GOSE'S AFRICAN EPHEMEROPTERA (BAETIDAE, HEPTAGENIIDAE)[1]

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ABSTRACT: Three new species of small minnow mayflies (Ephemeroptera: Baetidae) are described from larvae taken in the Democratic Republic of Congo as follows: *Acanthiops gosei*, n. sp., *Dicentroptilum imanishii*, n. sp., and *Tanzaniella gorillora*, n. sp. Each of these species is structurally distinctive within the Afrotropical genus to which it belongs. With respect to *D. imanishii*, the concept of *Dicentroptilum* is slightly expanded to accommodate the new species, and an analysis of the relationships with *Xyrodromeus* is given. With respect to *T. gorillora*, a more comprehensive analysis of the relationships of *Tanzaniella* with *Demoreptus* and certain other *Baetis* complex genera is given. The significance and interpretation of such characters as dorsal abdominal tubercles, numbers of rows of claw denticles, and integrity of mandibular incisors in Baetidae are discussed. Larvae of two species of Heptageniidae from D. R. Congo are placed to *Afronurus*, but must remain unnamed as species.

In 1958, Kyoto University in Japan sponsored an expedition to central Africa. Among the materials collected on this expedition, from what is now the Democratic Republic of the Congo, were numerous larval specimens of Ephemeroptera that had been collected by Kinji Imanishi. These specimens, representing the families Baetidae and Heptageniidae, were reasonably described and figured by Kyuemon Gose (1964), but could not be formally named at that time because of the dearth of knowledge about the larval African mayfly fauna. Neither Gose nor Imanishi pursued the further description or formalizing of names for these unnamed species, and neither researcher remains active in ephemeropterology today (Y. J. Bae, pers. comm.).

In the past decade giant strides have been made in our understanding of certain mayfly families and their biodiversity in Africa, and this is especially true for the family Baetidae, primarily vis-à-vis the revisionary work of Lugo-Ortiz and McCafferty and colleagues (e.g., Waltz and McCafferty 1994, Lugo-Ortiz and McCafferty 1996abc, 1997ab, 1998, Lugo-Ortiz et al. 1999, 2001, Jacobus and McCafferty 2001). This new knowledge base makes it now possible to place the African Baetidae treated by Gose within a generic and species framework that is to a large extent based on larval characterization. As a result of such an analysis, I am able to herein formally name those species that are clearly new, and offer some comments on each of the genera and species represented.

The baetid larvae treated by Gose (1964) represent three new species as treated below. All specimens of these new species are deposited at the Nara Women's University, Nara Prefecture, Japan, but have not been seen in recent years (S. Ishiwata, pers. comm).

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Acanthiops gosei, NEW SPECIES

This species was originally treated by Gose (1964) as *Pseudocloeon* sp. CPA, based on three larvae. The text and figures provided by Gose (1964:58-59, Figs. 15-30) represent sufficient description of the new species. Adults of the species remain unknown. The species is named after K. Gose, who first treated the species.

Larval diagnosis. Among the presently known 12 species of African *Acanthiops* Waltz and McCafferty, *A. gosei* is most closely related to *A. elgonensis* Lugo-Ortiz and McCafferty, *A. griffithsi* Lugo-Ortiz and McCafferty, *A. marlieri* (Demoulin), and *A. zomba* Lugo-Ortiz and McCafferty. These species all have relatively extensive medioposterior dorsal abdominal tubercles, a severely reduced median caudal filament, along with pigmented gills (see Lugo-Ortiz and McCafferty 1998, Lugo-Ortiz et al. 2001). The dorsal abdominal tubercles of *A. gosei* (Figs. 16,17 [Gose 1964]) are not nearly as highly developed as those of *A. marlieri* and *A. griffithsi* (see respectively Fig. 3 [Demoulin 1967] and Fig. 8 [Lugo-Oritz and McCafferty 1998]), and *A. gosei* differs from *A. elgonensis* and *A. zomba* as well as all other *Acanthiops* by having a thick, curved row of short setae subapically on either half of the dorsum of the labrum (Fig. 25 [Gose 1964]).

The presence of a pair of black spots on abdominal terga 3-9 (Fig. 15 [Gose 1964]) is also diagnostic of *A. gosei* among the group of species to which it is closely related. *Acanthiops io* Lugo-Oritz and McCafferty, which is also known from the D. R. Congo, has pairs of spots on the abdominal terga similar to *A. gosei*, but only on a few segments, and although the abdominal tuberculation is similar in the two species, there are distinct differences in the labral setation and gill pigmentation as mentioned above. In addition, *A. io* (as well as *A. faro* Barber-James and McCafferty) have a papillate projection on segment 2 of the maxillary palps that is absent in *A. gosei* (Fig. 26 [Gose 1964]), assuming it was not inadvertently missed by Gose (1964).

Type designation. HOLOTYPE: larva, Democratic Republic of Congo, mountain torrent flowing into Kivu Lake, IV-18-1958, K. Iminishi. PARATYPES: two larvae, same data as holotype.

Comments. *Acanthiops gosei* was taken from a torrential stream in far eastern D. R. Congo and is typical, both morphologically and ecologically, of *Acanthiops*. *Acanthiops* is a strictly Afrotropical genus whose larvae are known from relatively high gradient streams in sub-Saharan Africa and Madagascar. The genus has been treated in some detail by Waltz and McCafferty (1987a), Barber-James and McCafferty (1997), Lugo-Ortiz and McCafferty (1998), and most definitively by Lugo-Ortiz et al. (2001).

Gose (1964) did not mention or figure a second row of claw denticles on the claw of *A. gosei*, which have been found in all other *Acanthiops* and are also characteristic of most genera and species of the *Centroptiloides* complex of Baetidae in the Afrotropics, to which *Acanthiops* belongs (Lugo-Ortiz and

McCafferty 1998). The submarginal denticle row in *Acanthiops*, however, can be very small, limited sometimes to one or two minute denticles, and, because of this and the fact that these denticles cannot be seen in relief, high magnification and exact resolution is required in order to observe them properly. Based on all other characteristics associated with *A. gosei*, it may be presumed that the submarginal row of denticles were simply missed by Gose. It is not beyond possibility, however, that there is only one row of claw denticles in *A. gosei* because, as will be shown below, some variation in this regard can be demonstrated within the *Centroptiloides* complex and within genera of that complex as well as other Afrotropical genera. In any case, there is no doubt about the placement of this new species in *Acanthiops* because it demonstrates the distinctively shaped apomorphic pronotum (see Lugo-Ortiz et al. 2001, Figs. 2,3) that is unique to the *Acanthiops* lineage.

Dicentroptilum imanishii, NEW SPECIES

This species was originally treated by Gose (1964) as *Baetis* sp. CBA, based on 18 larvae. The text and figures provided by Gose (1964:59-61, Figs. 31-43) represent sufficient description of the new species. Adults of the species remain unknown. The species is named after K. Imanishi, the collector of the species.

Larval diagnosis. All six species of the Afrotropical genus *Dicentroptilum* Wuillot and Gillies are known as larvae, although the association of the larvae of *D. spinulosum* (Demoulin) is tentative (Wuillot and Gillies 1994). *Dicentroptilum imanishii* larvae are distinguished from other known larvae in the genus by their nipplelike terminal segment of the labial palps and the presence of minute nodules on the mediodistal margin of labial palp segment 2 (Figs. 43,43a [Gose 1964]), the extensive marginal row of nine claw denticles, the median caudal filament length, which is somewhat over one-half that of the cerci, and possibly the relatively very long antennae (close to three times that of the head capsule).

Type designation. HOLOTYPE: larva, Democratic Republic of Congo, small stream by ascent road to Ruwenzori, ca. 3500m elevation, III-16-1958, K. Imanishi. PARATYPES: two larvae, same data as holotype. OTHER MATERIAL: 15 larvae, same data as Holotype.

Comments. The short, broad labrum of *D. imanishii* larvae is very similar to that of *D. merina* Lugo-Ortiz and McCafferty. The presence of some extensive dorsal, submarginal setae on the labrum of *D. imanishii* is very similar to that of *D. papillosum* Wuillot. The lanceolate, bifurcate prostheca of the planate mandible and the distally serrate, somewhat robust prostheca of the angulate mandible of the new species are common throughout the genus, as is the presence of extensive rows of short setae between the mola and incisors on both mandibles. The rows of fine, simple setae on the tibiae and tarsi of the new species are also common throughout the genus, and gill

morphology and the length of the median caudal filament relative to the cerci, although somewhat variable among species of the genus, are all generally similar. The degree of development of procoxal papillae (or osmobranchiae) and any possible notal tuberculation is unknown, but these are expected to be minimal because they were not mentioned by Gose (1964) and thus may not have been easily detectable.

Dicentroptilum was placed in the *Centroptiloides* complex by Lugo-Ortiz and McCafferty (1998). *Xyrodromeus* Lugo-Ortiz and McCafferty is another recently described genus of Baetidae from the Afrotropics, but the relationships of this genus had not been determined. However, as a byproduct of the discovery of *D. imanishii* and a review of characters, there now appear to be new data of value in deciphering intergeneric relationships of *Dicentroptilum* and *Xyrodromeus*. Included among these indicators are two characteristics that are unique to *D. imanishii* among known *Dicentroptilum*., i.e., the claws having a single, extensive marginal row of denticles, and the labium having a nipplelike terminal segment of the labial palps.

The tarsal claws of *Xyrodromeus* consist of a single row of denticles (Lugo-Ortiz and McCafferty 1997c), and because historically, the double row of claw denticles was thought to be very important and stable throughout the *Centroptiloides* complex, including the genus *Dicentroptilum* (Lugo-Ortiz and McCafferty 1998), *Xyrodromeus* had not been considered part of the *Centroptiloides* complex. Numerous similarities of *Dicentroptilum* and *Xyrodromeus*, however, now suggest that *Xyrodromeus* is also a member of the *Centroptiloides* complex, and thus that not only can the number of rows of claw denticles vary among a single genus in the *Centroptiloides* complex as exemplified by the discovery of *D. imanishii*, but that it also can vary between genera. It is important to note that *Dicentroptilum* is not the first Afrotropical genus of Baetidae known to be variable with respect to the number of rows of claws denticles. McCafferty (2000) demonstrated that within the genus *Cheleocloeon* Wuillot and Gillies, there may be one or two rows, and the rows may be variously extensive or reduced, depending on the species.

The nipplelike terminal segment of the labial palps of *D. imanishii* are highly reminiscent of those that have been associated with *Xyrodromeus* (Lugo-Ortiz and McCafferty 1997c). The caplike terminal segment found in other species of *Dicentroptilum*, however, is not that different from the nipplelike segment. The latter appears simply to represent an additional grade of reduction of this labial segment in Baetidae.

Other mouthpart characteristics are also noteworthy with respect to possible intergeneric relationships. Lugo-Ortiz and McCafferty (1997c) noted strong similarities of the labra of *Xyrodromeus* and *Dicentroptilum*. In addition, although Lugo-Ortiz and McCafferty (1997c, 1998) described the maxillary palps of *Xyrodromeus* as being three segmented and those of *Dicen-*

troptilum as being two segmented, Wuillot and Gillies (1994) had found that the maxillary palps of *D. papillosum* usually had a third segment. This third segment is a small basal segment that is seen in *Xyrodromeus* and which is also present in *D. imanishii*, thus indicating another similarity, in this instance in at least two *Dicentroptilum* species and *Xyrodromeus*.

Also of pertinence, Lugo-Ortiz and McCafferty (1997c) pointed out that Demoulin (1964) had referred what are now known as *Xyrodromeus africanus* Lugo-Ortiz and McCafferty and *Dicentroptilum* sp. to the same species, which Demoulin had called *Centroptilum* sp. No. 2. This clearly illustrates a degree of similarity in the two genera that could lead to confusion about their identity. Nevertheless, based on current concepts, the two species referred to as *Centroptilum* No. 2 may be distinguished, as may all known larvae of *Dicentroptilum* from all known larvae of *Xyrodromeus*, by the slender and relatively simple prostheca of both mandibles in *Xyrodromeus*. In addition, if the mandibular incisors are not worn, the genera presumably may also be told by the presence of fused incisors on the planate mandible of *Xyrodromeus* compared with the separated incisors on the same mandible of *Dicentroptilum*.

The mandibular incisors of *Xyrodromeus* are normally highly attenuated and typify that genus. Such mandibles were referred to as bladelike by Lugo-Ortiz and McCafferty (1997c). Incisors also tend towards attenuation in *Dicentroptilum* and certain other Afrotropical genera, such as *Afroptilum* Gillies and *Demoreptus* Lugo-Ortiz and McCafferty (Lugo-Ortiz and McCafferty 1997b, 1998). All such incisors are apparently highly susceptible to being severely worn down through the feeding activities of the larvae. This was dramatically depicted by Demoulin's (1964) Figures 4b, 4c, 5a, and 5c, which are referable to *X. africanus*, and Figure 5b, which is referable to *Dicentroptilum* sp. As separated incisors of a baetid mandible become worn beyond a shallow separation, they will appear to be fused. This is presumably, but not assuredly, the situation with the material of *D. imanishii* that was illustrated in Figures 40 and 41 by Gose (1964). In any case, there are considerable comparative data reviewed here, including the compromising or possibly compromising characteristics of the new species, to suggest that *Dicentroptilum* and *Xyrodromeus* are either very closely related or possibly represent a single variable and graded genus.

Tanzaniella gorillora, NEW SPECIES

This species was originally treated by Gose (1964) as *Baetis* sp. CBB, based on three larvae. The text and figures provided by Gose (1964:61-63, Figs. 44-56) represent sufficient description of the new species. Adults of the species remain unknown. The specific epithet is a noun in apposition, literally gorilla-ora (-land).

Diagnosis. The following larval characteristics of *T. gorillora* may be used to differentiate the new species from *T. spinosa* Gillies, the only other

species known of the African genus *Tanzaniella* Gillies (see also Gillies 1991). The long, bristlelike setae are more extensively developed on the dorsum of the labrum (Fig. 52 [Gose 1964]) than in *T. spinosa*. The terminal segment of the labial palps are more prolongated (Fig. 56c [Gose 1964]) than in *T. spinosa*. Highly unusual, and thus possibly provisional, the subtending claw setae are present only on the hindclaws (Fig. 46a, 48 [Gose 1964)], as compared to being present on all claws of *T. spinosa*. The tibial setal row on the hindlegs is developed only in the basal half of the tibia (Fig. 48 [Gose 1964]), compared to being developed for the entire length of the tibia in *T. spinosa*. The abdominal terga lack small posteromarginal projections (Fig. 44 [Gose 1964]), compared to their presence on terga 1-7 or 1-8 in *T. spinosa*. A dorsal abdominal pattern is lacking (Fig. 44 [Gose 1964]), compared to terga 3, 4, and 7 being dark and others light in *T. spinosa*. The highly reduced median caudal filament has five small minute segments, compared to one segment in *T. spinosa*.

Type designation. HOLOTYPE: larva, Democratic Republic of Congo, mountain torrent flowing into Kivu Lake, IV-18-1958, K. Imanishi. PARATYPES: two larvae, same data as holotype.

Comments. *Tanzaniella* is a *Baetis* complex genus, and as such the larvae have a villopore and lack tufts of setae between the mandibular incisors and molae. Within that distinctive complex, *Tanzaniella* appears most related to a group consisting of *Acentrella* Bengtsson, *Baetiella* Ueno, *Demoreptus*, *Heterocloeon* McDunnough, *Liebebiella* Waltz and McCafferty, and *Plauditus* Lugo-Ortiz and McCafferty. These genera demonstrate strong tendencies in the larvae, for example, to be two-tailed, have compact labia, and have well-developed marginal femoral setal rows (see Waltz and McCafferty 1987b, Lugo-Ortiz and McCafferty 1997b). Furthermore within this grouping, there are larvae that tend to be clingers in current with outspread legs and cerci, and in Africa, these are represented by the genera *Demoreptus* and *Tanzaniella*. These two genera are distinguishable from each other by the absence of medial setae on the cerci and the separation of the incisors on the planate mandibles of *Tanzaniella* versus the presence of such setae on the cerci and the fusion of incisors of both mandibles in *Demoreptus*. *Demoreptus* appears to be confined to temperate southern Africa, whereas, *Tanzaniella* is known only from east-central Africa.

The Oriental genus *Liebebiella* appears closely related to the African genera within this subgroup of the *Baetis* complex. The mandibular incisors are fused in *Liebebiella* as they are in *Demoreptus*, and as in the angulate mandible of *Tanzaniella*. Also, at least one species of *Liebebiella*, *L. atoki* (Müller-Liebenau), lacks marginal setae on the cerci as do the larvae of *Tanzaniella*.

Among the *Baetis* complex genera, only the species of the Palearctic-Oriental genus *Baetiella* and the one species of *Tanzaniella* have abdominal tergal tubercles developed. However, this is such a common homoplasy in

many of the rheophilic baetids representative of different clades within the family (incl. *Acanthiops*, *Afrobaetodes* Demoulin, *Baetodes* Needham and Murphy, *Dicentroptilum* [see Lugo-Ortiz and McCafferty 2001], *Echinobaetis* Mol, *Jubabaetis* Müller-Liebenau [see Waltz and McCafferty 1987b], *Papuanatula* Lugo-Ortiz and McCafferty, and *Thraulobaetodes* Elouard and Hideux), that any commonality between genera in the absence of other cladistic data may be insignificant. Furthermore, the degree of development varies among species of all the genera having tergal tubercles (although this may be a rich source of cladistic data for determining species relationships [e.g., see Lugo-Ortiz et al. 2001]), and the presence or absence of tubercles is now known to be interspecifically variable in the genera *Dicentroptilum*, *Jubabaetis*, *Papuanatula*, and *Tanzaniella* (Waltz and McCafferty 1987b, Lugo-Ortiz and McCafferty 1999, 2001).

Although I presently recognize only two species of *Tanzaniella*, Gillies (1991) indicated that *Baetis* (*Acentrella*) sp. No. 4 of Demoulin (1965) was an additional unnamed species of *Tanzaniella* from Tanzania (Kilamajaro, Marangu). Based on more current information about the African fauna and a comparison of Figures 4a-4k of Demoulin (1965), it is impossible to confidently place this species to either *Tanzaniella* or *Demoreptus* at this time. The labial palps of the unnamed species appear more similar to those of *Tanzaniella* (not extending slightly beyond the glossae and paraglossae as do those of *Demoreptus*). Both mandibles of this unnamed species appear to have fused incisors, which would be characteristic of *Demoreptus*, not *Tanzaniella*. However, these mandibles also appear somewhat worn, and thus it is difficult to know the true condition of the incisors. Unfortunately, without examining the specimen, it is not apparent if the cerci are bare or setate on the unnamed species, and because this is probably critical to generic determination in this instance, any placing of Demoulin's larva to a specific genus would be tenuous at this time.

Heptageniidae

With respect to the Heptageniidae, Gose (1964) treated two species as *Ecdyonurus* sp. CEA and *E.* sp. CEB. It is apparent from Gose's descriptions and figures (particularly regarding the gill lamellae shape and caudal filament spination) that both species belong to the genus *Afronurus* Lestage, not *Ecdyonurus* Eaton, and also that two separate species are indeed represented.

Species of *Afronurus* in Africa have been based to a large degree on adult forms. In particular, the vast majority of the current 13 nominal African species of *Afronurus* that are known from either East, Central, or West Africa are unknown as larvae. This makes it impossible to identify Gose's larvae to a known species and imprudent at this time to name these larvae as new. Based on dorsal color patterns figured by Gose (1964), the unnamed species are not assignable to any of the three species that are known from larvae and known

from the same general region of Africa, i.e., *A. negi* Corbet, *A. peringueyi* (Esben-Petersen), or *A. ugandanus* Kimmins. All three of these latter species share a very similar dorsal color pattern (see e.g., Corbet 1960a,b, Schoonbee 1968), suggesting either a close relationship or perhaps some equivalency of the species.

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