

Nigrobaetis Novikova & Kluge (Ephemeroptera: Baetidae): first record and new species from southern Africa, with reassignment of one northern African species

C.R. Lugo-Ortiz & F.C. de Moor*

Department of Freshwater Invertebrates, Albany Museum, Somerset Street, Grahamstown, 6139 South Africa

Nigrobaetis bethuneae sp. n. (Ephemeroptera: Baetidae) is described from larvae collected from the Cunene (Kunene) River between Angola and Namibia. The new species represents the first record of *Nigrobaetis* Novikova & Kluge from southern Africa and a considerable extension of the distribution range for the genus. *Nigrobaetis bethuneae* is characterized by the presence of a small interantennal carina, arrangement of dorsal setae on the labrum, mandibular denticulation and setation, apicolaterally bluntly pointed labial palp segment 3, absence of hind-wing pads, presence of the first pair of gills, and general abdominal coloration. Ecological data on the new species are provided. The Algerian species *Baetis rhithralis* Soldán, previously considered to belong in *Dipheter* Waltz & McCafferty, is transferred to *Nigrobaetis*, and the biogeographic implications of the new assignment are discussed.

Key words: Ephemeroptera, Baetidae, *Nigrobaetis bethuneae*, new species, *N. rhithralis*, new combination.

INTRODUCTION

Nigrobaetis Novikova & Kluge (Ephemeroptera: Baetidae) is an *Indobaetis*-complex genus (see Waltz *et al.* 1994; Waltz & McCafferty 1997) whose larvae are distinguished by the following combination of characteristics: presence of a small interantennal carina (Fig. 1), elongate glossae and paraglossae, presence of dorsal setae on the glossae, tarsal claws without preapical setae, and paraprocts without a distomedial prolongation. Larvae of *Nigrobaetis* vary considerably with respect to the presence or absence of hind-wing pads and the first pair of gills, and therefore the presence or absence of those features cannot be used for diagnostic purposes. As is the case in most baetid genera, adults of *Nigrobaetis* cannot be reliably distinguished from other baetid adults owing to the prevalence of reductive trends and consequent morphological similarity across evolutionary lineages within the family. The attribution of the name *Nigrobaetis* to Novikova & Kluge (1994), as well as the taxonomic status of certain species of *Dipheter* Waltz & McCafferty assigned to *Nigrobaetis*, have been addressed by Waltz *et al.* (1994) and Waltz & McCafferty (1997).

Fifteen species of *Nigrobaetis* are at present known from the Palearctic and Oriental Regions (Waltz *et al.* 1994; Waltz & McCafferty 1997). Waltz

& McCafferty (1997), however, inadvertently suggested that *Nigrobaetis* also occurred in the Nearctic Region by stating that it has a Holarctic distribution. In the Afrotropical Region, *Nigrobaetis* was previously known from only one species, *N. harasab* (Soldán), from eastern Sudan (Soldán 1977).

A new species of *Nigrobaetis* was discovered from the Cunene (Kunene) River between Angola and Namibia during an intensive survey of the mayfly fauna of southern Africa that is currently under way. The new species represents the first record of *Nigrobaetis* from southern Africa. The new species is described and the biogeographical significance of the discovery is discussed below. Ecological data on the new species is also provided. It was also found that *Baetis rhithralis* Soldán & Thomas (1983) from Algeria, recently assigned to *Dipheter* Waltz & McCafferty by Waltz *et al.* (1994), agrees with the concept of *Nigrobaetis*, and the species is transferred to this genus. The new assignment has important biogeographical implications that are discussed below.

The material studied is housed in the following institutions: the Albany Museum (AM), Grahamstown, South Africa (AMGS); the Institute of Entomology, Czech Academy of Sciences, Czech Republic (IECAS); the State Museum, Windhoek, Namibia (SMWN), and the Purdue Entomological

*To whom correspondence should be addressed.
E-mail: f.demoor@ru.ac.za

Research Collection, West Lafayette, Indiana, U.S.A. (PERC). Codes after institutional abbreviations are for cataloguing purposes at the Albany Museum.

***Nigrobaetis bethuneae* sp. n.**, Figs 1–12

Description of larva

Lengths. Body: 3.6–3.8 mm; caudal filaments: 1.9–2.0 mm.

Head. Yellow-brown, with no distinct colour pattern. Small interantennal carina present (Fig. 1). Antennae approximately 2.0–2.5 times length of head capsule. Labrum (Fig. 2) anteriorly broadly rounded, with abundant branched setae, dorsally with anterolateral row of 3–4 long, fine, simple setae and submedial irregular row of 3–4 long, fine, simple setae on each side of midline, and with scattered short, fine, simple setae throughout. Hypopharynx as in Fig. 3. Right mandible (Fig. 4) with 3+4 denticles, incisors slender; prostheca uniformly slender, apically setose; row of 8–10 short, robust, simple setae between prostheca and mola. Left mandible (Fig. 5) with 3+4 denticles, incisors robust; prostheca basally slender, apically robust and denticulate; row of 4–5 short, robust, simple setae between prostheca and mola; triangular process slender. Maxillae (Fig. 6) with four falcate denticles on apex of galealacinia and submarginally with 4–5 short, fine, simple setae; medial hump with short, stout, simple seta; palp segment 1 subequal in length to segment 2, palp extending slightly beyond galealacinia. Labium (Fig. 7) with numerous long, somewhat robust, simple setae medially on glossae and paraglossae; glossae dorsally and ventrally with minute, fine, simple setae; palp segment 1 subequal in length to segments 2 and 3 combined; palp segment 2 dorsally with row of 4–5 short, fine, simple setae; palp segment 3 apicolaterally bluntly pointed, with numerous short, fine, simple setae scattered over entire surface.

Thorax. Yellow-brown to medium brown, with no distinct pattern. Hind-wing pads absent. Legs (Fig. 8) pale to medium yellow-brown; dorsally with 8–10 long, robust, apically-pointed simple setae (last two almost contiguous), ventrally with scattered short, stout, apically-pointed simple setae; tibiae ventrally with row of 6–8 short, robust, apically-pointed simple setae; tarsi dorsally with row of 10–11 robust, apically-pointed simple setae, increasing in length apically; tarsal

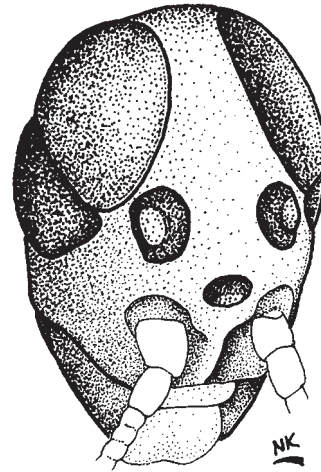


Fig. 1. *Nigrobaetis bethuneae*, larva. Head (anterolateral view; note interantennal carina).

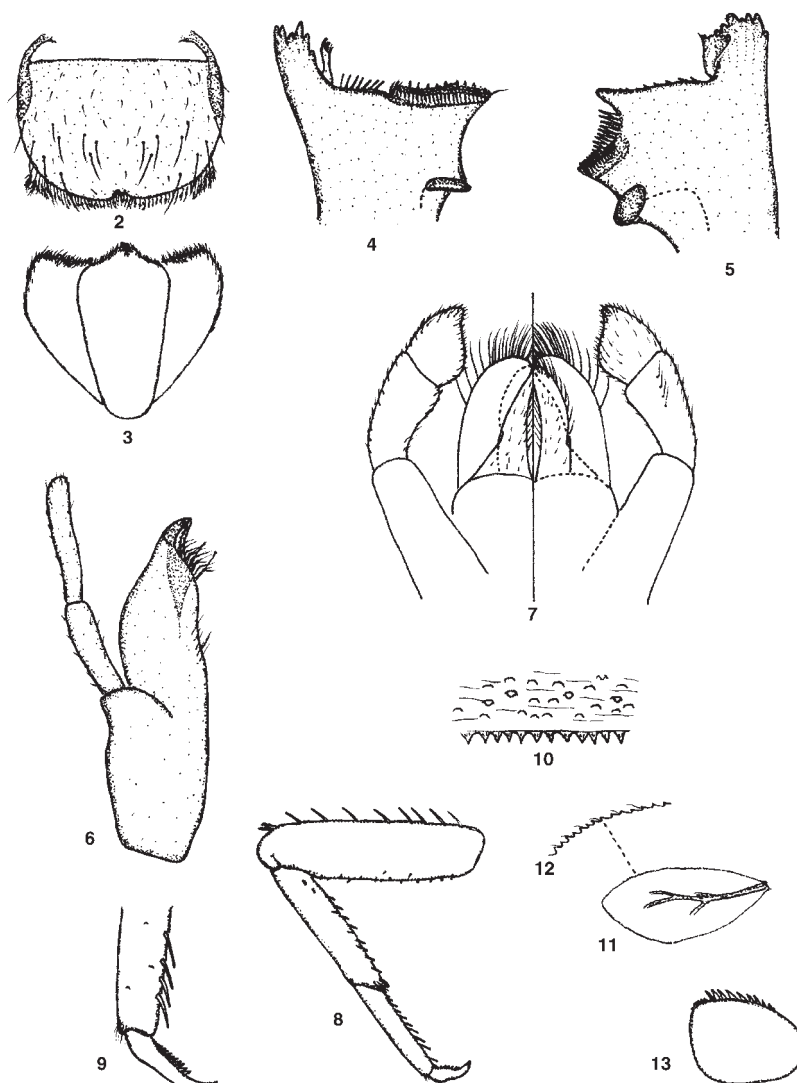
claws (Fig. 9) narrow-elongate, with 13–15 slender, sharp denticles, increasing in length apically.

Abdomen. Pale to medium yellow-brown and cream. Terga 1–3 and 5–7 uniformly pale to medium yellow-brown; tergum 4 anteriorly pale to medium yellow-brown, posteriorly cream; terga 8–10 cream. Terga (Fig. 10) creased, with numerous scale bases and scattered scales, posteriorly with irregular triangular spination. Sterna pale yellow-brown to cream. Gills (Figs 11, 12) on segments 1–7, narrow-elongate, apically pointed, poorly tracheated, marginally strongly serrate and with minute, fine, simple setae; middle gills approximately 1.5 times length of corresponding segments. Paraprocts (Fig. 13) with 10–12 slender, sharp marginal spines. Caudal filaments basally pale yellow-brown, apically cream; terminal filament approximately 0.75 times length of cerci.

Adult. Unknown.

Etymology. This species is named after Shirley Bethune, for her contributions to the understanding and preservation of aquatic ecosystems in southern Africa.

Type material examined. Holotype: Larva, Namibia–Angola border, Cunene River, 800 m upstream of Epupa Falls, marginal vegetation along riffle, 17°00′05″S 13°14′52″E, 19.xi.1997, F.C. de Moor (SMWN; KUN 80F). Paratypes: three larvae, Namibia–Angola border, Cunene River, Otjihandjaverro Guard Post, rapids, 17°05′58″S 13°31′11″E, 16.xi.1997, F.C. de Moor (mouthparts, forelegs, tergum 4, gills 3–4, and paraproct of one larva, and mouthparts, right foreleg, and tergum 4 of another



Figs 2–13. *Nigrobaetis bethuneae*, larva. **2**, labrum; **3**, hypopharynx; **4**, right mandible; **5**, left mandible; **6**, right maxilla; **7**, labium (left, ventral view; right, dorsal view); **8**, left foreleg; **9**, tarsal claw; **10**, tergum 4 (detail of posterior margin); **11**, gill 4; **12**, gill 4 (detail of margin); **13**, paraproct.

larva mounted on slide (medium: euparal) (two larvae in AMGS, one larva in PERC; KUN 51H); larva, Namibia–Angola border, Cunene River, Baynes Mountains, stones out of current, heavily covered in mud and algae, 17°01'12"S 12°56'42"E, 21.xi.1997, F.C. de Moor (AMGS; KUN 100D).

Additional material examined. Five larvae, Namibia–Angola border, Cunene River, Otjihandjaveru Guard Post, rapids, 17.05S 13.31E, 16.xi.1997, F.C. de Moor (AMGS; KUN 51H); larva, Namibia–Angola border, Cunene River, stones in swift current

over bedrock, besides rapids, 17.00S 13.25E, 17.xi.1997, F.C. de Moor (AMGS; KUN 59I); larva, Namibia–Angola border, Cunene River, below Epupa Falls, vegetation and driftwood wedged between boulders in swift current, 17.00S 13.14E, 19.xi.1997, F. C. de Moor (AMGS; KUN 76D); two larvae, Cunene River, Namibia–Angola border, Baynes Mountains, stones in current covered with moss, 17.01S 12.57E, 21.xi.1997, F.C. de Moor (AMGS; KUN 98N); two exuviae, Namibia–Angola border, Cunene River, drift net, ca 18h30–

21h30, 27.xi.1998, 13.28S 17.02E, F.C. de Moor (AMGS; KUN 140L).

Remarks. *Nigrobaetis bethuneae* is distinguished by the small interantennal carina (Fig. 1), arrangement of dorsal setae on the labrum (Fig. 2), mandibular denticulation (Figs 4, 5), apicolaterally bluntly pointed labial palp segment 3 (Fig. 7), absence of hind-wing pads, presence of the first pair of gills, and general abdominal coloration.

During two surveys of the Cunene River (November 1997 and November 1998), the flow was at a seasonal low. Furthermore, due to hydroelectric power demands, the river was subjected to regular fluctuations in flow discharge that resulted in a one-day 1.1 m rise and fall in the water level a few kilometres downstream of the Onduruso Falls and 38 km downstream of the Ruacana Falls at the hydroelectric power station. Larvae of *N. bethuneae* were collected from seven localities on the Cunene River between the Ohangonga Guard Post (50 km downstream from the Ruacana Falls and 700 m asl) and the Orokawe Guard Post in the Baynes Mountains area (30 km downstream of the Epupa Falls and 450 m asl). The Cunene River in this region flows mostly over bedrock and produces a large number of rapids and riffles, and *N. bethuneae* appears to be fairly widespread but uncommon in this lower, rejuvenated portion of the river. Larvae occurred mostly on stones in swift-flowing water, usually in the thalweg region that remained completely submerged and unaffected by water level fluctuations, and were commonly associated with the rooted macrophyte *Hydrostachys polymorpha* Klotzch (Hydrostachyaceae) or with marginal trailing vegetation and wedged driftwood. Only in one sample were larvae found out of the main current on a stone covered with sediment and filamentous algae. Larval exuviae were collected in drift nets.

Species of Baetidae commonly associated with *N. bethuneae* included *Centroptiloides bifasciata* (Esbén-Petersen), *Dabulamanzia media* (Crass), *Pseudocloeon glaucum* (Agnew), and *P. vinosum* Barnard. Mayfly species from other families frequently collected with *N. bethuneae* included *Ephoron savignyi* (Pictet) (Polymitarciidae), *Euthraulius elegans* Barnard (Leptophlebiidae), *Tricorythus tinctus* Kimmins (Tricorythidae), and *Afronurus barnardi* Schoonbee (Heptageniidae).

The presence of *N. bethuneae* in the Cunene River is of biogeographical significance because it represents a considerable southward extension of the

range of *Nigrobaetis*. The occurrence of *N. harasab* in northeastern Africa (Soldán 1977) and *N. bethuneae* in southern Africa, together with the reassignment of the Algerian species *D. rhithralis* to *Nigrobaetis*, suggest that *Nigrobaetis* is well established in Africa and that further species will be found throughout the northern and central parts of the continent. It is also possible that *Nigrobaetis* occurs south of the Cunene River.

***Nigrobaetis rhithralis* (Soldán & Thomas)
comb. n.**

Baetis rhithralis Soldán & Thomas, 1983: 356.

Diphetero rhithralis (Soldán & Thomas): Waltz *et al.* 1994: 34.

Type material examined. Paratypes: Three larvae, one male adult, Algeria, Chiffa, Oued Merdja, Rouisseau des Signes, 8.x.1981, T. Soldán (IECAS).

Remarks. Soldán & Thomas (1983) described *Baetis rhithralis* from larvae and male and female adults from Algeria. The species is assigned to *Nigrobaetis* because the larval description and figures provided by Soldán & Thomas (1983: Figs. 1–11) agree with the concept of the genus as discussed by Waltz *et al.* (1994). The species does not belong in *Diphetero* because it lacks the distinctive bifid prostheca of the right mandible characteristic of that genus (Waltz & McCafferty 1987; Morihara & McCafferty 1979: Fig. 34b).

The new assignment is also of considerable biogeographical importance because it indicates that *Diphetero* does not occur on the African continent. Moreover, it indicates that *Diphetero* is probably endemic to the Nearctic Region, because no species referable to the genus have been reported from the Palearctic, Oriental or Australian Regions. In the Nearctic, *Diphetero* is represented by *D. devinctus* (Traver) and *D. hageni* (Eaton). Both species have a primarily northern distribution in that region (McCafferty & Waltz 1990; McCafferty & Randolph 1998).

ACKNOWLEDGEMENTS

We are grateful to the National Research Foundation for providing funds to the first author to conduct postdoctoral research in South Africa. We also thank the Directorate of Museums and Heritage, Eastern Cape Province, for providing research facilities. S. Bethune and K. Roberts (Department of Water Affairs, Namibia) are

thanked for making the surveys of the Cunene River in 1997 and 1998 possible. S. Bethune, N. Clarke, N. Köhly, R. Pieterse, K. Roberts, K. Schachtschneider, R. Simmons, E. Taylor and R. Tharme assisted with collecting during the

surveys. We thank T. Soldán (Institute of Entomology, Czech Academy of Sciences, Czech Republic) who arranged for us to study type material of *N. rhithralis*. Finally, we thank N. Köhly for the preparation of Fig. 1.

REFERENCES

- McCAFFERTY, W.P. & RANDOLPH, R.P. 1998. Canada mayflies: a faunistic compendium. *Proceedings of the Entomological Society of Ontario* **129**: 47–97.
- McCAFFERTY, W.P. & WALTZ, R.D. 1990. Revisionary synopsis of the Baetidae (Ephemeroptera) of North and Middle America. *Transactions of the American Entomological Society* **116**: 769–799.
- MORIHARA, D.K. & McCAFFERTY, W.P. 1979. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). *Transactions of the American Entomological Society* **105**: 139–221.
- NOVIKOVA, E.A. & KLUGE, N. 1994. Mayflies of the subgenus *Nigrobaetis* (Ephemeroptera, Baetidae, *Baetis* Leach, 1815). *Entomologicheskoye Obozreniye* **73**: 623–644. (1995. *Entomological Review* (English translation) **74**: 16–39.)
- SOLDÁN, T. 1977. Three new species of mayflies (Ephemeroptera) from the mist oasis of Erkwit, Sudan. *Acta Entomologica Bohemoslovaca* **74**: 289–294.
- SOLDÁN, T. & THOMAS, A.G.B. 1983. New and little-known species of mayflies (Ephemeroptera) from Algeria. *Acta Entomologica Bohemoslovaca* **80**: 356–376.
- WALTZ, R.D. & McCAFFERTY, W.P. 1987. New genera of Baetidae for some Nearctic species previously included in *Baetis* Leach (Ephemeroptera). *Annals of the Entomological Society of America* **80**: 667–670.
- WALTZ, R.D. & McCAFFERTY, W.P. 1997. New generic synonymies in Baetidae (Ephemeroptera). *Entomological News* **108**: 134–140.
- WALTZ, R.D., McCAFFERTY, W.P. & THOMAS, A. 1994. Systematics of *Alainites* n. gen., *Dipheter*, *Indobaetis*, *Nigrobaetis* n. stat., and *Takobia* n. stat. (Ephemeroptera, Baetidae). *Bulletin de la Société d'Histoire Naturelle, Toulouse* **130**: 33–36.

Accepted 10 January 2000