



The genera *Demoulinia* Gillies and *Potamocloeon* Gillies (Ephemeroptera: Baetidae) in Madagascar

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Abstract

To complete a recent revision of Malagasy Baetidae from still and standing waters, a study of the genera *Demoulinia* Gillies and *Potamocloeon* Gillies was undertaken; the latter is reported for the first time from the island. A global revision of the genus is undertaken; the validity of the different species is discussed. A new species of *Demoulinia* is described herein. *Demoulinia assimilis* n. sp. is distinguished by the number of segments of the maxillary palp, the shape of the hypopharynx, and the edentate tarsal claws. The systematic position of *Demoulinia* and *Potamocloeon* is examined. A redefinition of the *Bugilliesia* complex is proposed.

Key words: Baetidae, Madagascar, *Demoulinia*, *Demoulinia assimilis* n. sp., *Potamocloeon*, systematics

Introduction

Important systematic works have been published recently on the Malagasy Baetidae, allowing the description of more than 40 new species (Gattolliat & Sartori, in press). Despite the fact that the Baetidae are quite abundant and diverse in still and standing waters, their knowledge remained deficient in Madagascar. To fill that gap, a revision of the genus *Cloeon* Leach has just been completed (Gattolliat & Rabeantoandro, 2002). Other genera such as *Demoulinia* Gillies and *Potamocloeon* Gillies also present adaptations for slow-moving waters (Gillies, 1988; Lugo-Ortiz & McCafferty, 1996a; 1998c).

The genus *Demoulinia* was established for *Centroptilum crassi* Demoulin (= *Centroptilum pulchrum* Crass), a rather unusual South African species previously assigned to *Centroptilum* Eaton (Crass, 1947; Demoulin, 1970; Gillies, 1990b). A new species, *Demoulinia insularis* Lugo-Ortiz and McCafferty, was recently described from Madagascar (Lugo-Ortiz & McCafferty, 1998c). This constituted the first report of the genus out of

South Africa. The description was based on a single specimen. Consequently, the distribution and the intraspecific variability were unknown. A new species from Madagascar is described herein.

Potamocloeon is an Afrotropical genus, erected for an unusual species of *Cloeon* (*C. dentatum* Kimmins) (Gillies, 1990a). At present time, the genus includes only two species: one widespread and well-known species (*P. dentatum* (Kimmins)) and one poorly documented species (*P. macafertiorum* Lugo-Ortiz) described from South Africa. *Potamocloeon* is mentioned herein for the first time from Madagascar. This discovery reinforces the strong affinities between the African and Malagasy fauna already put forward (Sartori et al., 2000).

The holotypes and some of the paratypes are housed in the Museum of Zoology, Lausanne, Switzerland. Other paratypes are deposited in the Museum National d'Histoire Naturelle, Paris.

Taxonomy

1. The genus *Demoulinia* Gillies, 1990

1.1 *Demoulinia assimilis* n. sp.

Larva

Maximal length: Body 5.7 mm. Cerci 2.4 mm. Median caudal filament 2.2 mm.

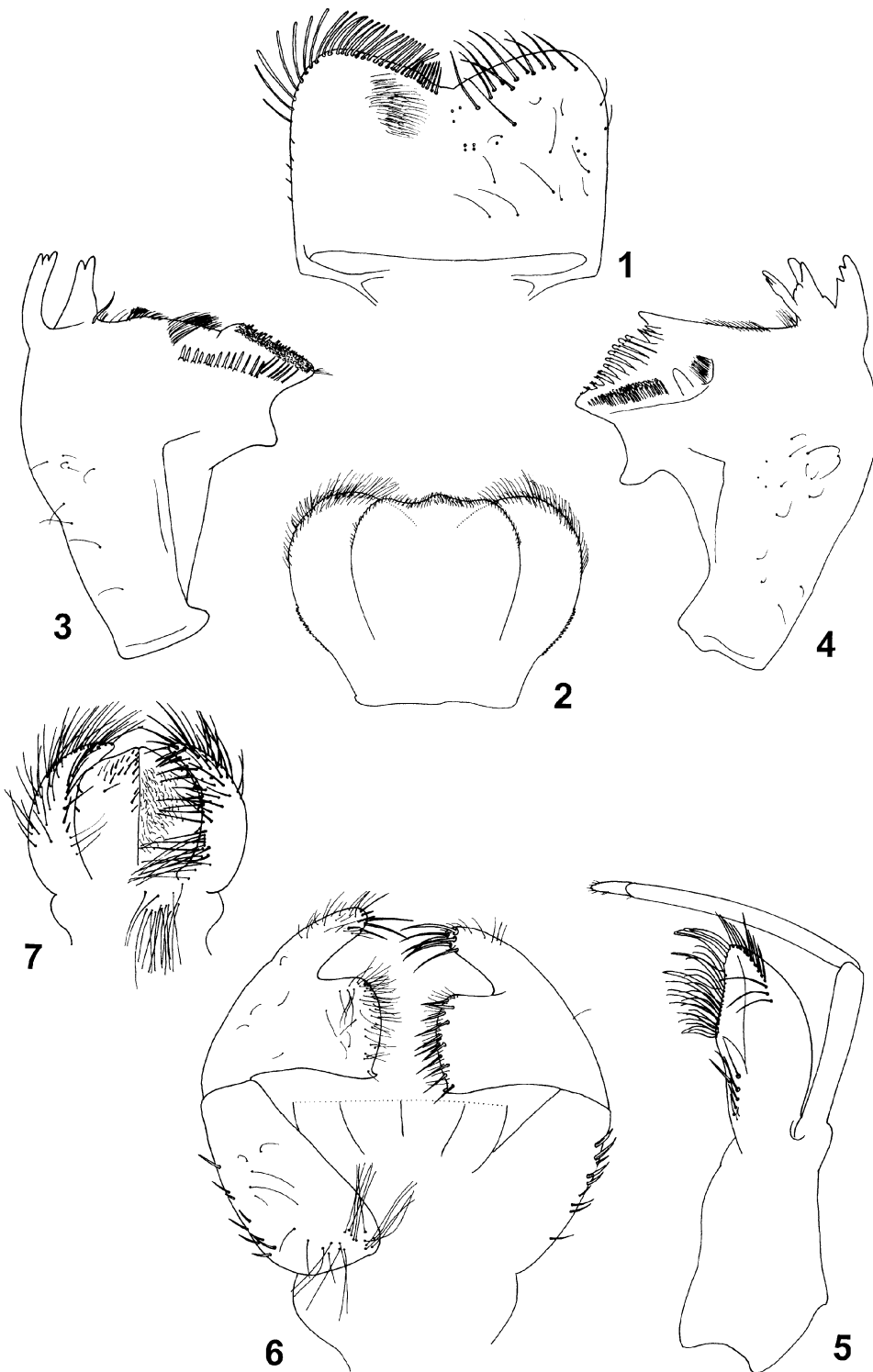
Head. Uniformly yellow cream; antennae yellow cream.

Dorsal surface of the labrum (Fig. 1) with a subapical row of about 11 long stout setae subparallel to the distal margin, a few long fine setae scattered over surface; distal margin bordered with two kind of setae, the six inner short and pointed, the others long and blunt.

Hypopharynx (Fig. 2) with a broad trilobate superlingua, covered only with minute setae; lingua weakly developed laterally, apically with long thin setae.

Right mandible (Fig. 3) with two clearly separated sets of incisors, outer set with 3 denticles and inner with 2 denticles; prosthema reduced, slender and edentate; tuft of abundant short feathered setae between prosthema and mola; tuft of setae at the apex of the mola present; basal half with a few thin long setae dorsally.

Left mandible (Fig. 4) with 2 sets of incisors, outer and inner sets with 3 denticles; prosthema elongated with 3 thin teeth; tuft of small setae between prosthema and mola; tuft of setae at the apex of the mola absent; basal half with long thin setae dorsally.



FIGURES 1-7. Larval structures of *Demoulinia assimilis* : 1 : labrum (left : ventral; right : dorsal). 2 : hypopharynx. 3 : right mandible, ventral. 4 : left mandible, ventral. 5 : left maxilla. 6 : labium (left : ventral; right : dorsal). 7 : glossae and paraglossae (right : ventral; left : dorsal)

Maxillae (Fig. 5) with 4 long teeth, none of them opposed to the others; 1 row of medium setae and 1 row of long setae with 2 spine-like setae; row of 15 long setae at the base of the crown; row of 5 long stout setae at base of galea; one long stout seta perpendicular to margin of galea; palp 3-segmented, much longer than galealacinia, segment 1 approximately 0.7x length of segment 2 and 3 combined, segment 2 approximately 6x length of segment 3.

Labium (Figs 6 and 7) with glossae slightly shorter and much broader than paraglossae (Fig. 7); apical third of the ventral surface with short stout setae, dorsally with numerous minute thin setae on the whole surface; paraglossae falcate, covered with numerous long stout setae ventrally, long thin setae roughly arranged in rows dorsally; labial palp (Fig. 6) 3-segmented, segment 1 basally with abundant very long thin setae, laterally with stout pointed setae, segment 1 0.9x length of segments 2 and 3 combined; segment 2 greatly produced apicomediaally ending with a fine recurved point, apicomediaal process ventrally with numerous long thin setae and dorsally with long stout setae; without an oblique row of setae dorsally; elongated subconical third segment, with long pointed stout setae apically.

Thorax. Yellow cream.

Hindwing pads absent.

Legs yellow except femora which have a brown transverse stripe in the distal quarter.

Femora (Fig. 8) slender, with dorsal and ventral margin parallel; dorsal margin with a row of about 30 minute pointed setae, row of 10 minute pointed setae subparallel to dorsal margin; dorsoapical setal patch formed by 3 small pointed setae; lateral margin with only a few long thin setae; ventral margin with abundant short pointed setae, a few long thin setae proximally.

Tibiae dorsally with only a few minute pointed setae; subproximal arc of about 10 thin setae; ventral margin with short pointed setae; tibio-patellar suture absent.

Tarsi with short thin setae dorsally; ventral margin with a row of about 30 pointed simple setae; tarsal claws (Fig. 9) elongated, about 0.65 times length of tarsi, edentate, subapical setae absent.

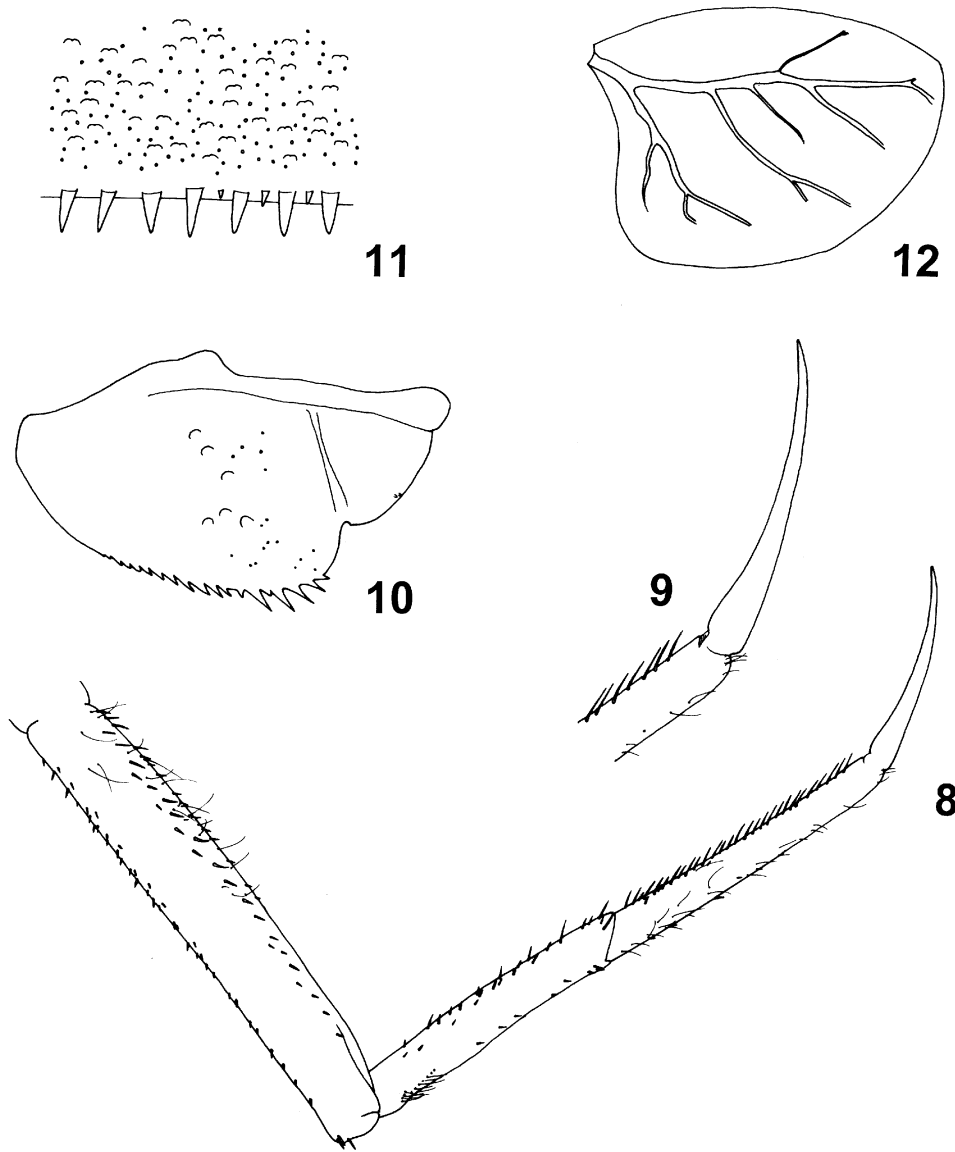
Abdomen. Terga 1-3 light brown, terga 4-10 yellow cream with two symmetric oblique marks. Terga (Fig. 11) with scale bases and numerous traces of insertion of setae; posterior margin with irregular blunt spines, clearly separated from the terga.

Sterna yellow cream.

Single gills (Fig. 12) on segments 1 to 7, broad strongly asymmetrical not serrated and without setae on the margin.

Paraproct (Fig. 10) with about 6 scale bases, margin with about 17 pointed spines increasing in length apically; posterolateral extension without scale bases, margin without spination.

Cerci uniformly yellow cream with abundant extremely thin setae on the inner margin; median caudal filament similar to cerci except thin setae on both margins.



FIGURES 8-12. Larval structures of *Demoulinia assimilis* : 8 : foreleg. 9 : tarsal claw. 10 : paraproct. 11 : distal margin of fourth abdominal tergum. 12 : fourth gill.

Imagos

Unknown

Material examined

Holotype

One female larva (P0374), Madagascar, Rianila bas., trib. of Sahatandra riv., Loc. Andasibe, Long. 48°24'07" E, Lat. 18°54'26" S, Alt. 915 m, 13.04.1995. Sartori, M. and Ruffieux, L.

Paratypes

Two female larvae 374a and 374b (on slides) and 11 larvae, same data as holotype.

One female larva 47a (on slide), Madagascar, Betsiboka bas., Andranolava riv., Loc. Andakana, Long. 47°09'59" E, Lat. 18°16'27" S, Alt. 1300 m, 18.04.1991. LRSAE.

One male larva 380a (on slide) and 2 larvae (P0380), Madagascar, Mangoro bas., trib. of Mangoro riv., Loc. 1 km from Sahafitahana, Long. 48°13'39" E, Lat. 18°59'42" S, Alt. 880 m, 26.04.1995. Sartori, M. and Ruffieux, L.

One female larva 388a (on slide), Madagascar, Mangoky bas., Fanindrona riv., Loc. Vohiposa, Long. 47°09'21" E, Lat. 20°59'03" S, Alt. 1210 m, 18.05.1995. Gibon, F.-M. and Andriambelo, Z.P.

One female larva MD008, Madagascar, Rianila bas., Amboasary riv., Loc. Andasibe, Alt. 950 m, 16.07.2001. Gerecke, R. and Goldschmidt, T.

One female larva MD075, Madagascar, Andohahela, stream W from the village (lower course of MD 069), Loc. Isaka, Alt. 50 m., 12.09.2001. Gerecke, R. and Goldschmidt, T.

1.2 Discussion

Demoulinia assimilis differs from the other Malagasy species, *D. insularis*, by the setation of the dorsal surface of the labrum (Fig. 1), the shape of the lingua (Fig. 2) and the number of the segments of the labial palp (Fig. 5) (Lugo-Ortiz & McCafferty, 1998c). The comparison between *Demoulinia assimilis* and the African species, *D. crassi*, is problematic because the illustrations are somewhat schematic and the description succinct (Crass, 1947). *Demoulinia assimilis* and *D. crassi* differ at least by the number of segments of the maxillary palp (Fig. 5) and the edentate/dentate tarsal claws (Fig. 9).

Despite the huge number of samples (more than 1000 samples!) made by the LRSAE team (Laboratoire de Recherche sur les Systèmes Aquatiques et leur Environnement, Antananarivo) and the about 200 samples made by the German hydrobiologists Gerecke and Goldschmidt, *Demoulinia insularis* was never found again. Two hypotheses can be proposed: either *D. insularis* has an extremely restricted distribution, or the description was based on an aberrant specimen. Both hypotheses arguably could be correct. The fact that no other sample was made in the type locality (Antananarivo Prov., Ankeniheny Riv., Manjakatempo forest station) corroborates the first hypothesis. Other species such as *Afrobaetodes lenae* Gattolliat & Sartori or *Pseudopannota camillae* Gattolliat present this kind of extremely restricted distribution (Gattolliat & Sartori, 1999; Gattolliat, 2002). On the other hand, the description of *Demoulinia insularis* is based on a single specimen, which excludes an intraspecific comparison and the dismissal of aberrant features.

2. The genus *Potamocloeon* Gillies, 1990

2.1 *Potamocloeon* spA

Female larva

Maximal length: Body 5.6 mm. Cerci and median caudal broken.

Head. Uniformly yellow cream; antennae yellow cream.

Dorsal surface of the labrum (Fig. 13) with a few long fine setae scattered over surface; distal margin with two kinds of setae: six outer long, pointed and simple setae and the 9 inner bifid setae, except the central seta feathered.

Hypopharynx (Fig. 14) with a broad trilobate superlingua, covered with minute setae, thicker on the median lobe; lingua apically with long thin setae.

Right mandible (Fig. 15) with two clearly separated sets of incisors, outer set with 3 denticles and inner with 2 denticles; edentate prostheca; tuft of abundant short setae between prostheca and mola; tuft of setae at the apex of the mola present; basal half without setae.

Left mandible (Fig. 16) with 2 sets of incisors, outer and inner sets with 3 denticles; prostheca elongated with 4 thin teeth; tuft of small setae between prostheca and mola; tuft of setae at the apex of the mola absent; basal half without setae.

Maxillae (Fig. 17) with 4 long teeth, none of them opposed to the others; 1 row of thin setae as long as the teeth and 3 spine-like setae; absence of setae at the base of the crown; row of 4 long stout setae at base of galea; 1 stout seta perpendicular to margin of galea; palp 2-segmented, much longer than galealacinia, segment 1 approximately 1.2x length of segment 2.

Labium (Fig. 18), glossae with an arc of thin setae; margin of paraglossae with long stout setae row of long stout setae subparallel to the inner margin. Labial palp 2-segmented, segment 1 almost bare; segment 2 with a triangular extremely developed lateral projection, apex ending with a recurved point; inner and distal margins with long stout setae.

Thorax. Yellow cream with brown median symmetrical lines on pro- meso and metanotum.

Hindwing pads absent.

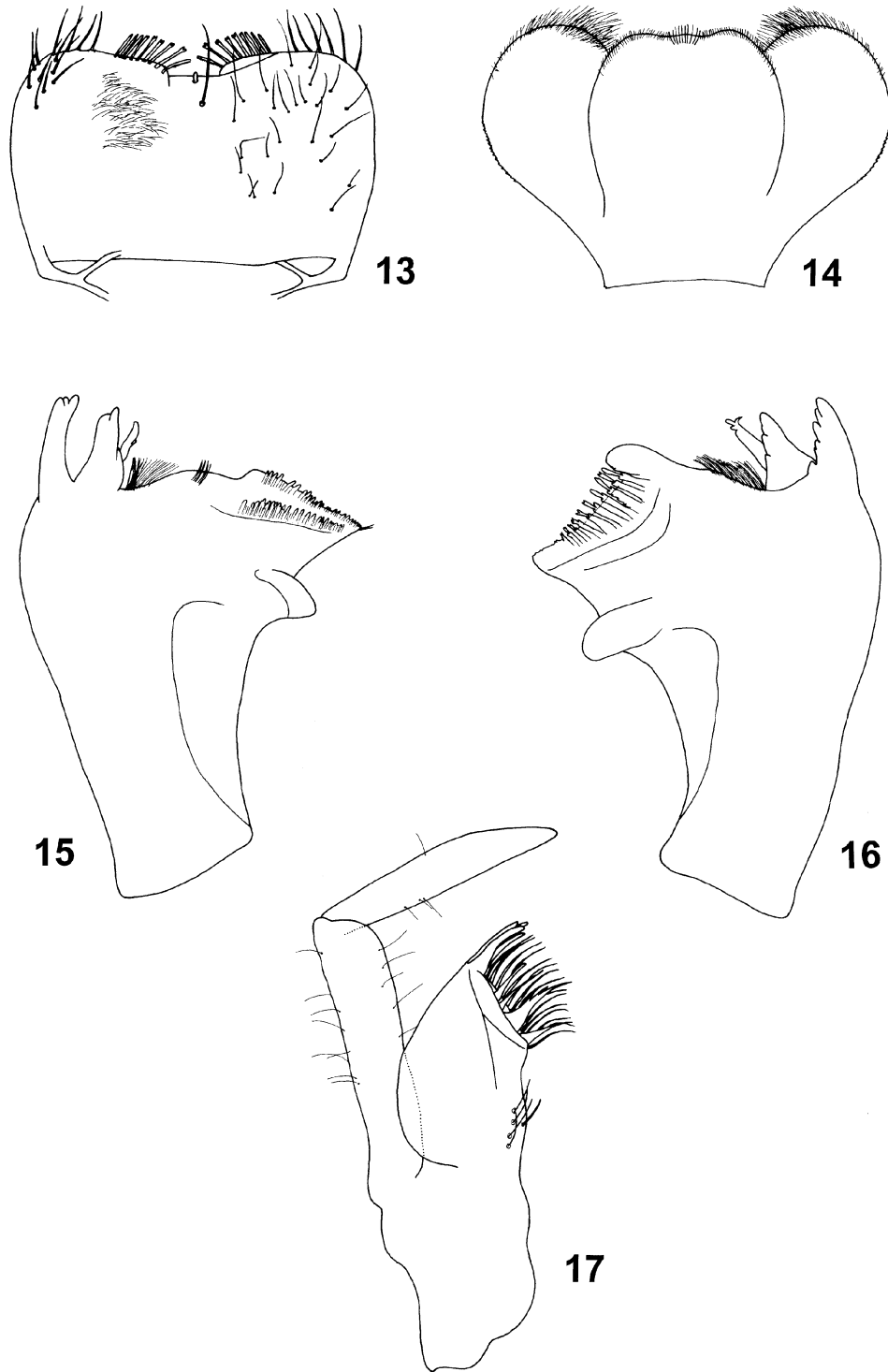
Legs yellow cream, slender with the dorsal and ventral margins parallel (Fig. 20).

Ventral margin of femora with minute setae, dorsal and lateral margins bare.

Tibiae bare except a subproximal arc of setae (Fig. 21).

Tarsi with only minute setae on ventral margin; tarsal claws elongated, about 0.9 times length of tarsi, edentate, subapical setae absent.

Abdomen. Terga 1, 3 to 9 yellow cream with a central and two lateral brown spots, darker on terga 3, 6 and 7; terga 3 to 5 with three median brown specks distally; tergum 2 yellow with a brown broad W-shaped pattern; tergum 10 uniformly yellow cream except distal margin dark brown (Fig. 19).



FIGURES 13-17. Larval structures of *Potamocloeon* spA : 13 : labrum (left : ventral; right : dorsal). 14 : hypopharynx. 15 : right mandible, ventral. 16 : left mandible, ventral. 17 : right maxilla.

Sterna uniformly yellow cream, except sterna 7 and 8 with laterally a brown longitudinal stripe.

Lateral margins of segments 4 to 9 with respectively 2, 2, 4, 6, 8 and 7 spines (spine at posterior angle excluded from count).

Gills 1 to 4 double (Fig. 22), gills 5 to 7 simple (Fig. 23), broad, strongly asymmetrical, not serrated and without setae on the margin; gill 7 broader and larger than the others.

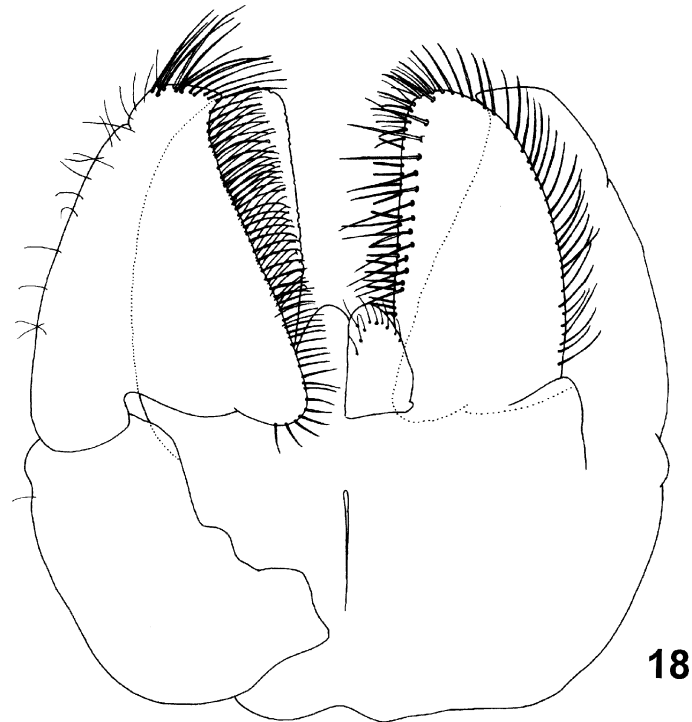


FIGURE 18. Larval structures of *Potamocloeon* spA : 18 : labium (left : ventral; right : dorsal).

Imagos

Unknown.

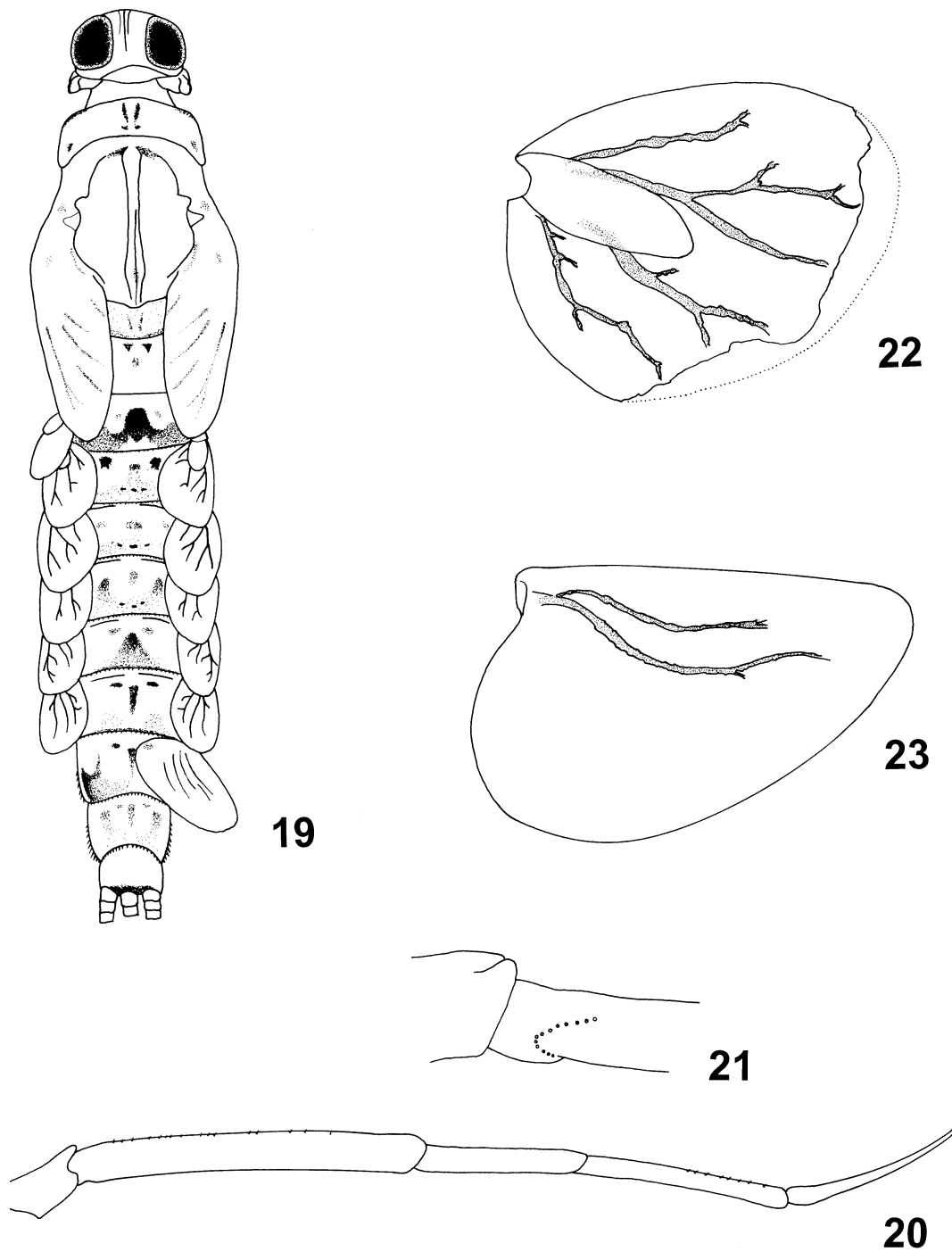
Material examined

One female larva MD053, Madagascar, Mandrare bas., Mandrare riv., Loc. Ifotaka, Alt. 60 m, 31.08.2001. Gerecke, R. and Goldschmidt, T.

2.2 *Potamocloeon* spB

Larva

Unknown.



FIGURES 19-23. Larval structures of *Potamocloeon* spA : 19 : in toto (dorsal view). 20 : foreleg. 21 : proximal part of tibia. 22 : third gill. 23 : seventh gill.

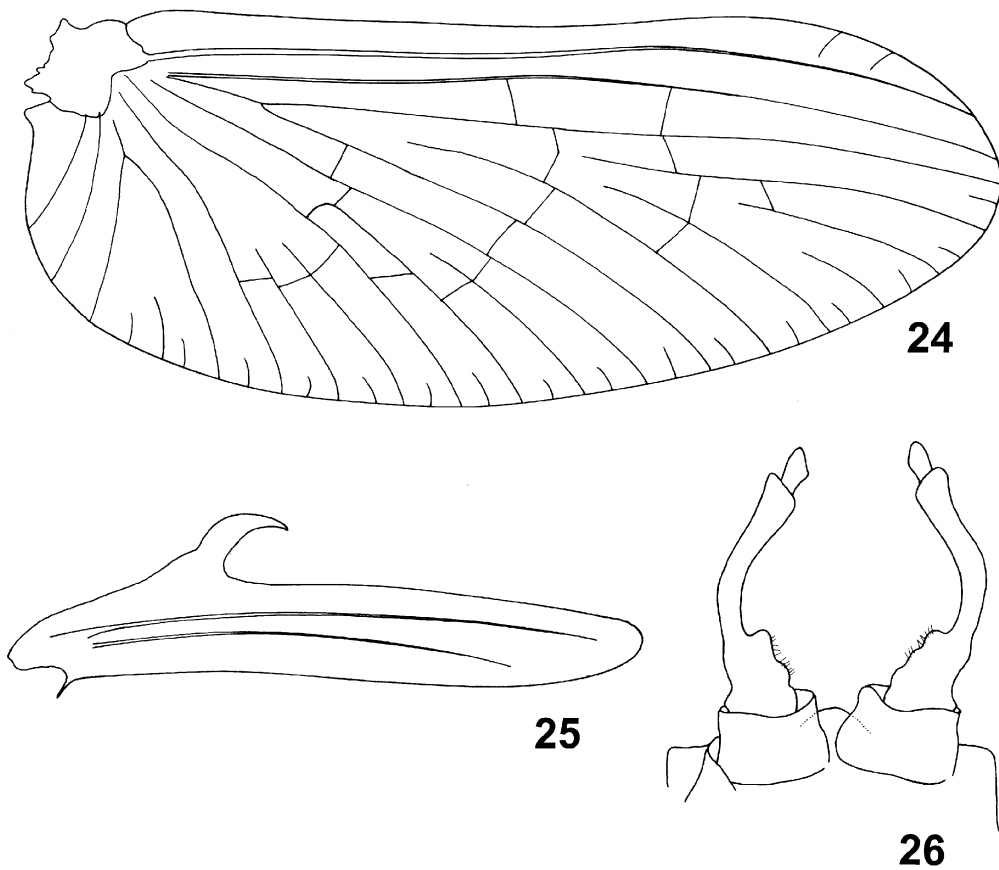
Male imago

Maximal length: Forewing 3.9 mm, hindwing 0.5 mm.

Head: Turbinate eyes honey-brown, with circular dark brown stripes.

Thorax: Forewing (Fig. 24) hyaline without cross-veins in the cubital area; pterostigma with 2 to 4 cross-veins that generally do not reach the subcostal vein. Hindwing (Fig. 25) hyaline, slender with 2 distinct longitudinal veins, not joined at the base; one single long acute spur on the costal margin.

Genitalia with 3-segmented gonopods; presence of a sclerotized plate between the gonopods (Fig. 26); basal segment with the inner apical angle only slightly produced; inner margin of first segment dilated and rounded apically; second segment clearly dilated apically; third segment longer than broad, obliquely truncated.



FIGURES 24-26. Male imaginal structures of *Potamocloeon* spB : 24 : forewing. 25 : hindwing. 26 : genitalia.

Material examined

One male imago P0405, Madagascar, Costal basin between F-Dauphin/Manampanihy, Antorendrika riv., Loc. Belavenoka, Long. 47°05'02" E, Lat. 24°50'18" S, Alt. 20 m, 23.4.1995. J.-M. Elouard and T. Pilaka.

One male imago P0528, Madagascar, Manampanihy bas., Manampanihy riv., Loc. Enosiary, Long. 46°49'19" E, Lat. 24°40'37" S, Alt. 100 m, 22.11.1995. T. Pilaka.

2.3 Discussion

The larva described herein clearly belongs to the genus *Potamocloeon*. It presents all the main apomorphies, especially the unique highly transformed labium (Fig. 18). There are no reliable characters which allow the larval stage of the Malagasy specimen to be distinguished from the African ones (*Potamocloeon dentatum* and *P. macafertiorum*). The mouthparts are rather alike. The minute observable distinctions, such as the setation of the dorsal margin of the labrum (Fig. 13; Gillies, 1988: Fig. 25; Lugo-Ortiz and McCafferty, 1996: Fig. 2) or the setation between the prosthema and mola (Figs 15 and 16; Gillies, 1988: Figs 23 and 24; Lugo-Ortiz and McCafferty, 1996: Figs 4 and 5), could be due more to the precision of the drawing or to intraspecific variation rather than to distinctive characters. The colouration of the abdomen of *Potamocloeon* spA (Fig. 19) and *P. dentatum* (Gillies, 1988: Fig. 21) also presents a few differences, but the main pattern remains rather similar.

The male imago of *Potamocloeon* spB possesses genitalia typical of the genus *Potamocloeon*, having a sclerotized plate between the gonopods, the first segment apically with a projection and the third segment obliquely truncated (Fig. 26). *Potamocloeon dentatum* is the only other species of the genus known at the imaginal stage. The male imago of *Potamocloeon* spB clearly differs from *Potamocloeon dentatum* in the degree of development of the lateral projection of the first segment of the gonopods and the apex of the second segment of the gonopods (Fig. 26; Kimmins, 1956: Fig. 9). The presence of a well-developed hindwing in my male imagos also clearly indicated that they definitely do not belong to *Potamocloeon dentatum*. With a slender shape and a single, well-developed acute spur, the hindwing of *Potamocloeon* spB (Fig. 25) is rather unusual among the Afro-Malagasy genera.

The larva and the imagos were found in the same area and in the same kind of stream. Despite intensive sampling in this area and in other parts of Madagascar, no other specimens were caught. It clearly means that *Potamocloeon* is scarce in Madagascar. Does it mean that they all belong to the same species? The absence of hindwing pads in my larva and the presence of hindwings in my imagos is not sufficient to consider them as two different species. As the imagos are male and the larva is female, the presence and absence of hindwing could be explain by sexual dimorphism as can be observed in *Cheleocloeon*

dimorphicum Soldán & Thomas (Soldán & Thomas, 1985). However, there is no evidence in the abdominal pattern or any other character to indicate that they belong to the same species. The wisest solution remains to consider them as two separate taxa and to leave them unnamed until new evidence arises to settle the matter.

As mentioned above, no reliable differences allow the separation between *Potamocloeon* spA and the African species *P. dentatum* and *P. macafertiorum*. Moreover, it has recently emerged that the Malagasy species of Baetidae are not necessarily endemic (Gattholliat & Rabeantoandro, 2002). The colonisation of the Malagasy plate from Africa after the breakoff of the Gondwana must be considered as possible (Gattholliat & Sartori, in press). Consequently, the Malagasy species of *Potamocloeon* are not automatically new species, but could be species with a broad distribution including Africa and Madagascar.

The question can be asked about the validity of the two African species. A recent revision of the Afrotropical genus *Afrobaetodes* (Jacobus & McCafferty, 2001) clearly put forward the inadequacies in species descriptions and the erection of some species based on characters often subject to variability. Moreover, a lot of species are known from a very few specimens collected from a very few localities (Jacobus & McCafferty, 2001). *Potamocloeon dentatum* presents a wide distribution including East and West Africa (Gambia, Guinea, Ivory Coast, and Uganda). This species is well known both at the larval and at the imaginal stages (Kimmins, 1956; Gillies, 1988; 1990a). At the opposite, *Potamocloeon macafertiorum* was described on a single larva collected in the Kruger Park (South Africa). The authors recognised that this species is rather similar to *P. dentatum* (Lugo-Ortiz & McCafferty, 1996a). They use the relative length of the second segment of the maxillary palp, the difference in abdominal colouration and the presence/absence of hindwing pads to justify the establishment of this new species (Lugo-Ortiz & McCafferty, 1996a). Unless the character appears constant in a large population, the relative length of the two segments of the maxillary palp should be considered as intraspecific variation, as it was illustrated in *Cloeodes caraibensis* Hofmann and Thomas (Hofmann et al., 1999). For the same reasons, species discrimination based on the colouration of the abdomen and the presence/absence of hindwing pads have been shown to be unreliable, especially in Baetidae (Jacobus & McCafferty, 2001).

With one well-known and widespread species and another characterised by doubtful minor variations, *Potamocloeon* presents the same problems as *Afrobaetodes*. Based on these considerations and following the same logic as for *Afrobaetodes* (Jacobus & McCafferty, 2001), *P. macafertiorum* should be considered as a junior synonym of *P. dentatum* (*Potamocloeon dentatum* (Kimmins) = *Potamocloeon macafertiorum* Lugo-Ortiz syn. n.). The genus *Potamocloeon* is not monotypic since it has been shown that *P. dentatum* and *P. spB* are not conspecific. However, I refrain from naming the Malagasy species. Two hypotheses can be considered. The larva collected in Madagascar could belong to the same species as the male imago, which means that the African and Malagasy species are not distinguishable at the larval stage. The second hypothesis is that the Malagasy larva and

imagos are not conspecific, which means that the larva of *Potamocloeon* spA probably belongs to *P. dentatum*.

2.4 Taxonomic synopsis

Type species

Potamocloeon dentatum (Kimmins 1956)

Species included

Potamocloeon dentatum (Kimmins 1956) (Gambia, Guinea, Ivory Coast, South Africa and Uganda)

= *Cloeon dentatum* Kimmins 1956 (Uganda)

= *Potamocloeon macafertiorum* Lugo-Ortiz 1996 syn. n. (South Africa)

Potamocloeon spA (Madagascar)

Potamocloeon spB (Madagascar)

3 The systematic position of *Demoulinia* and *Potamocloeon*

In the original description of the genus, Gillies (1990a) included *Potamocloeon* in the group of cloeonine mayflies. This group is characterised by the posterior abdominal segments of the larva having small lateral spines (Fig. 19). Moreover, *Potamocloeon* shares with *Cloeon* and *Pseudocentropilum* Bogoesco gills with double lamellae (Fig. 22). Gillies (1990a) considers that *Potamocloeon* is the sister group of *Cloeon*.

Lugo-Ortiz and McCafferty (1996a) assigned *Potamocloeon* to the *Bugilliesia* complex. This complex included genera with a conspicuous basomedial protuberance on the male genitalia. It originally comprised the genera *Afrobaetodes* Demoulin, *Bugilliesia* Lugo-Ortiz and McCafferty, *Kivua* Lugo-Ortiz and McCafferty, *Mutelocloeon* Gillies and Elouard, *Potamocloeon* and *Rhithrocloeon* Gillies. The genus *Cheleocloeon* Wuillot and Gillies was later included in the complex (Lugo-Ortiz & McCafferty, 1997), then excluded by the same authors to assign it to the *Centropiloides* complex (Lugo-Ortiz & McCafferty, 1999). The attribution of *Potamocloeon* to the *Bugilliesia* complex is only justified by the presence of a baso-medial protuberance on the male genitalia (Fig. 26). The authors completely neglected the larval characters.

The systematic position of *Demoulinia* was regarded as difficult to determine. Demoulin (1970) considered that the larva shares characters with *Baetis*, *Centropilum* and *Cloeon*. Gillies (1990b) put forward some similarities (but also differences) to *Rhithrocloeon*. In the description of *Demoulinia insularis*, Lugo-Ortiz and McCafferty (1998c) did not tackle the subject.

According to the literature, *Demoulinia* and *Potamocloeon* were never assigned to the same group. The observation of the larval features however clearly indicates that *Pota-*

mocloeon is closely related to *Demoulinia*: mandibles with two completely divided sets of incisors (Figs 3, 4, 15 and 16), insertion of the prostheca (Figs 3, 4, 15 and 16), shape of hypopharynx with trilobate lingua (Figs 2 and 14), unusual shape of labrum with ventrally a row of two kind of setae along the distal margin (Figs 1 and 13), subproximal arc of setae on tibiae (Figs 8 and 21). The two genera present long and slender legs (Figs 8 and 20), tarsal claws edentate or with minute teeth (Figs 9 and 20). These two characters have evolved independently in several lineages as an adaptation to life on sandy or silted substrates (Gillies, 1990a). They cannot be considered as strict synapomorphies but as additional characters that contribute to establish the close relationship between the two genera.

At the imaginal stage, the affinities between the two genera are less evident. They both possess forewings with single intercalary veins and absence of cross-veins in the cubital area (Fig. 24; Crass 1947: Fig. 28a). The genitalia of *Demoulinia* have not been illustrated since the original description by Crass (1947: Fig 27g). Although somewhat basic, he put however in evidence the unusual shape of the last segment of the gonopods.

Although the shape of the legs (Figs 8 and 20), the presence a subproximal arc of setae on tibiae (Figs 8 and 21) and to some extent the glossae and paraglossae (Figs 6, 7 and 18) are similar to those of the genus *Cloeon* and related genera, *Demoulinia* and *Potamocloeon* differ from all the African genera. The relationships within the cloeonine Baetidae put forward by Gillies (1988; 1990a), such as posterior abdominal segments of the larvae with small lateral spines (Fig. 19) and gills with double lamellae (Fig. 22), are only valid for *Potamocloeon* as these characters are not present in *Demoulinia*. Consequently the affinity of *Demoulinia* and *Potamocloeon* with the cloeonine are less evident than Gillies had suggested (Gillies, 1990a).

Demoulinia and *Potamocloeon* appear more closely related to the Neotropical genus *Waltzoyphius* Lugo-Ortiz & McCafferty (Lugo-Ortiz & McCafferty, 1995). The latter also possesses mandibles with two well-separated sets of incisors, left prostheca inserted between the two sets of incisors and similar hypopharynx. Moreover, *Waltzoyphius* shares with *Demoulinia* an unusual setation of the maxillary crown. Some characters such as the long, two or three segmented maxillary palp, tuft of setae between prostheca and mola, and incisors in two sets indicate that these genera are probably relatively less derived (Lugo-Ortiz and McCafferty, 1995: Figs 21 to 34). As mentioned above, Lugo-Ortiz and McCafferty (1996a) considered that *Potamocloeon* belongs to the *Bugilliesia* complex because of the lateral extension on the genitalia. The observation of the larval features of the different genera clearly indicates that the *Bugilliesia* complex is polyphyletic. Only *Bugilliesia*, *Rhithrocloeon* and *Mutelocloeon* constitute a monophyletic group. They share synapomorphies at larval and imaginal stages that separate them from the other genera previously included in the complex. They present the rare combination in the right and left mandibles of one set of incisors and setae between prostheca and mola. Most African genera possess either one set of incisors without setae between prostheca and mola (Baetinae (sensu Gillies (1991) or *Baetis* complex sensu Waltz and McCafferty (1987)) or at least the right

mandibles with two sets of incisors and setae between protheca and mola (Cloeoninae sensu Gillies (1991) or *Centroptiloides* complex and *Cloeon* complex sensu Lugo-Ortiz and McCafferty (1998a)). These three genera are the only Baetidae that possess two segmented genitalia. It is no more tenable to gather together genera apparently so distinct just because they present a more or less developed lateral extensions of the genitalia. Moreover, other genera presenting lateral extensions, such as *Dabulamanzia*, are not included in the complex (Lugo-Ortiz & McCafferty, 1996b; Gattolliat & Sartori, 2000), or were excluded secondarily (Lugo-Ortiz & McCafferty, 1999). It ensues from this that *Potamocloeon* and also *Afrobaetodes* must be excluded from the *Bugilliesia* complex.

The relative position of *Demoulinia* and *Potamocloeon* can be summarised as follow: *Demoulinia* and *Potamocloeon* are extremely closely related; they are also probably closely related to the South American genus *Waltzoyphius*. The knowledge of their exact positions in Baetidae, in particular relationships with the *Cloeon* complex, will require a complete cladistic analysis.

As pointed out by Jacobus and McCafferty (2001) and illustrated by the case discussed above, the systematics of the Baetidae greatly suffered of insufficiency in species description. I can also only regret the lack of satisfactory and conscientious phylogenetic works. The African genera are still in great need of a global cladistic analysis in order to clarify their relationships and the validity of the different complexes recently established (Lugo-Ortiz & McCafferty, 1996a; 1998a; b; d).

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References

- Crass, R.S. (1947) The May-flies (Ephemeroptera) of Natal and the Eastern Cape. *Annals of the Natal Museum*, 11, 37-110.
- Demoulin, G. (1970). Ephemeroptera des faunes éthiopienne et malgache. *South African Animal Life*, 14, 24-170.
- Gattolliat, J.-L. (2002) A new species of *Pseudopannota* (Baetidae: Ephemeroptera) from Madagascar. *Bulletin de la Société Vaudoise des Sciences Naturelles*, 88, 19-29

- Gattolliat, J.-L. & Rabeantoandro, S.Z. (2002) The genus *Cloeon* (Ephemeroptera, Baetidae) in Madagascar. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 74:, 195-209 (2001).
- Gattolliat, J.-L. & Sartori, M. (1999) A new species of *Afrobaetodes* (Ephemeroptera, Baetidae) and first report of this genus from Madagascar. *Annales de Limnologie*, 35, 179-184.
- Gattolliat, J.-L. & Sartori, M. (2000) Contribution to the systematics of the genus *Dabulamanzia* (Ephemeroptera: Baetidae) in Madagascar. *Revue Suisse de Zoologie*, 107, 561-577.
- Gattolliat, J.-L. & Sartori, M. (in press) An overview of the Baetidae of Madagascar. Proceedings of the X International conference on Ephemeroptera, Perugia.
- Gillies, M.T. (1988). Description of the nymphs of some afrotropical Baetidae (Ephemeroptera). I. *Cloeon* Leach and *Rhithrocloeon* Gillies. *Aquatic Insects*, 10, 49-59.
- Gillies, M.T. (1990a) A new genus for the Afrotropical mayfly, *Cloeon dentatum* Kimmins (Ephemeroptera, Baetidae). 126 (1516-1519), 207-208.
- Gillies, M.T. (1990b) A revision of the African species of *Centroptilum* Eaton (Baetidae, Ephemeroptera). *Aquatic Insects*, 12, 97-128.
- Gillies, M.T. (1991) A diphyletic origin for the two-tailed baetid nymphs occurring in East African stony streams with a description of the new genus and species *Tanzaniella spinosa* gen. sp. nov. In: Alba-Tercedor, J. & Sanchez-Ortega, A. (Eds), *Overview and strategies of Ephemeroptera and Plecoptera*. Sandhill Crane Press., Inc., Gainesville, pp. 175-187.
- Hofmann, C., Sartori, M. & Thomas, A.G.B. (1999) Les Ephéméroptères (Ephemeroptera) de la Guadeloupe (petites Antilles françaises). *Mémoires de la Société vaudoise des Sciences Naturelles*, 20, 1-96.
- Jacobus, L.M. & McCafferty, W.P. (2001) Contribution to the systematics of *Afrobaetodes* Demoulin (Ephemeroptera: Baetidae). *African Entomology*, 9, 97-103.
- Kimmins, D.E. (1956). New species of Ephemeroptera from Uganda. *Bulletin of the British Museum (Natural History) Entomology*, 4, 71-87.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1995) Three distinctive new genera of Baetidae (Insecta, Ephemeroptera) from South America. *Annales de Limnologie*, 31, 233-243.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1996a) The *Bugilliesia* complex of African Baetidae (Ephemeroptera). *Transactions of the American Entomological Society*, 122, 175-197.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1996b) The composition of *Dabulamanzia*, a new genus of Afrotropical Baetidae (Ephemeroptera), with descriptions of two new species. *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 132, 7-13.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1997). Contribution to the systematics of the genus *Cheleocloeon* (Ephemeroptera: Baetidae). *Entomological News*, 108, 283-289.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1998a) The *Centroptiloides* Complex of Afrotropical small minnow mayflies (Ephemeroptera: Baetidae). *Annals of the Entomological Society of America*, 91, 1-26.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1998b) A new *Baetis*-complex genus (Ephemeroptera: Baetidae) from the Afrotropical region. *African Entomology*, 6, 297-301.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1998c) New species of *Cloeon* and *Demoulinia* (Ephemeroptera: Baetidae) from Madagascar. *Entomological News*, 109, 357-362.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1998d) Phylogeny and biogeography of *Nesydemius* n.gen., and related Afrotropical genera (Insecta: Ephemeroptera:Baetidae). *Bulletin de la Société d'Histoire Naturelle de Toulouse*, 134, 7-12.
- Lugo-Ortiz, C.R. & McCafferty, W.P. (1999) *Delouardus*, a new *Centroptiloides* complex genus from Madagascar and its relationship with *Cheleocloeon* Wuillot & Gillies (Ephemeroptera: Baetidae). *African Entomology*, 7, 63-66.
- Sartori, M., Gattolliat, J.-L., Oliarinony, R. & Elouard, J.-M. (2000) Biogeography of Malagasy Mayflies (Insecta, Ephemeroptera): preliminary results. In: Lourenço, W.R. & Goodman, S.M.

- (Eds), *Diversité et endémisme à Madagascar*. Société française de Biogéographie, Paris, pp. 307-317.
- Soldán, T. & Thomas, A.G.B. (1985) *Centroptilum dimorphicum* sp. n., a new species of mayfly (Ephemeroptera, Baetidae) from Algeria. *Acta entomologica bohemoslovaca*, 82, 180-186.
- Waltz, R.D. & McCafferty, W.P. (1987) Systematics of *Pseudocloeon*, *Acentrella*, *Baetiella*, and *Liebebiella*, new genus (Ephemeroptera: Baetidae). *Journal of New York Entomological Society*, 95, 553-568.