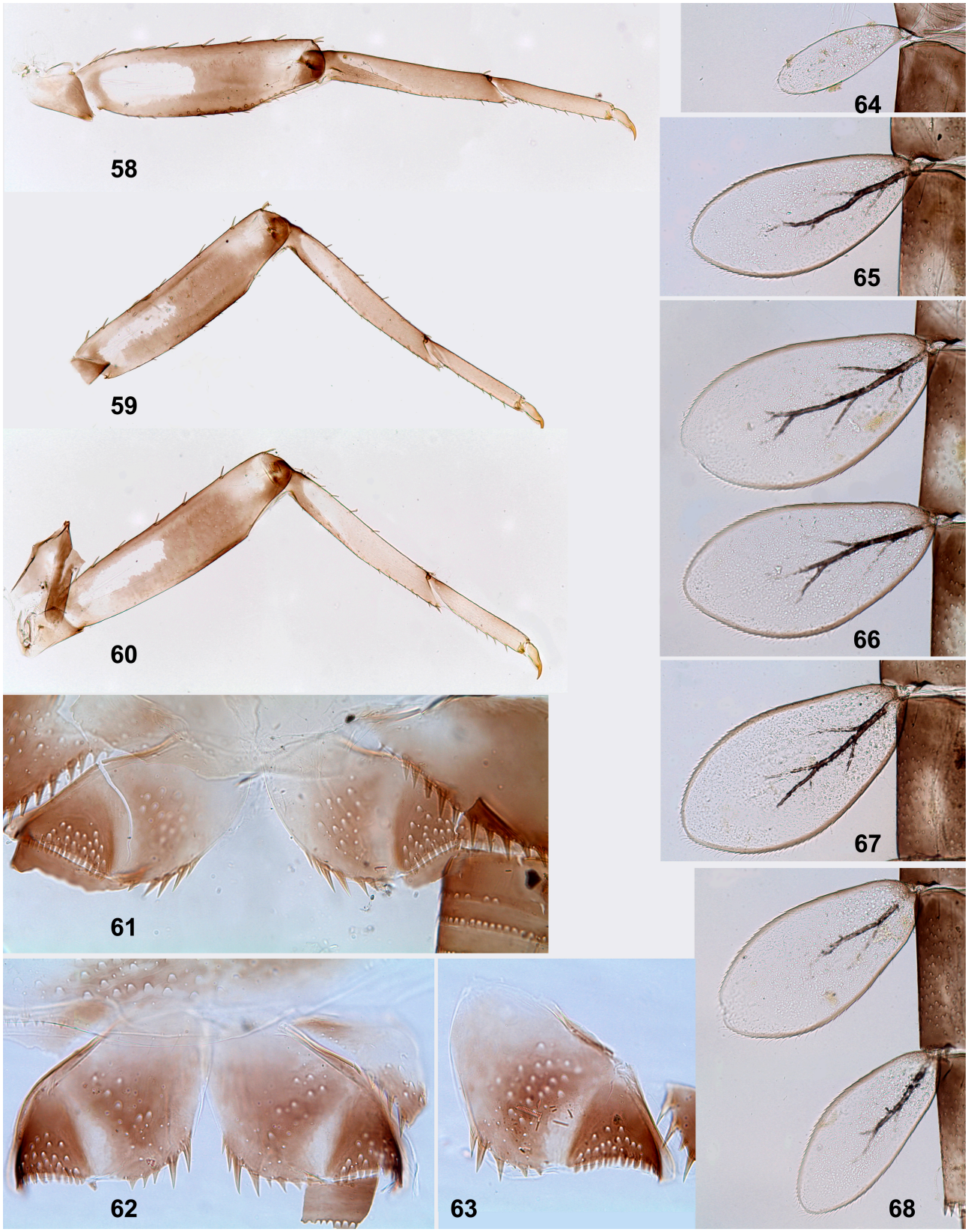
HYPODERMAL COLORATION: Not expressed.

SHAPE AND SETATION: Labrum semicircular (Fig. 53; Sivaruban *et al*. 2022: fig. 2A). Other mouthparts as in drawings and photos (Fig. 54; Sivaruban *et al*. 2022: figs 2B–G).

Hind protoptera present (Fig. 46; Sivaruban *et al*. 2022: fig. 3H).

Each tibia with one stout, parallel-sided, blunt seta on outer side near apex (subapical seta); middle and hind tibiae, besides subapical seta, with several (2–10) setae of same kind forming longitudinal row on outer side (Figs 56–57); outer side of fore tibia with no more than one stout seta other than subapical one (Fig. 55).

Posterior margins of abdominal terga I–X or II–X with triangular denticles, shorter and blunter on anterior segments, longer and more pointed on posterior segments (Sivaruban *et al*. 2022: fig. 3G). Posterior margins of all abdominal sterna smooth, without denticles (Figs 61, 62). Paraproct with few especially long and pointed denticles (Figs 61–63; Sivaruban *et al*. 2022: fig. 3K). All 7 pairs of tergalii present; tergalii of 1st pair much smaller than others, twice shorter than tergalii of next pair (Figs 64–68). Cercus with several prominent, pointed denticles on outer (lateral) side of each 4th segment; paracercus with 2 such denticles on dorsal side of each 4th segment, sometimes with one such denticle on segment between them (Figs 69–71).

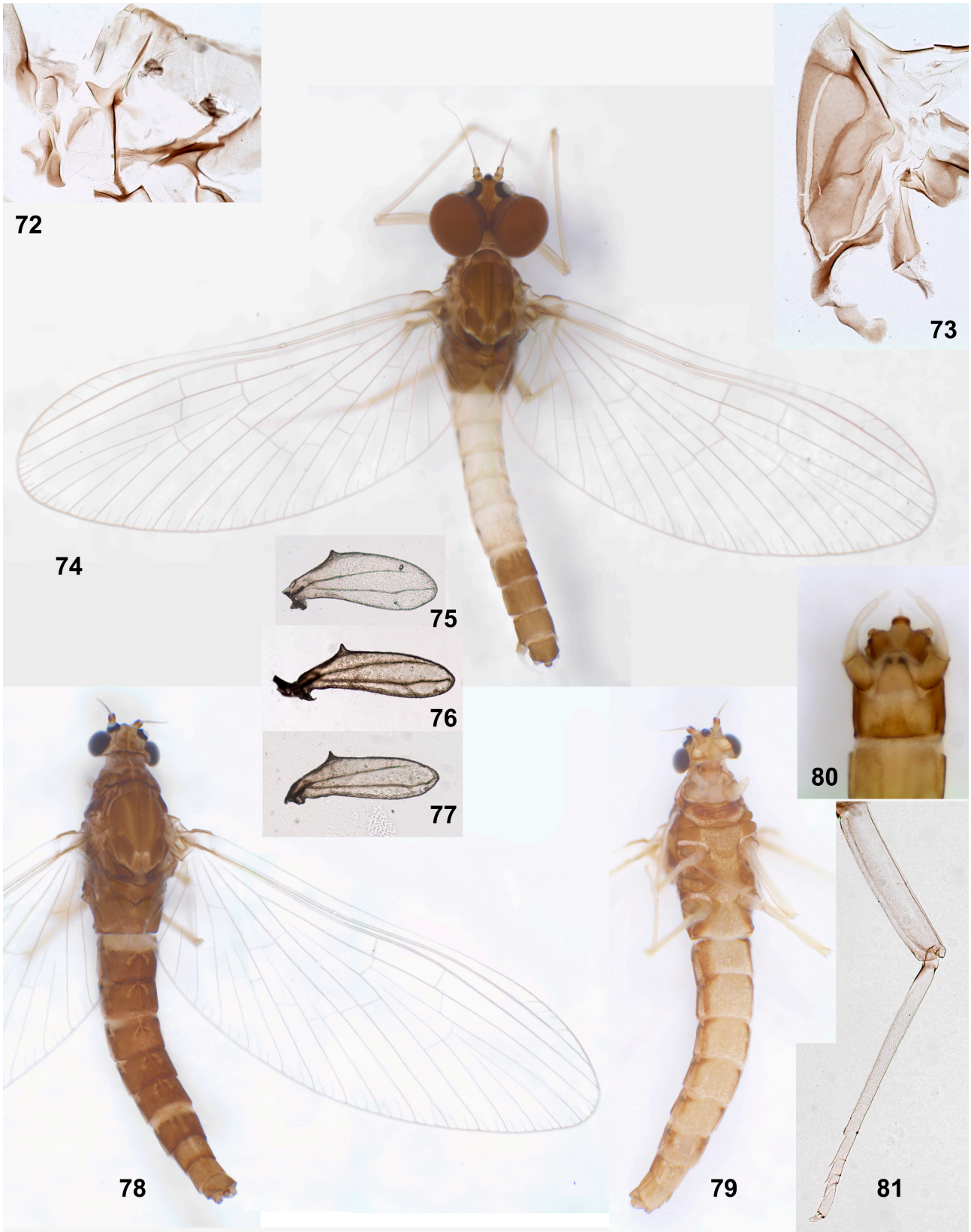


FIGURES 58–68. *Nigrobaetis* (*Margobaetis*) *klugei*, larval exuviae. 58–60, fore, middle and hind legs; 61–63, paraprocts; 64–68, fragments of abdomen with tergalii I–VII.

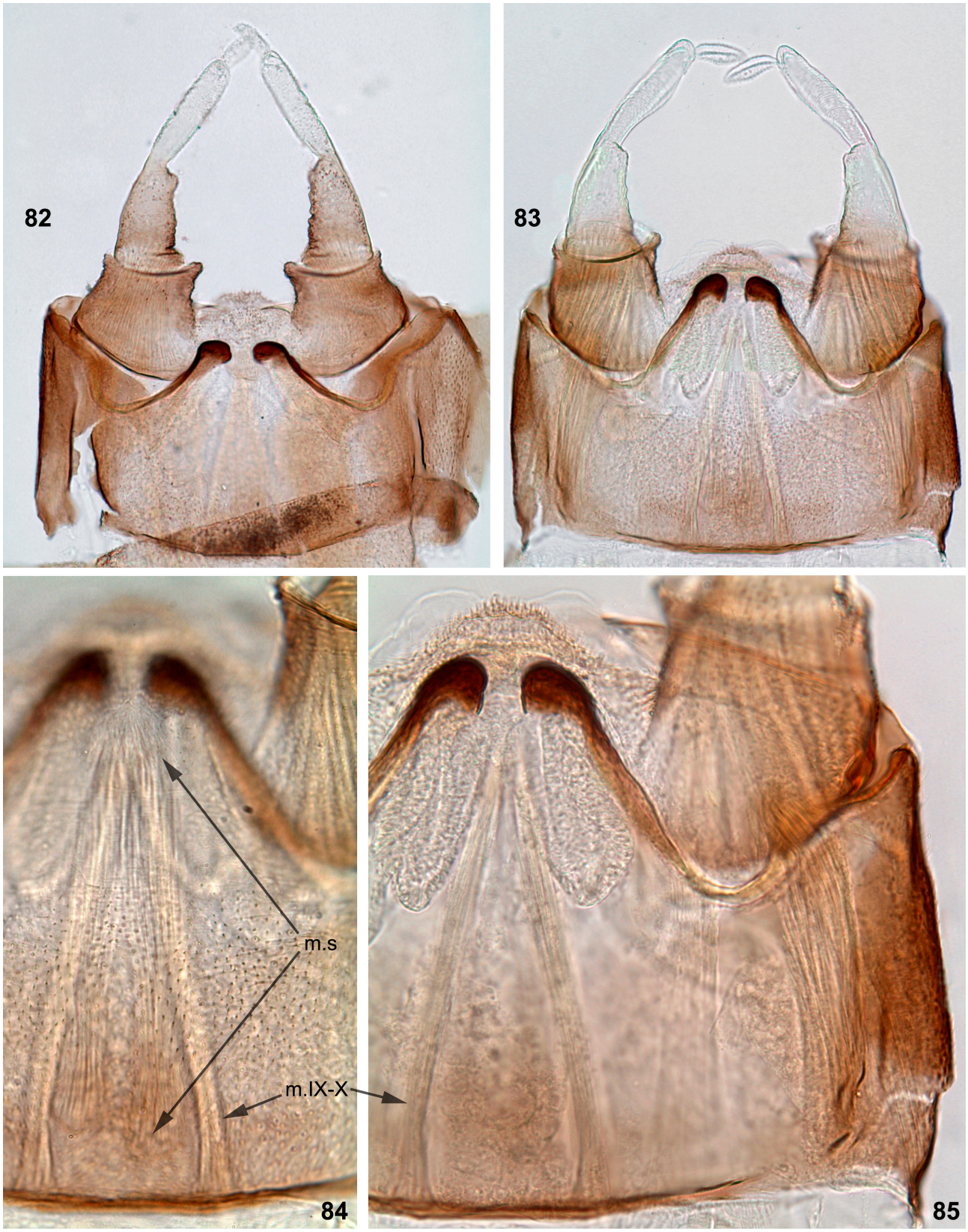
***Subimago*.** CUTICULAR COLORATION: Head colorless, antennae light brown. Pronotum light brown. Mesonotum light brown, with darker sutures (Fig. 73). Thoracic pleura and sterna mostly ochre, with certain sclerites

brown (Fig. 72). Legs mostly colorless, with brown marking proximad of patella-tibial suture (Fig. 81) or its place (on fore leg of male). Abdomen light brownish. Caudalii colorless.

FIGURES 69–71. *Nigrobaetis* (*Margobaetis*) *klugei*, larval exuviae of caudalii (dorsal view). 69, caudalii; 70, fragment of paracercus; 71, fragment of right cercus.



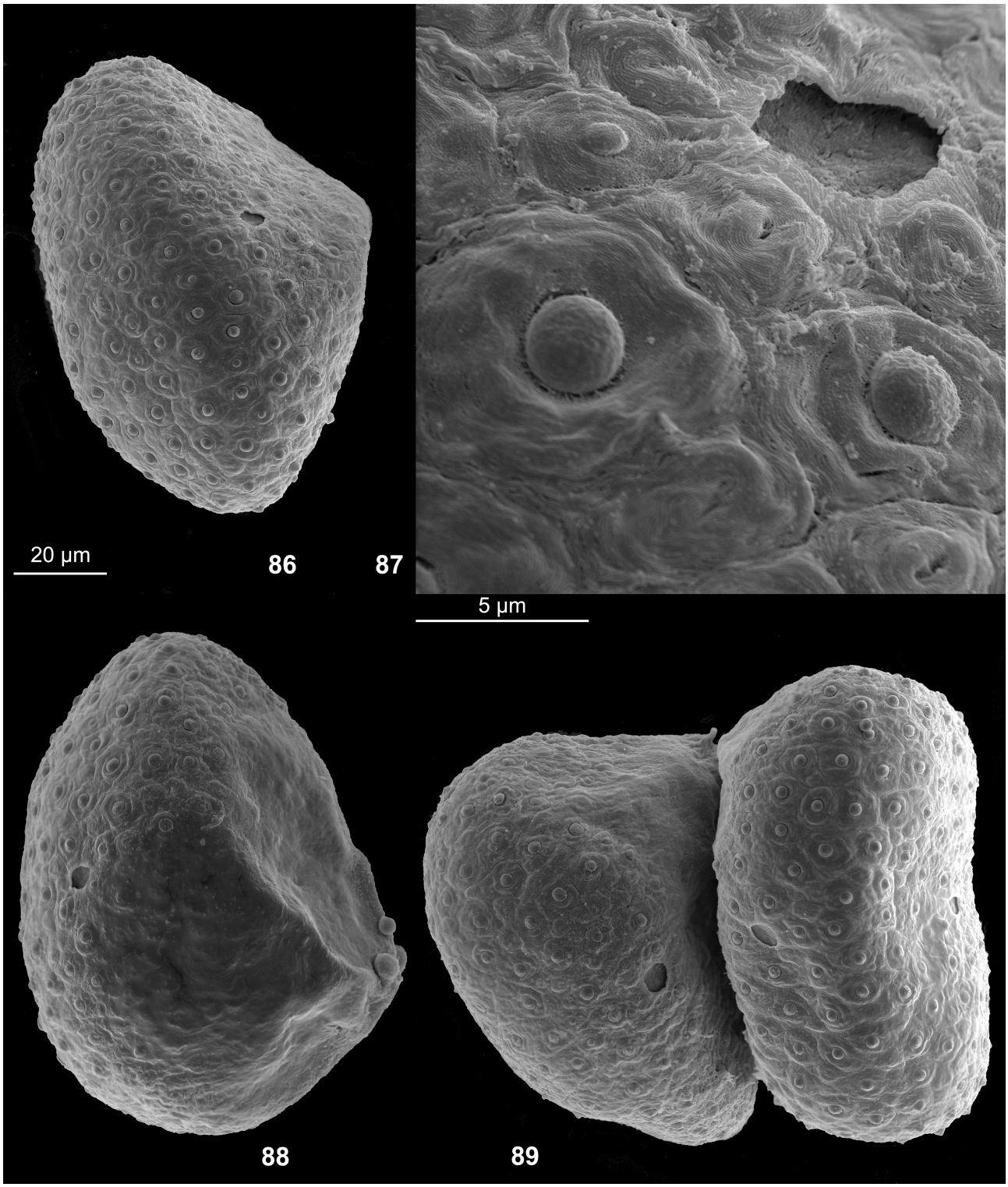
FIGURES 72–81. *Nigrobaetis* (*Margobaetis*) *klugei*. 72, subimaginal exuviae of meso- and metapleura; 73, subimaginal exuviae of mesonotum; 74, male imago; 75, hind wing of male imago; 76–77, hind wings of female imago (one and the same specimen); 78–79, female imago; 80, genitalia of male imago; 81, subimaginal exuviae of hind leg.



FIGURES 82–85. *Nigrobaetis* (*Margobaetis*) *klugei*, genitalia of male imago, ventral view. 82, with gonovectes retracted; 83–85, with gonovectes protracted (84, with focus on surface and sterno-styligeral muscle; 85, with focus on gonovectes and intersegmental sternal muscles). Abbreviations: m.IX-X, paired intersegmental muscles going to paraprocts base; m.s, median sterno-styligeral muscle.

HYPODERMAL COLORATION: As in imago.

TEXTURE: On all legs of both sexes, last tarsal segment covered with pointed microlepides; other tarsomeres covered mostly with blunt microlepides, with few pointed microlepides on distal margin (Kluge 2022).



FIGURES 86–89. *Nigrobaetis* (*Margobaetis*) *klugei*, eggs.

Imago, male (Fig. 74). Head ochre-brownish. Turbinate eyes dark reddish-brown. Thorax ochre-brownish, equally colored dorsally, laterally and ventrally. Wings colorless, veins ochre-brownish, C and Sc+R proximad of costal brace darker. Pterostigma with simple, oblique crossveins. Hind wing with costal projection and two veins, second vein asymmetrically forked (Fig. 75). Legs of all pairs uniformly light ochre. On middle and hind legs, tarsus

with 2 apical spines, on 1st+2nd and 3rd tarsomeres. Abdominal terga and sterna I–VI colorless, translucent, with brown spots on spiracles; terga VII–X ochre-brownish. Cerci ochre.

Male genitalia (Figs 82–85): Styliger without median sclerite (in contrast to *N. minutus*). 1st segment of gonostylus narrowing from base to apex, angulate apically-medially. 3rd (terminal) segment of gonostylus elongate. Penial bridge non-sclerotized medially. Gonovectes with apices greatly thicken and darkened, so that well visible through styliger even in living specimens and specimens in alcohol (Fig. 80).

Imago, female (Figs 78–79). All abdominal terga ochre-brownish, sterna ochre with pair of brownish stripes laterally. Hind wing narrower than in male (Figs 76–77). On fore leg, tarsus with 2 apical spines, on 2nd and 3rd tarsomeres.

Egg (Figs 86–89). Asymmetric: one side bluntly cone-like pointed, opposite side evenly convex, hemi-ellipsoid. Convex surface evenly and regularly covered with relief consisting of round papillae surrounded by concentric folds. Conic surface partly with less expressed papillae, partly smooth. Micropyle wide, located on any part of egg.

Dimension. Fore wing length (and approximate body length): male 3.5 mm, female 4 mm.

Distribution. Oriental Region (known from India, Thailand and Java).

Comparison with *N. gracilis*. The species currently known as *Nigrobaetis* (*Margobaetis*) *gracilis*, was originally described by Bogoescu & Tabacaru (1957) based on larvae from Romania as «*Baetis* sp. nympha *gracilis*». Sowa (1962) described imagines and larvae of *B. gracilis* from Poland, based on 2 male imaginal specimens (which he wrongly called «syntypy») and 3 larval specimens. Müller-Liebenau (1969) redescribed male imago and larva of *B. gracilis* based on imagines collected by Sowa in Poland and larvae collected by Tabacaru in Romania.

Nigrobaetis (*Margobaetis*) *gracilis* is closely related to *N.* (*M.*) *klugei*. Denticles on its larval cerci and paracercus have not been described. To reveal their features, we examined a last-instar male larva with label «Ukraine, Vyshkiv: Tysa (Visk: Tisza), 29.06.2004, Tibor Kovács»; it was kindly sent by T. Kovács and currently is deposited in ZIN. This larva differs from *N.* (*M.*) *klugei* by smaller lateral denticles on cerci and by absence of two long denticles on dorsal side of each 4th segment of paracercus.

Egg surface *N. gracilis* is covered by wide protuberances separated by narrow rings of threads (Kopelke & Müller-Liebenau 1981: Abb. 20), in contrast to eggs of *N. kluge*, which bear small papillae surrounded by wide fields of fused threads (Figs 86–89).

Comparison with *N. tatuensis*. The species currently known as *Nigrobaetis* (*Margobaetis*) *tatuensis*, was originally described based on two larvae from Taiwan as *Baetis tatuensis* Müller-Liebenau 1985. However, figures in the original description were mismatched, so that the drawings of larval parts belonging to *B. tatuensis* were indicated as belonging to *Baetis taiwanensis* Müller-Liebenau 1985 (which is described in the same paper), and the drawings of larval parts belonging to *B. taiwanensis* were indicated as belonging to *B. tatuensis*. The photos of abdominal terga belonging to *B. taiwanensis* and *B. tatuensis* (Müller-Liebenau 1985: figs 14–15) are arranged in such a way that it is unclear which legend belongs to which figure. Because of this, Kang, Chang & Yang (1994) redescribed larva of *B. taiwanensis* under the wrong name «*Baetis* (*Tatubaetis*) *tatuensis*» and designated it as the type species of the subgenus *Tatubaetis* Kang, Chang & Yang 1994; they redescribed *B. tatuensis* under the wrong name «*Baetis* (*Margobaetis*) *taiwanensis*» and wrongly placed it in the newly established subgenus *Margobaetis* Kang, Chang & Yang 1994. This confusion was revealed by Fujitani, Hirowatari, Kobajashi & Tanida (2004).

Nigrobaetis (*Margobaetis*) *tatuensis* is closely related to *N.* (*M.*) *gracilis* and *N.* (*M.*) *klugei*. Denticles on its larval cerci and paracercus have not been described neither by Müller-Liebenau (1985), nor by Kang *et al*. 1994. To reveal their features, we examined a mature male larva ready to molt to subimago with the label «Taiwan, Shanherchiaur, Linkuei, Kooshiung Hsien, 27.VII.1993, S.C. Kang»; it was used by Kang *et al*. 1994 for their description of «*Baetis* (*Margobaetis*) *taiwanensis*» and currently is deposited in ZIN. It differs from *N.* (*M.*) *klugei* by smaller lateral denticles on cerci and by absence of two long denticles on dorsal side of each 4th segment of paracercus. Difference between *N.* (*M.*) *tatuensis* and *N.* (*M.*) *gracilis* is not revealed yet.

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