

CONTRIBUTION TO THE SYSTEMATICS OF THE GENUS *CHELEOCLOEON* (EPHEMEROPTERA: BAETIDAE)^{1, 2}

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ABSTRACT: The Afrotropical genus *Cheleocloeon* (Ephemeroptera: Baetidae) is shown to constitute a small, but widespread, monophyletic group of species that are distinguished by an anteriorly convex medial process of the second segment of the labial palps and long, poorly denticulate tarsal claws. The genus is hypothesized to belong to the *Bugilliesia* complex of genera on the basis of the basally bulbous second segment of the male genital forceps and general morphology of the larval tarsal claws and gills. *Cheleocloeon dimorphicum*, n. comb., and *C. excisum*, n. comb., are transferred from the genus *Afroptilum*, and are distinguishable among species of *Cheleocloeon* by the presence of hindwings in male adults and modifications of the medial process of the second segment of the labial palps. The commonly collected larval stage of *C. excisum* is redescribed, and new figures are provided to illustrate previously overlooked characters of the species.

Wuillot and Gillies (1993) erected the genus *Cheleocloeon* for two distinctive species of small minnow mayflies (Ephemeroptera: Baetidae) from Guinea: *C. carinatum* Wuillot and *C. yolandae* Wuillot. Those authors distinguished larvae of *Cheleocloeon* by the long, distally acute medial process of the second segment of the labial palps (Wuillot and Gillies 1993: Figs. 6, 15), absence of hindwingpads, elongate first pair of gills (Wuillot and Gillies 1993: Figs. 9, 18), and relatively long, poorly denticulate tarsal claws (Wuillot and Gillies 1993: Figs. 8, 17). They stated, however, that adults of *Cheleocloeon* could not be confidently separated from other baetid adults with single marginal intercalaries in the forewings.

Our examination of the baetid fauna of Africa has revealed that *Afroptilum dimorphicum* (Soldán and Thomas), from Algeria, and *A. excisum* (Barnard), from southern Africa, belong in *Cheleocloeon*. Both species were originally described in the genus *Centroptilum* Eaton but later assigned to the *dimorphicum* group of *Afroptilum* Gillies by Gillies (1990). The inclusion of these two species in *Cheleocloeon* expands the concept of the genus because they have certain characteristics not present in the type of the genus, *C. yolandae*. Here, we provide a revised diagnosis of *Cheleocloeon* and discuss the newly observed variability in the genus. We also redescribe the larval stage of *C. excisum* and provide new figures showing characteristics overlooked by Barnard (1932). The material examined is housed in the Albany Museum (AM), Grahamstown, South Africa, and the Purdue Entomological Research Collection (PERC), West Lafayette, Indiana.

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Cheleocloeon Wuillot and Gillies

Cheleocloeon Wuillot and Gillies 1993:213.

Diagnosis. Larvae of *Cheleocloeon* are distinguished by the anteriorly convex medial process of the second segment of the labial palps (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15) and the long, poorly denticulate tarsal claws (Figs. 8, 9; Soldán and Thomas 1985: Fig. 8; Wuillot and Gillies 1993: Figs. 8, 17). Male adults have the second segment of the genital forceps basally bulbous (Wuillot and Gillies 1993: Fig. 2), and, when hindwings are present, these are long and have two longitudinal veins and a hooked costar process located near the basal third (Barnard 1932: Fig. 14c). These adult characteristics, however, will not allow them to be distinguished from all other baetid genera with single marginal intercalaries in the forewings.

Type species. *Cheleocloeon yolandae* Wuillot.

Included species.

Cheleocloeon dimorphicum (Soldán and Thomas), n. comb.

Centroptilum dimorphicum Soldán and Thomas 1985:180 (larva; male subimago; female adult).

Afroptilum dimorphicum (Soldán and Thomas): Gillies 1990:99.

Cheleocloeon excisum (Barnard), n. comb.

Centroptilum excisum Barnard 1932:224 (larva; male, female subimagos; male, female adults).

Afroptilum excisum (Barnard): Gillies 1990:99.

Cheleocloeon carinatum Wuillot

Cheleocloeon carinatum Wuillot, in Wuillot and Gillies 1993:214 (larva; male adult).

Cheleocloeon yolandae Wuillot

Cheleocloeon yolandae Wuillot, in Wuillot and Gillies 1993:214 (larva; male adult).

Distribution. Algeria (*C. dimorphicum*); Guinea (*C. carinatum*, *C. yolandae*); Lesotho (*C. excisum*); South Africa: Eastern Cape, KwaZulu Natal, Mpumalanga, Western Cape (*C. excisum*).

Discussion. We consider the anteriorly convex medial process of the second segment of the labial palps (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15) and long, poorly denticulate tarsal claws (Figs. 8, 9; Soldán and Thomas 1985: Fig. 8; Wuillot and Gillies 1993: Figs. 8, 17) to be autapomorphies that cladistically define *Cheleocloeon*. This monophyletic group is now known to include species with larvae that have either an apically blunt or pointed medial process of the second segment of the labial palps, and that have male adults with or without hindwings. *Cheleocloeon dimorphicum* and *C. excisum* differ from *C. carinatum* and *C. yolandae* in the morphology of the medial process of the second segment of the labial palps. In

C. excisum, that process is apically pointed (Figs. 6, 7), but it is not as long as in *C. carinatum* (Wuillot and Gillies 1993: Fig. 15) or *C. yolandae* (Wuillot and Gillies 1993: Figs. 6). In contrast to those three species, *C. dimorphicum* has a process that is somewhat short and apically blunt (Soldán and Thomas 1985: Fig. 5). Only the male adults of *C. dimorphicum* and *C. excisum* have hindwings, but both males and females of *C. carinatum* and *C. yolandae* have hindwings. The hindwings of the male alate stages of *C. excisum* are somewhat long and possess two longitudinal veins and a hooked costal process located near the basal third (Barnard 1932: Fig. 14e). Male adults of *C. dimorphicum* are not known; however, the hindwings were described by Soldán and Thomas (1985) based on male subimago hindwings dissected from mature larvae, and their morphology is similar to that of *C. excisum*.

The inclusion of *C. dimorphicum* and *C. excisum* in *Cheleocloeon* considerably extends the known geographic range of the genus. Not only is the genus widespread in Africa (see Distribution, above), but it occurs at low and high altitudes and in arid, semiarid, and humid biomes (Soldán and Thomas 1985, Palmer et al. 1993, Wuillot and Gillies 1993).

Wuillot and Gillies (1993) suggested that *Cheleocloeon* and *Demoulinia* Gillies are sister groups due to the shared absence of hindwings, pointed medial process of the second segment of the labial palps, and long, poorly denticulate tarsal claws. We cannot agree based on that assessment alone. Irrespective of the fact that hindwings are now known to be present in some species of *Cheleocloeon*, the absence of hindwings in Baetidae has been shown to be a generally unreliable characteristic for inferring common ancestry and generic constraints due to the numerous instances of convergence among unrelated species throughout the family (McCafferty and Waltz 1990). The morphology of the medial process of the second segment of the labial palps is actually quite different in *Cheleocloeon* and *Demoulinia*. In *Demoulinia*, that process is anteriorly straight and distally convex (Crass 1941: Fig. 27d), not anteriorly convex as in *Cheleocloeon* (Figs. 6, 7; Soldán and Thomas 1985: Fig. 5; Wuillot and Gillies 1993: Figs. 6, 15), and it is not always pointed in *Cheleocloeon* (Soldán and Thomas 1985: Fig. 5). Furthermore, the presence of long, poorly denticulate tarsal claws in *Cheleocloeon* and *Demoulinia* may or may not be commonly derived because such claws are found in many unrelated taxa in Baetidae (e.g., *Apobaetis* Day, *Paracloeodes* Day, *Potamocloeon* Gillies, *Pseudocentropiloides* Jacob).

Cheleocloeon apparently belongs to the *Bugilliesia* complex of genera defined by Lugo-Ortiz and McCafferty (1996) because the second segment of the male genital forceps is basally bulbous (Wuillot and Gillies 1993: Fig. 2). Furthermore, within the hypothesized cladogram of the *Bugilliesia* complex, *Cheleocloeon* would be in a position intermediate between the two most ancestral genera of the complex, *Potamocloeon* and *Afrobaetodes* Demoulin

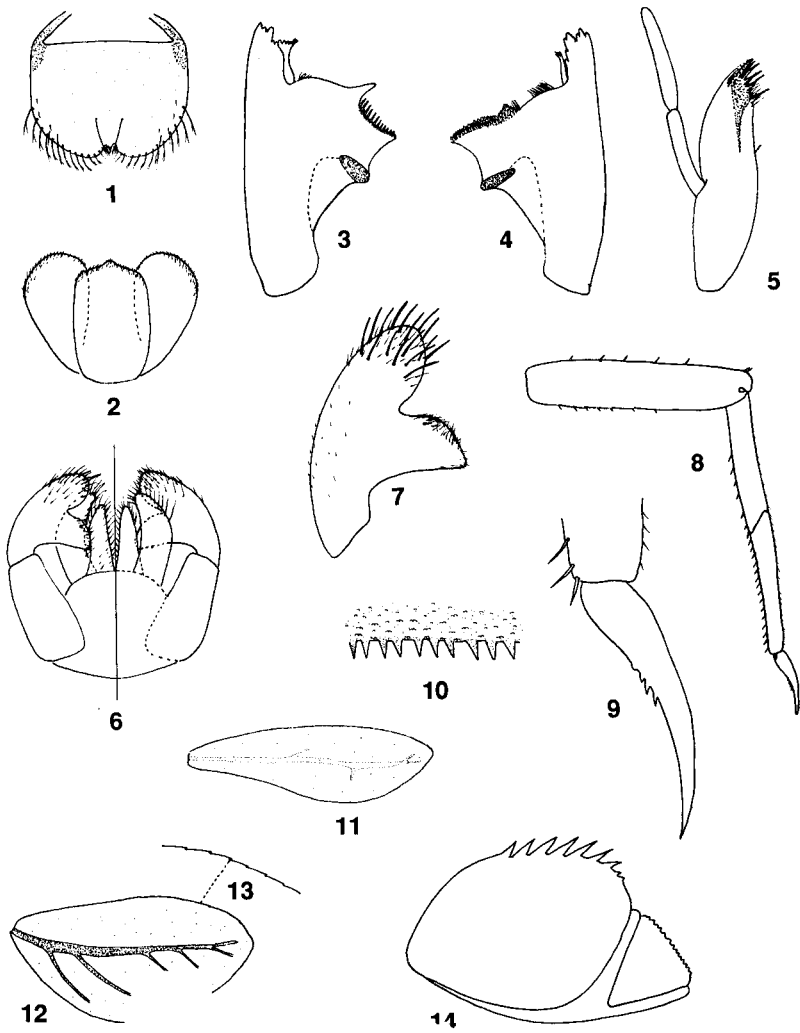
(Lugo-Ortiz and McCafferty 1996: Fig. 1). *Cheleocloeon* shares reduction of the tarsal claws (Fig. 9) and loss of the dorsal gill flaps (Figs. 11, 12) with *Afrobaetodes* and other more apotypic genera of the *Bugilliesia* complex; however, it does not share the absence of the third segment of the male genital forceps with that same group of genera. Thus, we hypothesize a sister relationship of *Cheleocloeon* with those genera, and the relatively basal phyletic derivation mentioned above. Although the larval characteristics and lack of hindwings in *Demoulinia* are inconclusive with respect to deducing its relationships, as noted above, there remains the possibility that the genus may also prove to belong to the *Bugilliesia* complex. Unfortunately, the male genital forceps figured by Crass (1947) are too schematic to allow a definitive analysis, and we have not been able to secure adult male specimens for examination.

Cheleocloeon excisum (Barnard), n. comb.

Larva. Body length: 5.9-6.2 mm; caudal filaments length: 2.5-2.7 mm. Head: Coloration yellow-brown, with vermiform markings on frons. Antennae nearly 2.0x length of head capsule. Labrum (Fig. 1) with submedial setae and bifurcate anterior marginal setae. Hypopharynx as in Figure 2. Left mandible incisors (Fig. 3) with 3 + 3 denticles; prosthema apically denticulate; small tuft of simple setae present between prosthema and mola; triangular process at base of mola somewhat sharp and elongate. Right mandible incisors (Fig. 4) with 3 + 4 denticles; prosthema apically setose; large tuft of simple setae present between prosthema and mola; small tuft of setae present at base of mola. Maxillae (Fig. 5) with four apical denticles on galealaciniae; three to four fine, simple setae present laterally near base of denticles; medial hump with stout, simple seta; palps two segmented, extending beyond galealaciniae, palp segment 2 slightly longer than segment 1. Labium (Fig. 6) with many long, simple setae marginally on glossae and paraglossae; palps two segmented; palp segment 1 subequal to segment 2; segment 2 (Fig. 7) with well-developed, distally pointed medial process, and abundant long, robust and short, fine, simple setae on surface. Thorax: Coloration yellow-brown, with no distinct pattern. Hindwingpads present in males, absent in females. Legs (Fig. 8) pale yellow-brown; femora dorsally with four to six short, simple setae and ventrally with six to eight short, simple setae; tibiae dorsally with numerous minute, fine, simple setae and ventrally with six to eight short, simple setae; tarsi dorsally with numerous minute, fine, simple setae and ventrally with 15-17 short, simple setae, somewhat increasing in length distally; tarsal claws (Fig. 9) long, nearly 0.5x length of tarsi, with three to four poorly developed denticles. Abdomen: Coloration medium brown to cream, with variable color patterns. Terga 1, 3, 5, 6, and 9 usually medium brown with various cream markings; other terga usually cream with various medium brown markings. Tergal surfaces (Fig. 10) with minute scale bases, mostly in pairs; posterior margins with sharp triangular spination. Sterna cream to pale yellow. Gill 1 (Fig. 11) elongate, paddle-shaped, poorly tracheated, without marginal serrations; gills 2-7 (Fig. 12) broadest in middle, well tracheated, with minute marginal serrations (Fig. 13). Paraprocts (Fig. 14) with six to seven sharp marginal spines. Caudal filaments cream to pale brown; terminal filament subequal to cerci.

Adult. See description by Barnard (1932).

Material examined. LESOTHO: Linakeng-Sengu, Sani R, pool above Sani bridge, IX-23-1988, P. H. Skelton, larvae (AM); SOUTH AFRICA: Eastern Cape Province: Klein Vispruit at Groot Valley, ca 20 km SW of Cradock, X-11-1990, W. P. and N. McCafferty, larvae (PERC);



Figs. 1-14. *Cheleocloeon excisum*, larva. 1. Labrum. 2. Hypopharynx. 3. Left mandible. 4. Right mandible. 5. Right maxilla. 6. Labium (left-ventral; right dorsal). 7. Segment 2 of labial palps (enlarged). 8. Right foreleg. 9. Right foretarsal claw. 10. Detail of tergum 4. 11. Gill 1. 12. Gill 4. 13. Detail of gill 4. 14. Paraproct.

Fish R, N of Karoo Sulphur Springs, nr Cradock, XI-10-1990, W. P. and N. McCafferty, larvae (PERC); Little Fish R, at R 32, nr Sheldon, XI-11-1990, W. P. and N. McCafferty, larvae (PERC); Kap R crossing, Bathurst St. For., 10 km S of Rd N 2, nr Grahamstown, IX-14-1990, W. P. and N. McCafferty, larvae (PERC); Blaukrans R at Blaukrans Pass, on Rd 67, between Grahamstown and Bathurst, XI-14-1990, W. P. and N. McCafferty, larvae (PERC); KwaZulu-Natal Province: Howick Falls, Umgeni R, X-2-1971, G. F. and C. H. Edmunds, larvae (PERC); Umzinkulu R, between Underberg and Boesmansnek, 15.5°C, X-2-1971, G. F. and C. H. Edmunds (PERC); Krantzkloof Nat. Res., Molweni R, nr Kloof, X-4-1971, G. F. and C. H. Edmunds, larvae (PERC); Umlaas R, at Durban waterworks filtration plant, nr Pinetown, X-4-1971, G. F. and C. H. Edmunds, larvae (PERC); Umgeni R, above Nagel Dam Impoundment, IX-21-1990, W. P. and N. McCafferty, larvae (PERC); Wilge R, at R 714, W of Warden, X-16-1990, W. P. and N. McCafferty, larvae (PERC); Molweni R, at Krantzkloof Nat. Res., nr Durban, IX-21-1990, W. P. and N. McCafferty and B. Fowles, larvae (PERC); Mpumalanga Province: Buffelspruit at Shalom (Aalwan), 4 km W of Badplaas paralleling Rt 38, off Avantune Rd, 1167 m, X-17-1990, W. P. and N. McCafferty, larvae (PERC); Sabie-Sand Game Res., Sand R at Londolozzi, X-20-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R at Molondozi, X-23-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R, SE corner of Old Rhino Camp, X-24-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Ntl. Pk., Sabie R at Lisbon Estates, X-27-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Nat. Pk., Olifants R, 15 km from Blacktop Rd, at Fig Tree Site, X-29-1990, W. P. and N. McCafferty, larvae (PERC); Kruger Nat. Pk., Olifants R at bridge on dirt rd, nr Olifants Camp, X-29-1990, W. P. and N. McCafferty, larvae (PERC).

Discussion. Barnard (1932) described *C. excisum* based on larvae and reared adults from the Western Cape Province in South Africa. However, his description of the larval stage is brief and his drawings are schematic and inaccurate.

Larvae of *C. excisum* are distinguished from those of *C. dimorphicum* by the distally pointed medial process of the second segment of the labial palps (Figs. 6, 7). Larvae of *C. carinatum* and *C. yolandae* are generally similar to those of *C. excisum*, but the medial process of the second segment of the labial palps of *C. carinatum* and *C. yolandae* is longer (Wuillot and Gillies 1993: Figs. 6, 15), and their males and females lack hindwingpads.

Larvae of *C. excisum* are found in riffles and stony backwaters (Crass 1947, Palmer et al. 1993). Palmer et al. (1993) found that they mostly feed on ultrafine and fine particulate organic matter (0.5-250 μm), but mature individuals are capable of handling relatively large diatoms. Adults emerge primarily during the south-temperate winter months (June-August) according to Crass (1947).

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