

***Aturbina georgei* gen. et sp. n.: A Small Minnow Mayfly
(Ephemeroptera: Baetidae) without Turbinate Eyes**

C.R. LUGO-ORTIZ and W.P. McCafferty

C.R. LUGO-ORTIZ and W.P. McCafferty: *Aturbina georgei* gen. et sp. n.: A Small Minnow Mayfly (Ephemeroptera: Baetidae) without Turbinate Eyes. Aquatic Insects, Vol. 18 (1996), No. 3, pp. 175-183.

Aturbina (Ephemeroptera: Baetidae), gen. n., is described from a single species, *A. georgei*, sp. n., based on larvae and male and female adults from western Brazil, French Guiana, and Paraguay. Besides being the first baetid mayfly known to lack the turbinate portion of the male compound eyes, the genus is distinct in that larvae possess an elongate, distally branched seta at the base of the right prostheca and male adults have genital forceps with a distinct distomedial process on segment 1 and a highly reduced segment 3. Male and female adults are further distinguished by the possession of a small medial hump on the metanotum and a costal process with two peaks in the hindwings. The significance of the new baetid taxon is discussed.

Keywords: Ephemeroptera, Baetidae, *Aturbina georgei*, new genus, new species.

C.R. LUGO-ORTIZ and W.P. McCafferty, Department of Entomology, Purdue University, West Lafayette, IN, 47907, USA.

INTRODUCTION

The mayfly family Baetidae, or small minnow mayflies, is distinct in that adults have veins IMA, MA₂, IMP, and MP₂ basally detached and three-segmented mid- and hindtarsi. Male adults are further distinguished by the presence of turbinate eyes and membranous penes. Larvae, for the most part, are distinguished by the relatively elongate antennae and labial glossae and paraglossae. Except for New Caledonia, New Zealand, and other oceanic islands, native baetids occur worldwide, in both lentic and lotic freshwater habitats. Currently 53 genera have been described, mostly from the Holarctic and Oriental regions.

Generic diversity in the Baetidae of the Neotropics remains poorly known. Only the generic nomens *Acerpenna* Waltz and McCafferty, *Baetis* Leach, *Baetodes* Needham and Murphy, *Bernerius* Waltz and McCafferty, *Callibaetis* Eaton, *Camelobaetidius* Demoulin, *Cloeodes* Traver, *Cloeon* Leach, *Guajirolus* Flowers, *Harpagobaetis* Mol, *Moribaetis* Waltz and McCafferty, and *Pseudocloeon* Klapálek have been recognized in the Baetidae of South America (Hubbard and Peters, 1981; Waltz and McCafferty, 1985a, 1987a,b; Flowers, 1985; Mol, 1986; Lugo-Ortiz and McCafferty, 1994). Species that have been assigned to *Baetis* and *Cloeon* in South America are doubtfully placed to the correct genus because most probably neither occurs on the continent, and Waltz and McCafferty

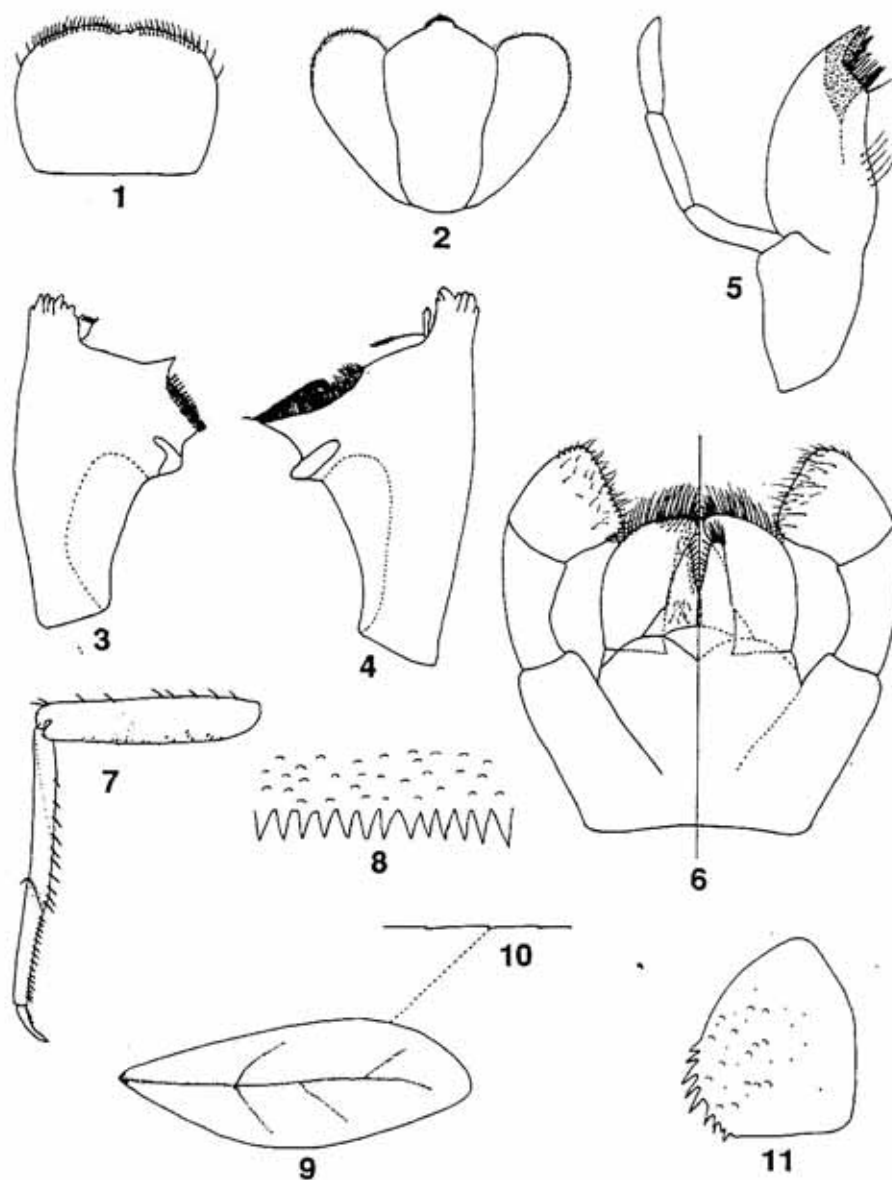
ty (1985b) restricted the generic concept of *Pseudocloeon*, requiring the eventual reassignment of Neotropical species described under that name [see, e.g., Flowers (1987) and Waltz (1993)].

We have recently become engaged in an extensive survey of the baetid fauna of South America to assess its biodiversity and biogeographic affinities. Among the new taxa discovered is a highly unusual genus whose male adults lack the turbinate portion of the compound eyes. Below, we describe the new genus and a single species based on larvae and male and female adults collected in western Brazil, French Guiana, and Paraguay. The material studied is housed in the following institutions: Paris Museum (PM), France; Purdue Entomological Research Collection (PERC), West Lafayette, Indiana; United States National Museum (USNM), Washington, D. C.; and Zoologische Staatssammlung (ZS), Munich, Germany.

Aturbina Lugo-Ortiz and McCafferty, gen. n.

Larva. Antennal scapes and pedicels bare. Frontal keel absent. Labrum (Fig. 1) basally broad, with small, round denticle on anteromedial emargination. Hypopharynx (Fig. 2) with distolaterally expanded superlinguae. Mandibles (Figs. 3-4) with incisors fused; tuft of branched setae between prosthecae and molae absent. Prostheda of left mandible (Fig. 3) with small apical denticles. Prostheda of right mandible (Fig. 4) with sclerotized, slender process and elongate, distally branched seta arising from base of process. Maxillae (Fig. 5) with three-segmented palps, extending beyond apices of galealacinae. Labium (Fig. 6) with three-segmented palps; palp segment 1 subequal in length to segments 2 and 3 combined; palp segment 2 lacking distomedial projection; palp segment 3 distally truncate; glossae basally broad and apically narrow, shorter than paraglossae, without setae dorsally; paraglossae broad, somewhat round distally. Legs (Fig. 7) without villopore; anterior and posterior margins of femora subparallel; distal end of femora round; tarsal claws somewhat elongate, with small denticles basally. Hindwingpads present. Abdominal terga (Fig. 8) with scale bases throughout surface and triangular spination on posterior margin. Gills (Fig. 9) on abdominal segments 1-7, plate-like, somewhat narrow and elongate, held dorsolaterally. Paraproct as in Figure 11. Three caudal filaments present; terminal filament subequal to cerci.

Adult. Male compound eyes (Fig. 12) without turbinate portion. Male forelegs with tibiae 1.5x length of femora. Forewings (Fig. 13) with paired marginal intercalaries. Hindwings (Fig. 14) elongate, with compound costal process having two peaks (Fig. 15). Metanotum (Fig. 16) with small medial hump. Genitalia (Fig. 17) with three-segmented forceps, covered with minute setae; segment 1 subequal in length to segments 2 and 3 combined, with elongate distomedial process; segment 2 elongate, tapering distally; segment 3 conical, appearing fused to segment 2. Distally truncate process present between forceps.



Figs. 1-11. *Aturbina georgei*, sp.n., larva. 1. Labrum (dorsal). 2. Hypopharynx. 3. Left mandible. 4. Right mandible. 5. Left maxilla. 6. Labium (left-ventral; right-dorsal). 7. Right foreleg. 8. Detail of hind margin of tergum 4. 9. Gill 5. 10. Detail of gill margin. 11. Paraproct.

Etymology. Feminine, an arbitrary combination of letters alluding to the absence of turbinate eyes in male adults.

Type species. *Aturbina georgei*, sp. n.

Distribution. Brazil: Amazonas, Mato Grosso, Pará; French Guiana; Paraguay.

Remarks. *Aturbina* possesses numerous remarkable features in the larval and adult stages that distinguish it from other known baetid genera. The elongate, distally branched seta at the base of the right prostheca (Fig. 4) readily separates larvae of *Aturbina* from all other baetids. The labium (Fig. 6) is also unlike any other baetids, having a unique combination of basally broad and apically narrow glossae, broad paraglossae, and truncate apices of segment 3 of the palps.

Male adults are readily distinguished by lacking a dorsal turbinate portion of the compound eyes (Fig. 12). This eye characteristic is also apparent in mature male larvae, whose compound eyes are round and enlarged, being somewhat reminiscent of those of mature larvae of *Siphlaenigma* Penniket (Siphlaenigmatidae) and *Siphonurus* Eaton (Siphonuridae). Other unusual characters of the adults include the compound costal process of the hindwings (Figs. 14-15), the small medial hump on the metanotum (Fig. 16), and the general morphology of the male genitalia (Fig. 17).

We interpret the presence of the elongate, distally branched seta at the base of the right prostheca, the lack of turbinate eyes in male adults, the small dorsal hump on the metanotum of the adults, and the reduced genitalia of male adults to be autapomorphies of *Aturbina*. Non-baetid mayfly families, including more primitive Pisciforma (see McCafferty, 1991), lack turbinate eyes, but the presence of such eyes is considered an autapomorphy for Baetidae. In *Aturbina*, the lack of turbinate eyes is considered to be secondarily evolved because other characteristics of the genus are generally apotypic. The compound costal process of the hindwings is very similar to that of some species currently assigned to the African genus *Afroptilum* Gillies [see Gillies (1990): Fig. 21], but we consider it to be a homoplasy due to parallelism because *Afroptilum* clearly belongs to Cloeoninae, and *Aturbina* would fall to Baetinae, as interpreted by Gillies (1991).

The generic relationships of *Aturbina* can hardly be ascertained at this time, beyond the possible affinities suggested by the presence of double marginal intercalaries in the forewings and lack of punctures in the cuticle of the adults, which would place it among Baetinae, not Cloeoninae nor Callibaetinae as interpreted by Gillies (1990, 1991). It is apparent, however, that *Aturbina* cannot be assigned to certain recently studied groups of Baetinae. The lack of the villopore clearly removes *Aturbina* from consideration in the *Baetis* complex of genera consisting of *Acentrella* Bengtsson, *Baetiella* Uéno, *Baetis*, *Barbaetis* Waltz and McCafferty, *Gratia* Thomas, *Heterocloeon* McDunnough, *Labiobaetis* Novikova and Kluge, *Leibebilla* Waltz and McCafferty, *Platybaetis* Müller-Liebenau, and *Tanzaniella* Gillies [see McCafferty and Waltz (1990), Gillies (1991), and Waltz et al. (1994)]. In addition, the absence of dorsal setae on the glossae removes it from consideration in the *Indobaetis* complex of genera, another monophyletic grouping consisting of *Indobaetis* Müller-Liebenau and Morihara, *Nigrobaetis* Novikova and Kluge, and *Takobia* Novikova and Kluge (Waltz et al., 1994).

The anomalous lack of turbinate eyes in male adults of *Aturbina* somewhat compromises the traditional definition of the family Baetidae. However, *Aturbina* shares with other baetids the apomorphies of basally detached IMA, MA₂, IMP, and MP₂ veins in the forewings (see Fig. 13) and three-segmented tarsi in the mid- and hindlegs of the adults. Additionally, male adults of *Aturbina* also have membranous penes.

The loss of turbinate eyes in male adults suggests that *Aturbina* may swarm differently from other baetids. Turbinate eyes apparently greatly enhance the ability of males to locate females in swarms. However, in *Aturbina* the visual acuity of males may be somewhat compromised, and it is possible that they use other, non-visual cues to mate.

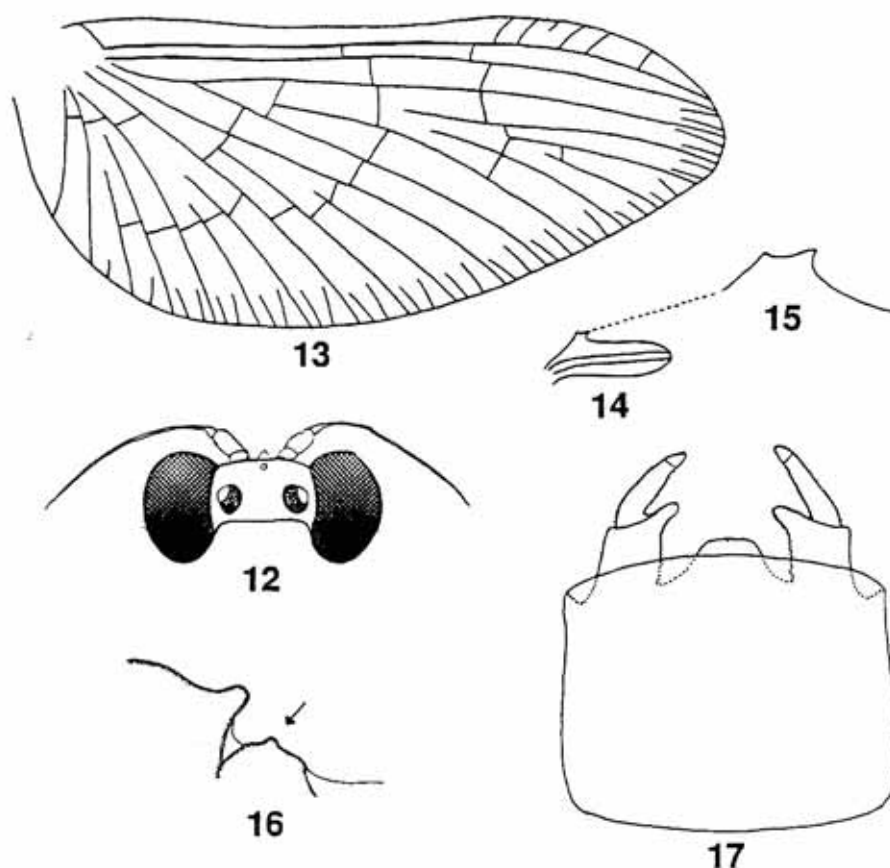
Aturbina georgei Lugo-Ortiz and McCafferty, sp. n.

Larva. Body length: 3.6-4.4 mm; caudal filaments: 2.0-2.2 mm. Head: Coloration yellow-brown, with no distinct pattern. Antennae nearly three times as long as head capsule. Labrum (Fig. 1) with 15-17 submarginal, short, simple setae on each side of midline. Hypopharynx as in Figure 2. Left mandible (Fig. 3) incisors with 4 + 4 denticles. Right mandible (Fig. 4) incisors with 4 + 3 denticles. Maxillae (Fig. 5) with three sharp denticles on galealaciniae and five-six simple setae basally. Labium (Fig. 6) with many long, simple setae distally on glossae and two rows of long, simple setae on paraglossae; second segment of labial palps dorsally bare, third segment with many short and long simple setae dorsally and ventrally.

Thorax yellow-brown, mottled with clear spots. Legs (Fig. 7) yellow-brown; femora with weak pale brown submedial band and with six to nine simple setae of medium length dorsally and scattered short, stout setae ventrally; tibiae diffuse pale brown distally, bare dorsally, except for single seta distally, and with 10-12 simple setae of medium length ventrally; tarsi diffuse pale brown proximally and distally, bare dorsally, and with 13-15 relatively short, simple setae ventrally; tarsal claws elongate, with six to seven small, slender denticles basally.

Abdomen yellow-brown, variably mottled with clear spots. Tergal surfaces (Fig. 8) covered with scale bases; posterior margins with sharp, triangular spines, bases width 0.5x spine length. Sterna yellow-brown. Gills (Fig. 9) as long as three abdominal segments, weakly tracheated, weakly serrate anteriorly (Fig. 10). Paraprocts (Fig. 11) with 8-10 marginal spines and scattered scale bases. Caudal filaments yellow-brown; cerci with six or eight long, simple setae medially on each segment and three to four sharp spines laterally every four segments; terminal filament with six or eight, long simple setae laterally on each segment.

Male adult. Body length: 3.8-4.0 mm; forewing length: 3.4-3.5 mm; hindwing length: 0.6-0.7 mm; caudal filaments: 7.0-8.0 mm. Head (Fig. 12): Coloration cream, with no pattern. Antennae nearly 2.5x length of head width, pale; scapes and basal portion of pedicels light yellow-brown or cream.



Figs. 12-17. *Aturbina georgei*, sp.n., male adult. 12. Head (dorsal). 13. Forewing. 14. Hindwing. 15. Detail of hindwing costal projection. 16. Meso- and metanotum (lateral; arrow indicates small hump). 17. Genitalia.

Thorax cream, without distinct pattern. Legs cream, with black streaks on posterior face and black marking on distal end of femora. Forewings as in Figure 13. Hindwings (Fig. 14) with two longitudinal veins; costal process as in Figure 15.

Abdominal segment 1 light cream or translucent; segments 2-7 translucent, with medial and sublateral purplish markings dorsally, sometimes medial marking on segment 7 absent; segments 8-10 cream, segment 8 usually with sublateral purplish markings; vestiges of abdominal tracheation conspicuous on segments 1-9. Genitalia as in Figure 8. Caudal filaments cream.

Female adult. Body length: 4.0-4.2 mm; forewing length: 3.5-3.6 mm; hindwing length: 0.6-0.7 mm; caudal filaments: 7.0-8.0 mm. Head: Coloration cream, with no pattern; eyes smaller than in male. Antennae as in male.

Thorax as in male, except tibiae of forelegs nearly 1.25x length of femora and forewing somewhat longer.

Abdomen as in male, except cream throughout due to presence of eggs and vestiges of tracheation more conspicuous.

Etymology. This species is named after the given name of George F. Edmunds, Jr., for his extensive contributions to the study of mayflies and for the donation of most of the material examined of this species.

Type material. Holotype: Male larva, BRAZIL, Amazonas State, Aracu Cr. 15 km from Manaus, rd nr Rio Branco, VI-8-1962, E. J. Fittkau (PERC). Paratypes: One larva, BRAZIL, Amazonas State, Gigante Cr, rapids, Reserva Duke, N of Manaus, VII-3-1961, E. J. Fittkau (ZS); three larvae, BRAZIL, Amazonas State, Rio Amazonas, Careiro Island, nr Divinópolis, SE of Manaus, VII-30-1961, E. J. Fittkau (USNM); one larva, BRAZIL, Amazonas State, Paracai Cr, 30 min above jet with Rio Negro, 1 h below Rio Branco, II-5-1962, E. J. Fittkau (ZS); one male adult, BRAZIL, Amazonas State, Rio Negro, Ponta Negra, nr Manaus, at light, VI-5-1962, E. J. Fittkau (ZS); four male and one female adults, BRAZIL, Mato Grosso State, shoreline Rio Bento Gomes, nr "Transpantaneira," V-14-1994, U. Nolte (PERC); six larvae, BRAZIL, Pará State, Parará do Tapará, VII-15-1946, H. Sioli (PERC); three larvae, BRAZIL, Pará State, Acuda Bréu, XI-26-1946, H. Sioli (USNM); one larva, BRAZIL, Pará State, Mission, Rio Cururú, V-12-1942, H. Sioli (PERC); one larva, BRAZIL, Pará State, Assaial Cr, Mulata, IX-23-1954, H. Sioli (PERC); one larva, PARAGUAY, Departamento Cordillera, Piribebuy, Río Piribebuy, V-3-1985, R. T. Bonace (PERC); one larva, PARAGUAY, Departamento Paraguari, Parque Nacional Ybycuí, Arroyo Mina, edge, R. T. Bonace, IV-20-1984, larva (PERC); one larva, same data, except X-2-1984 (USNM).

Additional material examined: Three larvae, BRAZIL, Acre State, Territorio Federal do Rio Branco, Cachangá Cr, IX-16-1941, H. Sioli (PERC); one larva, BRAZIL, Amazonas State, large cr. nr Tres Casas, XI-21-1941, H. Sioli (PERC); one larva, BRAZIL, Amazonas State, Jandiá Cr, IX-19-1952, H. Sioli (PERC); one larva, BRAZIL, Amazonas State, Rio Negro in Içana, IX-25-1952, H. Sioli (PERC); one larva, BRAZIL, Amazonas State, Cr at Caparapoço, XII-10-1959, H. Sioli and W. Sattler (PERC); one larva, BRAZIL, Amazonas State, mouth of Rio Arara at Rio Negro, about 80 km NW of Manaus, X-6-1960, E. J. Fittkau (ZS); three larvae, BRAZIL, Amazonas State, Barro Branco Cr, Reserva Duke, N of Manaus, XII-3-1960, E. J. Fittkau (ZS); one larva, same data, except V-8-1961 (PERC); one larva, BRAZIL, Amazonas State, Rio Negro, nr jet with Bica Cr, N of Manaus, VI-23-1961, E. J. Fittkau (PERC); one larva, BRAZIL, Amazonas State, Rio Amazonas, Careiro Island, nr Divinópolis, SE of Manaus, VII-28-1961, E. J. Fittkau (PERC); one larva, same data, except VII-30-1961 (PERC); one larva, BRAZIL, Amazonas State, Camilo Cr, nr Maturá, X-15-1959, H. Sioli and W. Sattler (PERC); one larva, BRAZIL, Amazonas State, Rio Branquinho, nr Rio Cuieiras, N of Manaus, IV-20-1961, E. J. Fittkau (ZS); two larvae, BRAZIL, Amazonas State, Rio Negro, above Arara Island, N of Manaus, XII-15-1961, E. J. Fittkau (PERC); two larvae, BRAZIL, Amazonas State, Rio Aripuana, 7 h above jet with Rio Madeira, I-14-1962, E. J. Fittkau (PERC); one larvae, BRAZIL, Amazonas State, Pedras Cr, nr Rio Aripuana, I-18-1962, E. J. Fittkau (PERC); four larvae, BRAZIL, Amazonas State, Aracu Cr, 15 km from Manaus, rd nr Rio Branco, VI-8-1962, E. J. Fittkau (PERC); one larva, BRAZIL, Amazonas State, Cachoeira Cr, nr jet with Rio Cuieiras, N of Manaus, XI-26-1962, E. J. Fittkau (PERC); one larva, BRAZIL, Amazonas State, Rio Marauia, nr Equator, NW of Taparuará, I-3-1963, E. J. Fittkau (PERC); five male and five female adults, BRAZIL, Mato Grosso State, shoreline Rio Bento Gomes, nr "Transpantaneira," V-14-1994, U. Nolte (PERC); one larva, BRAZIL, Pará State, Mission Cururú, IV-25-1942, H. Sioli (PERC); one larva, BRAZIL, Pará State, Rio Cupary, at mouth, VII-29-1946, H. Sioli (PERC); two larvae, BRAZIL, Pará State, Acará-pequeno, Thomé-assú, XI-14-1946, H. Sioli (PERC); one larva, BRAZIL, Pará State, Rio Tinga, XII-23-1947, H. Sioli (PERC); one larva, BRAZIL, Pará State, Rio Cuminá, IV-17-1948, H. Sioli (PERC); one larva, BRAZIL, Pará State, Paroni Cr, IX-22-1950, H. Sioli (PERC); one larva, BRAZIL, Pará State, cr at Baião, X-28-1960, E. J. Fittkau (ZS); three larvae, BRAZIL, Pará State, Rio Paru, nr Tiriyo Mission, nr Brazil-Suriname border, III-31-1962, E. J. Fittkau (ZS); one larva, FRENCH GUIANA, Sinnamary R, Saut Dalles Fleuve, VI-15-16-1992, V. Horeau (PM); one larva, PARAGUAY, Departamento Paraguari, Parque Nacional Ybycuí, Arroyo Corrientes, VII-25-1985, R. T. Bonace (PERC).

Remarks. Because *A. georgei* is the only known species of *Aturbina*, it is difficult to establish which characters are reliable to distinguish it at the species level. Traditionally within the Baetidae, the number and arrangement of mandib-

ular denticles in the larvae have been used to separate species, and the combination of those presumably distinguish *A. georgei*. Additionally, the number and size of denticles in the tarsal claws may serve to separate *A. georgei* from other new species. Although we have seen larval specimens with distinct clear spots on the abdominal terga, we also found that coloration varies widely, with some specimens being completely pale or with discrete pale brown spots on some terga. We therefore do not consider abdominal coloration reliable to distinguish *A. georgei*.

Male and female adults would appear to be distinguished by the distinct purple markings of the abdominal terga, which are consistent in the specimens examined. The male genitalia may be found to vary, especially with respect to the relative length of the three segments of the forceps and the degree of development of the process between these.

Although the adults we have studied were not reared from larvae, we are confident that they belong to *A. georgei* because some of them were collected from the same localities where larvae were collected. Most significantly, mature male larvae ready to emerge do not show the development of turbinate eyes.

ACKNOWLEDGMENTS

We thank George F. Edmunds, Jr. (Salt Lake City, Utah), Ulrike Nolte (guest lecturer and researcher at the Universidade Federal de Mato Grosso, Brazil), and W. L. Peters (Florida A&M University, Tallahassee) for the donation or loan of the material used in this study. We also thank R. D. Waltz (Indiana Department of Natural Resources, Indianapolis) for critically reviewing the manuscript and providing suggestions. This paper has been assigned Purdue Agricultural Research Program Journal No. 14759.

REFERENCES

- FLOWERS, R.W. (1985): *Guajirolus*, a new genus of Neotropical Baetidae. — Stud. Neotrop. Faun. Env. 20: 27-31.
- (1987): The adult stage of three Central American *Baetodes* (Ephemeroptera: Baetidae) with notes on the genus. — Aquat. Insects 9: 1-10.
- GILLIES, M.T. (1990): A revision of the African species of *Centroptilum* Eaton (Baetidae, Ephemeroptera). — Aquat. Insects 12: 97-128.
- (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. nov. sp. nov. Pp. 175-187. — In: J. ALBA-TERCEDOR and A. SÁNCHEZ-ORTEGA (eds.), Overview and strategies of Ephemeroptera and Plecoptera. Sandhill Crane Press, Florida.
- HUBBARD, M.D. and W.L. PETERS (1981): Ephemeroptera. Pp. 55-63. In: S. H. HURLBERT, G. RODRÍGUEZ and N. D. SANTOS (eds.), Aquatic biota of tropical South America, Part 1: Arthropoda. San Diego State University, California.
- LUGO-ORTIZ, C.R. and W.P. McCAFFERTY (1994): The mayfly genus *Acerpenna* (Insecta, Ephemeroptera, Baetidae) in Latin America. — Stud. Neotrop. Faun. Env. 29: 63-74.
- McCAFFERTY, W.P. (1991): Toward a phylogenetic classification of the Ephemeroptera (Insecta): a commentary on systematics. — Ann. Entomol. Soc. Am. 84: 343-360.
- MOL, A.W.M. (1986): *Harpagobaetis gulosus* gen. nov., spec. nov., a new mayfly from Suriname (Ephemeroptera: Baetidae). — Zool. Medede. 60: 63-70.

- WALTZ, R.D. (1993): *Cloeodes binocularis* (Ephemeroptera: Baetidae), a new combination for a Neotropical species of *Pseudocloeon* s. auctt. – Entomol. News 104: 233-234.
- WALTZ, R.D. and W.P. McCafferty (1985a): *Moribaetis*: a new genus of Neotropical Baetidae (Ephemeroptera). – Proc. Entomol. Soc. Wash. 87: 239-251.
- (1985b): Redescription and new lectotype designation for the type species of *Pseudocloeon*, *P. kraepelini* Klapálek (Ephemeroptera: Baetidae). – Proc. Entomol. Soc. Wash. 87: 800-804.
- (1987a): Generic revision of *Cloeodes* and description of two new genera (Ephemeroptera: Baetidae). – Proc. Entomol. Soc. Wash. 89: 177-184.
- (1987b): Revision of the genus *Cloeodes* Traver (Ephemeroptera: Baetidae). – Ann. Entomol. Soc. Am. 80: 192-207.
- WALTZ, R.D., W.P. McCafferty and A. THOMAS (1994): Systematics of *Alainites* n. gen., *Dipheter*, *Indobaetis*, *Nigrobaetis* n. stat., and *Takobia* n. stat. (Ephemeroptera, Baetidae). – Bull. Soc. Hist. Nat., Toulouse 130: 33-36.