

Phylogenetic Revision of Ephemerythidae (Ephemeroptera: Pannota)

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ABSTRACT

We conducted a phylogenetic analysis of the Afrotropical mayfly family Ephemerythidae using PAUP* and MacClade. The subgenus *Tricomerella* Demoulin proved to be applicable to a clade of species with apomorphically reduced hind wings that includes the type species of *Ephemerythus* Gillies and therefore is placed into strict synonymy with *Ephemerythus* [= *Tricomerella*, n. syn.]. *Limnokijara*, n. gen., is described for the second clade within Ephemerythidae and includes the species *L. kiboensis* (Gillies), n. comb., and *L. picta* (Gillies), n. comb. *Limnokijara* is differentiated from *Ephemerythus* by the adult males having stout spines distally on the inner margin of genital forceps segment 1. Larvae associated with *Ephemerythus*, s.s., have enlarged apical spines on the maxilla and abdominal gills 6 present. Larvae associated with *Limnokijara* have reduced apical spines on the maxilla and gills 6 absent.

KEY WORDS: phylogenetic revision, *Ephemerythus*, Ephemerythidae, *Limnokijara*, new genus, *Tricomerella*, new synonym.

INTRODUCTION

McCafferty and Wang (2000) gave Ephemerythidae family status as part of their comprehensive study of the mayfly infraorder Pannota (Ephemeroptera: Furcatergalia). The monogeneric family is endemic to Africa (Jacob 2003), and initially it was considered a subfamily of Tricorythidae (Gillies 1960).

Gillies (1960) described the genus *Ephemerythus* and three species based on adults only. His three species include *E. kiboensis* Gillies, *E. niger* Gillies (type species of the genus), and *E. pictus* Gillies. Gillies (1960) remarked that an unnamed larva described by Kimmins (1955: Figs. 8, 9a–d) was associated with certain adults he described, but he did not specify which species. Demoulin (1964: Figs. 1a–i) described an additional species, *E. straeleni* Demoulin, based on a female subimago and a larva different from the unnamed larva described by Kimmins (1955). Demoulin (1964) established the subgenus *Tricomerella* Demoulin for his new species, which has lamellate gills on abdominal segments 2 through 6 in the larval stage, in contrast to Gillies' concept of *Ephemerythus*, s. s., which was assumed to have gills only on segments two through five (Gillies 1960). Kopelke (1980, 1981a) described a fifth species, *E. dissimillimus* Kopelke, based on the egg, male adult, and female adult stages. These five species have not been analyzed in a comparative manner, and no hypotheses have been made regarding their interrelationships.

Our review of published descriptions of *Ephemerythus* species (see above) and examination of specimens in the Purdue University Entomological Research Collection has led us to conduct a cladistic analysis of the five species detailed above. As a result, we recognize two distinctive clades as genera: *Ephemerythus* and a new genus that we describe below.

PHYLOGENETICS

We used MacClade (Maddison and Maddison 2005) to build a simple character matrix (Fig. 1), and we conducted an exhaustive search for the most parsimonious trees using the parsimony criterion of PAUP* (Swofford 2002). All characters were considered to be of the unordered type (Swofford 2002, Maddison and Maddison 2005), and all were weighted equally. We rooted trees and inferred character polarity using *Teloganella umbrata* Ulmer (Teloganellidae) as an outgroup. This species has been detailed by Wang et al. (1995) and is hypothesized to represent a pleisiotypic lineage within the Ephemeroidea clade that includes Ephemerythidae (McCafferty and Wang 2000, Molineri and Domínguez 2003).

We present, as Figure 2, a strict consensus of the two best trees derived from our analysis. Hypothesized apomorphies are indicated on the branches. A numeral with superscript (n^{*}) denotes that character “n” has changed to state “x,” as indicated in the list of characters. Characters and states included in our matrix, and indicated on our cladogram, are listed below. Only adult characters were used to determine cladistic relationships, because the associations of larvae with adults have been tentative.

CHARACTERS

1. Male adult genital forceps segment 1 inner margin (0=with hairlike setae distally; 1=with spinelike setae distally [Gillies 1960: Fig. 10]).
2. Number of marginal intercalaries in each interspace of forewing (0=1; 1=2).
3. Size and venation of hind wings or wingpads (0=relatively little or no reduction; 1= reduced [Gillies 1960: Fig. 2]; 2=greatly reduced or absent [Kopelke 1981a: Figs. 11b,c]).
4. Coloration of hind wing, if present (0=transparent or translucent; 1=darkly tinted in basal half [Kopelke 1981a: Figs. 11b, 11c]).

CLASSIFICATION

Ephemerythus dissimillimus, *E. niger*, and *E. straeleni* group together in a clade based on shared coloration and great reduction or absence of hind wings or hind wingpads. The former two species apparently differ as male adults, with the shape of the penes lobes appearing rounded in *E. dissimillimus* and acute in *E. niger* (Gillies 1960, Kopelke 1981a: Fig. 12a). The reported relative lengths of leg segments differ also between the two species, but specific differences in these ratios may be dubious (e.g., Peters and Peters 1993). We dissected a female final instar *E. straeleni* and took eggs from the anterior portion of the abdomen. These eggs correspond to the egg figured by Kopelke (1980: Figs. 38–42) for *E. dissimillimus*. A male final instar *E. straeleni* preserved in alcohol contains a pharate subimago, and the developing genitalia appear similar to those of *E. niger*

and *E. dissimillimus*. These three species should be reared in order to confirm stage associations, but *E. straeleni* (type species of subgenus *Tricomerella*) might represent the undescribed larva of either *E. niger* (type species of *Ephemerythus*) or *E. dissimillimus*, considering their overlapping geographic distributions. Therefore, we do not recognize *E. (Tricomerella) straeleni* as a separate supraspecific taxon, and we place it into strict synonymy with *Ephemerythus* [= *Tricomerella*, new synonym]. The association of the *E. straeleni* larva with *E. niger*-like male adults indicates that Gillies (1960) must have associated Kimmins' (1955) larva with adults of *E. kiboensis* and *E. pictus*, rather than *E. niger*.

Ephemerythus kiboensis and *E. pictus* share an apomorphic armature of the genital forceps, but they differ from each other in color (Gillies 1960). These two closely related species, and their associated (Gillies 1960) larva (Kimmins 1955), are distinctive from members of the strict *Ephemerythus* clade discussed above. We therefore recognize this second clade (Fig. 2) as a new genus, named and diagnosed in the Systematic Account below.

SYSTEMATIC ACCOUNT

Ephemerythus Gillies [= *Tricomerella* Demoulin, new synonym]

Diagnosis.—Larvae are differentiated from the new genus described below by having the maxilla with enlarged apical spines and spinous processes (Demoulin 1964: Figs. 1f, 1g), lamellate gills on abdominal segments 2–6, and hind wingpads that are greatly reduced or absent. Male adults have fine setae along the inner margin of genital forceps segment 1 (Gillies 1960: Fig. 9), and the hindwings are highly reduced or absent. If present, the hindwings are darkly colored (Kopelke 1981a: Figs. 11b, 11c).

Included species.—*Ephemerythus dissimillimus*, *E. niger*, *E. straeleni*.

Known distribution.—Congo, Democratic Republic of Congo, Tanzania (Gillies 1960; Demoulin 1964, 1965, 1970; Kopelke 1980, 1981a,b).

Material examined.—*Ephemerythus straeleni*: Congo, Brazzaville, W538, 30-VI-1956, one larva. Tanzania, Sanya R., Moshi, Q146, 10-VII-1952, one larva; Sigi R., Amani, 5-VI-1955, MT Gillies, two larvae.

Limnokijara, new genus

Type species.—*Ephemerythus kiboensis* Gillies, 1960: 37.

Diagnosis.—Larvae are differentiated from *Ephemerythus* by having the maxilla with reduced apical spines and spinous processes (Kimmins 1955: Figs. 8–9; Demoulin 1981: Fig. 11f), lamellate gills on abdominal segments 2–5 only (Kimmins 1955: Fig. 8), and hind wingpads that are much larger than those of *Ephemerythus*. Male adults have prominent spinelike setae distally on the inner margin of genital forceps segment 1 (Gillies 1960: Fig. 10), and the hindwings are always present and are not colored.

Etymology.—The genus name is an arbitrary recombination of the letters in “Kilimanjaro,” the locale from which the type species was collected.

Included species.—*Limnokijara kiboensis*, new combination; *L. picta*, new combination.

Known distribution.—Kenya, Malawi, Nigeria, Tanzania (Gillies 1960;

Demoulin 1965, 1970).

Material examined.—*Limnokijara kiboensis*: “Managu, K’jaro,” 13-X-1958, seven adults. *Limnokijara* spp.: Malawi, 13 Ω mi. E. Ft. Johnston, 11-VIII-1952, L. Berner, two larvae. Nigeria, Obudu Cr., SE State (upper crossing), 19-VIII-1973, JT Medler, one larva. Tanzania, Bombo, S. Pare Mts., 16-V-1959, MT Gillies, one larva; Kilahara R., Morogoro, P122/3, MT Gillies.

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	1	4
dissimillimus	0	1 2 1
kiboensis	1	1 1 0
niger	0	1 2 1
pictus	1	1 1 0
straeleni	?	1 2 ?
umbrata	0	0 0 0

Fig. 1. Character matrix.

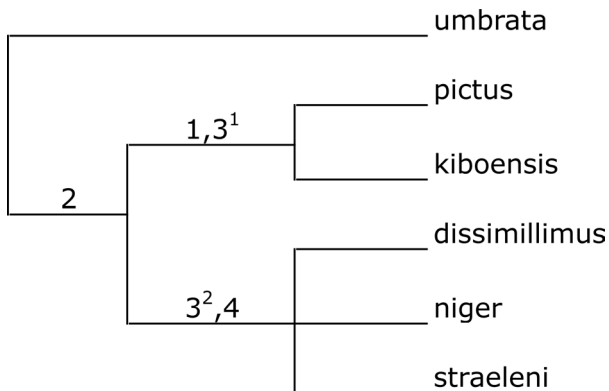


Fig. 2. Strict consensus tree of Ephemerythidae species, with outgroup *Teloganella umbrata*. Numerals represent apomorphies indicated in text.