

The genus *Cloeon* (Ephemeroptera, Baetidae) in Madagascar

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The genus *Cloeon* in Madagascar is revised. Of five species known from the island, *C. durani* NAVAS, *C. cambouei* NAVAS, *C. irretitum* NAVAS and *C. waterloti* DEMOULIN were described from imaginal stages only and *C. emmanueli* LUGO-ORTIZ & MCCAFFERTY was recently described from the larval stage. Because of inadequate descriptions, the three species of Navás were declared *nomina dubia*. Based on larger collections and reared material from Madagascar, *C. durani* is reinstated and *C. waterloti* is placed as its junior synonym (**syn. nov.**). *Cloeon cambouei* remains a *nomen dubium*. *Cloeon irretitum* does not belong to *Cloeon*, but its generic assignment remains uncertain. The female imago of *C. emmanueli* is described for the first time, and the African species *C. smaeleni* LESTAGE is reported for the first time from Madagascar. This discovery is of great importance, since it represents the first Malagasy species of Ephemeroptera not endemic to the island. A redescription based on larvae, male and female imagos from Madagascar is given. Keys to *bona fide* species are given.

Keywords: Ephemeroptera, Baetidae, *Cloeon*, revision, new synonymy, Madagascar

INTRODUCTION

At present, 23 species of *Cloeon* are reported from Africa (including Madagascar), and several recent works have been concerned with Afrotropical species of this nearly cosmopolitan genus, especially in East and West Africa (GILLIES 1980, 1985, 1988). Keys now exist allowing specific identification of nymphs and male and female imagos (GILLIES 1979, 1985, 1990). Some species, previously assigned to *Cloeon* have been reassigned to other genera such as *Afrobaetodes* DEMOULIN, *Potamocloeon* GILLIES or *Rhithrocloeon* GILLIES (1979, 1985, 1988, 1990). Recently, GILLIES (1997) transferred two species of *Cloeon* back to *Procloeon*. He noticed that there are no reliable characters to distinguish imagos of *Cloeon* and *Procloeon*. The main difference between the larvae lies on the degree of development of the gills (GILLIES 1997). This character appears to be rather tenuous and we prefer to consider that our material belongs to *Cloeon* s.l. until a complete revision is led.

Unfortunately, the knowledge of *Cloeon* in Madagascar is not as satisfactory. Ulmer (1909) first reported *Cloeon* sp. in Madagascar based on male and female subimagos from the Lake Alaotra; he also mentioned larvae from the same locality, from Andranohinaly (South-West of Madagascar) and from the Comoros. In the first half of the 20th century, NAVAS (1926, 1930, 1936) established three Malagasy species of *Cloeon*, but descriptions were inadequate for identification (DEMOULIN 1970). Because they were so poorly known, LUGO-ORTIZ & MCCAFFERTY (1998) declared the three species of Navás to be *nomina dubia*, leaving only one *bona fide* species *C. emmanueli* LUGO-ORTIZ & MCCAFFERTY. In their 1998 revision of the

Malagasy species of *Cloeon*, a fifth species, *C. waterloti* DEMOULIN, was neglected. Its status will be discussed herein.

Based on collections from more than 800 localities in Madagascar, including reared series, it is now possible to revise the genus *Cloeon* in Madagascar. Three species of *Cloeon* are recognized, described and keyed. The material examined is housed in the Museum of Zoology, Lausanne, Switzerland.

TAXONOMY

Cloeon smaeleni LESTAGE, 1924

Cloeon smaeleni LESTAGE, 1924, *Rev. Zool. Afr.* 12: 426 (terra typica: Lubumbashi [ex Elisabethville], Katanga, ex Zaire); KIMMINS, 1955, *Ann. Mag. Nat. Hist.* (1) 8: 863; DEMOULIN, 1957, *Bull. Ann. Soc. R. Entomol. Belg.* 43: 266; GILLIES, 1963, *Entomol. Mon. Mag.* 98: 233; DEMOULIN, 1966, *Bull. I.F.A.N.* 28 (A): 1415; DEMOULIN, 1970, *S. Afr. Animal Life* 14: 58; GILLIES, 1980, *Bull. I.F.A.N.* 42 (A): 154; GILLIES, 1997, *Entomol. Mon. Mag.* 133: 249.

Procloeon smaeleni KIMMINS, 1960, *Bull. Brit. Mus. (Nat. Hist.) Entomol.* 9: 344.

Procloeon fraudulentum DEMOULIN, 1957, *Bull. Ann. Soc. R. Entomol. Belg.* 93: 274 (terra typica: Kapolowe, Katanga, ex Zaire); syn. fide DEMOULIN, 1970, *S. Afr. Animal Life* 14: 58 (holotype (female imago) of *P. fraudulentum* designated as neotype of *C. smaeleni*).

Cloeon affine NAVAS, 1930, *Rev. Zool. Bot. Afr.* 19: 322 (nec RAMBUR 1842) (terra typica: Kisangani [ex Stanleyville], ex Zaire); renamed *Cloeon incertum* by DEMOULIN, 1957, *Bull. Ann. Soc. R. Entomol. Belg.* 93: 268.

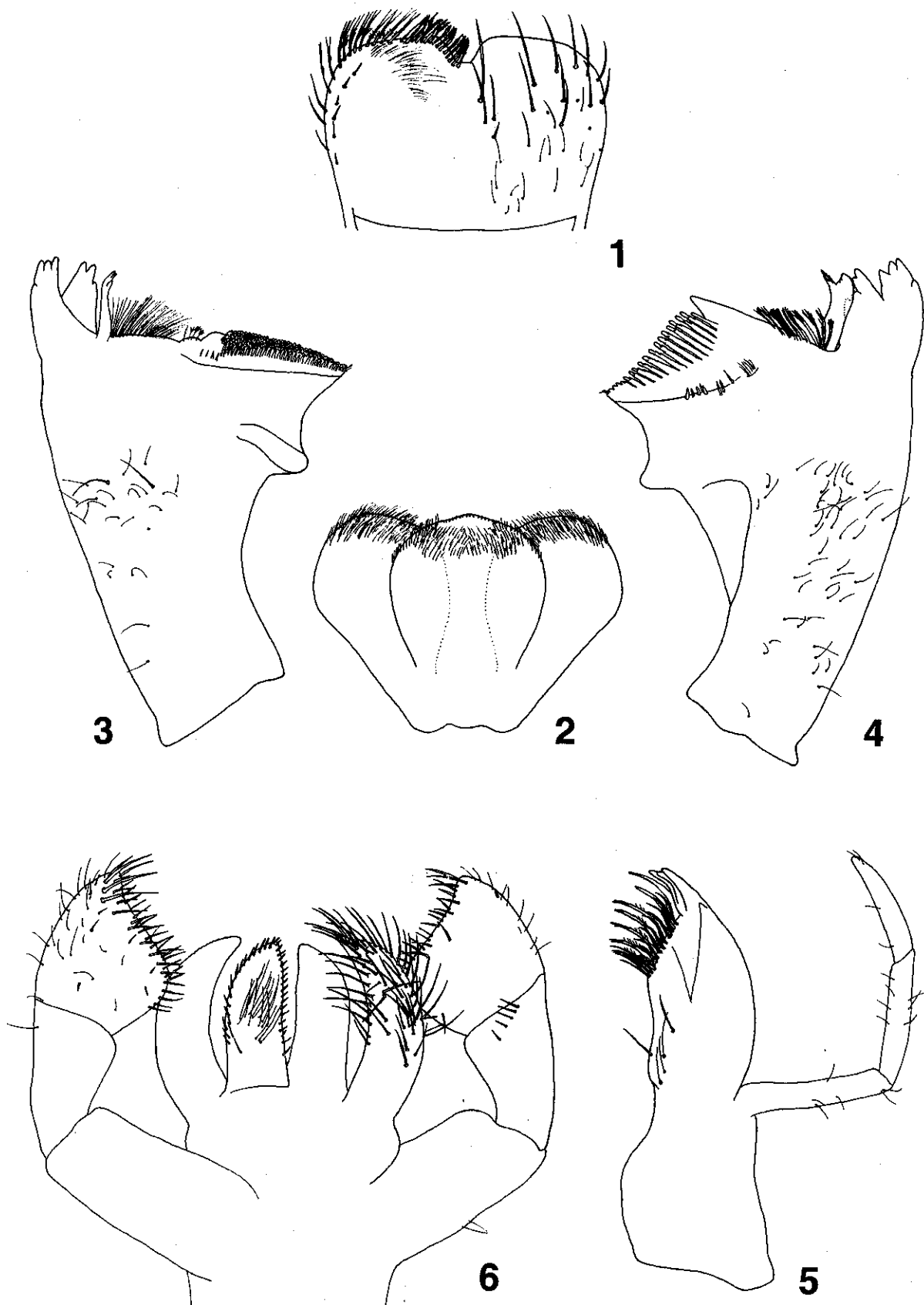
Cloeon incertum DEMOULIN, 1957, *Bull. Ann. Soc. Roy. Entomol. Belg.* 93: 268; syn. fide DEMOULIN, 1966, *Bull. I.F.A.N.* 4(A): 1416.

Cloeon punctatum NAVAS, 1931, *Broteria* 27: 122 (terra typica: Tchad); syn. fide GILLIES, 1980, *Bull. I.F.A.N.* 42(A): 154.

Larva

Maximum length: body 7.0 mm; cerci 7.5 mm; median caudal filament 5.0 mm.

HEAD. Uniformly medium amber brown. Antennae yellow. Dorsal surface of labrum (Fig. 1) apically with about 24 long and stout setae not arranged in a row, fine setae proximally; ventral surface with 6 small pointed setae; distal margin bordered with bifid and sometimes feathered setae. Hypopharynx (Fig. 2) with superlingua subcircular, covered apically only with minute setae. Right mandible (Fig. 3) with two sets of incisors, each with 3 denticles; prostheca with 4 elongated denticles; tuft of very abundant long setae between prostheca and mola; tuft of setae at the apex of the mola reduced to two or three setae; basal half with thin setae and few stout setae dorsally. Left mandible with one set of incisor with 7 denticles (Fig. 4); prostheca with 3 poorly developed denticles and an elongated comb-shaped structure; tuft of branched setae between prostheca and mola; tuft of setae at the apex of the mola reduced to 2 minute setae; basal half with thin setae dorsally. Maxillae (Fig. 5) with 4 hooked teeth, none of them opposed to others; one row of medium subequal setae and one row of spine-like, sometimes feathered setae; row of 4 stout setae at base of galea; one single stout seta perpendicular to margin of galea; palp 3-segmented with a few thin setae, segment 1 approximately 0.6 x as long as combined length of segment 2 and 3, segment 2 approximately 1.1 x as long as segment 3. Labium (Fig. 6) with glossae subequal to paraglossae; margin of glossae with short and stout setae, ventrally with long and thin setae; paraglossae falcate covered with numerous, long and stout setae not arranged in rows; labial palp



Figs 1-6. *Cloeon smaeleni*, larva. 1: labrum (left: ventral; right: dorsal); 2: hypopharynx; 3: right mandible, ventral; 4: left mandible, ventral; 5: left maxilla; 6: labium.

3-segmented; segment 1 subrectangular, 0.9 x as long as combined length of segment 2 and 3; segment 2 expanded apically, with a dorsal oblique row of 4 small pointed setae; segment 3 very broad, clavate, distal margin with stout pointed setae, the apical ones very long.

THORAX. Thorax medium amber brown with two yellow longitudinal stripes and yellow spots laterally. Femora of all legs yellow with a brown subdistal transverse stripe; tibiae yellow with a brown subproximal transverse stripe; proximal half of tarsi brown, distal half yellow; claws yellow. Forelegs as in Fig. 7. Coxae with about 7 stout setae and a few thin setae. Femora dorsally with two rows of 11-16 small and pointed setae, row of 15 small pointed setae subparallel to dorsal margin; dorsoapical setal patch formed by 5 small setae; lateral margin with small flattened setae; ventral margin with numerous short and pointed setae. Tibiae dorsally with few setae, apically with one long pointed seta; subproximal arc of about 6 thin setae; ventral and lateral margins with very abundant pointed setae; tibiopatellar suture present. Tarsi with few setae dorsally; ventral margin with a row of about 30 pointed setae, apical setae pectinate; tarsal claws (Fig. 8) hooked and elongated, approximately 0.6x as long as tarsi, with 2 rows of about 15 small acute teeth increasing in length toward the apex; subapical setae absent.

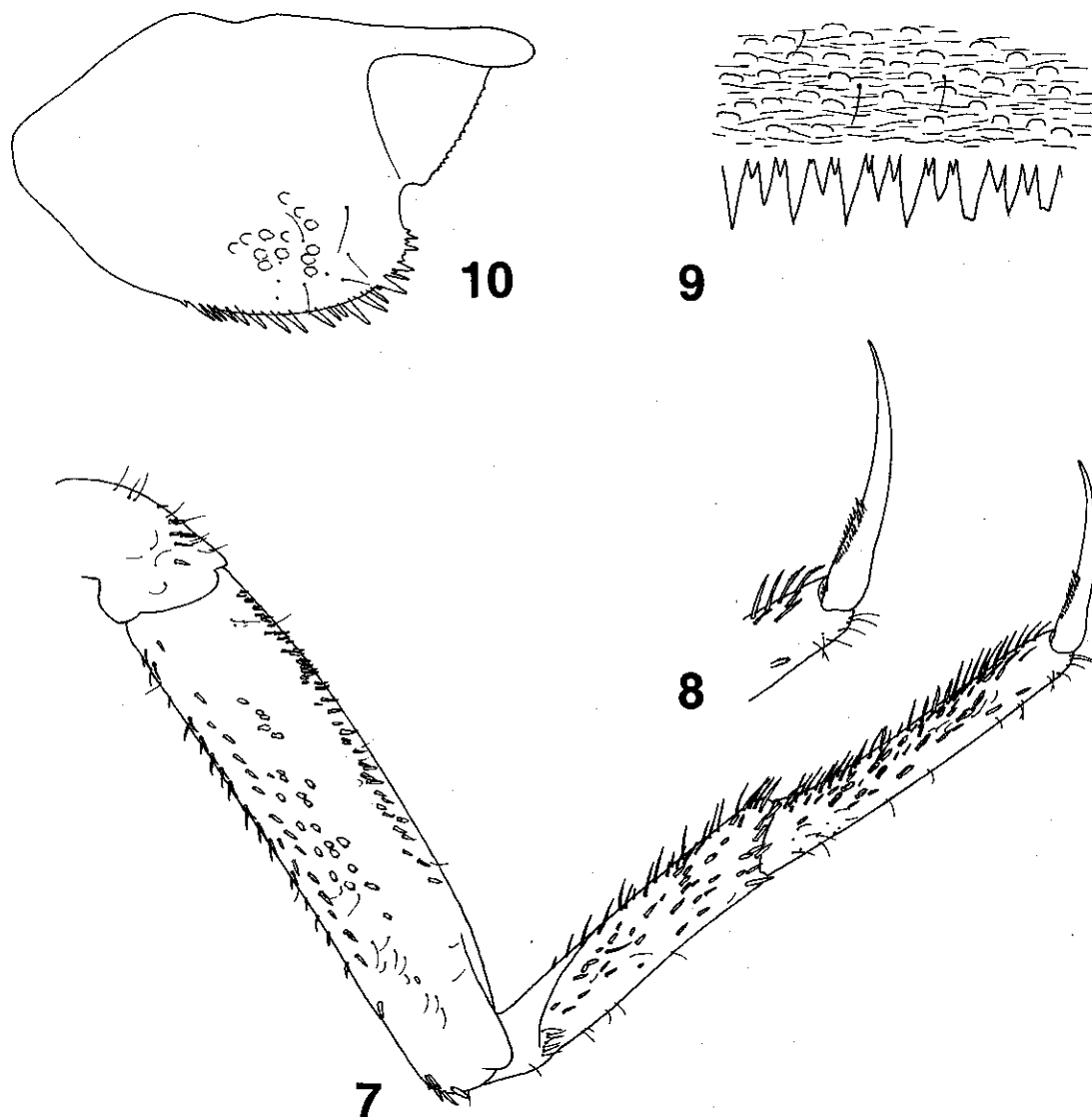
ABDOMEN. Tergal coloration a contrasting yellow and brown. Tergum 1 brown, laterally yellow; tergum 2 brown with 1 central and 2 sublateral symmetrical yellow spots; tergum 3 brown except distomedially and lateroproximally yellow; tergum 4 yellow with a brown oblique distolateral stripe; tergum 5 brown with 2 yellow symmetrical central broad spots and a yellow oblique distolateral stripe; tergum 6 similar except the two central spots generally fused; tergum 7 similar to tergum 5 except brown color more faded and two central spots larger; tergum 8 brown except distal margin yellow and 2 yellow symmetrical central large spots; tergum 9 similar to 8; tergum 10 yellow except apically light brown. Terga (Fig. 9) shagreened with scales bases and a few setae; posterior margin with alternating long and short acute spines. Sterna yellow, sterna 7 to 9 generally with 2 light brown symmetrical posterolateral broad spots. Lateral margin of abdominal segment 8 with 6 to 8 spines; lateral margin of abdominal segment 9 with 8 to 10 spines; lateral margins of segments 1-7 without spines. Gills on segments 1 to 6 with two lamellae, gill 7 single, tracheation dark brown. Paraproct (Fig. 10) with about 12 scale bases, sometimes scales also present, margin with about 20 pointed spines; posterolateral extension without scale bases, margin with minute spination. Cerci yellow with abundant thin setae on inner margins in basal half, apical half extremely thin and without setae, brown annulations every four segments; median caudal filament similar to cerci except thin setae on both margins.

Female imago

Length: body 5.2 to 8.9 mm (average length 7.0 mm); forewings 6.0 to 8.4 mm (average 7.1 mm); cerci 14 mm.

HEAD. Yellow with two brown broad longitudinal lines. Eyes black in recently emerged specimens, gray with a black broad transverse stripe or yellowish gray with two black narrow transverse stripes (corresponding to the border of the broad stripe) in older specimens. Antennae yellow brown except scape and pedicel apically, or entirely dark brown.

THORAX. Yellow with two brown central transverse lines and two brown broad lateral lines. Forewings with costal and subcostal areas brown with dark brown and hyaline markings, color spreading distally into the first radial interspace; veins and cross vein coppery brown, except cross veins of the costal and subcostal area hyaline; pterostigma with 3 cross-veins (Fig. 11). Femora yellow with a brown broad subdistal stripe (in some specimens, forefemora entirely brown); tibiae and tarsi yellow.



Figs 7-10. *Cloeon smaeleni*, larva. 7: foreleg; 8: tarsal claw; 9: distal margin of fourth abdominal tergum; 10: paraproct.

ABDOMEN. Terga light brown with a symmetrical dark red brown λ -shaped mark laterally. Abdominal sterna yellow with a brown median longitudinal stripe, interrupted on sterna 1-7, and continuous on sterna 8-9; sublaterally brown. Cerci yellow with alternatively broad and narrow dark brown annulations.

Male imago.

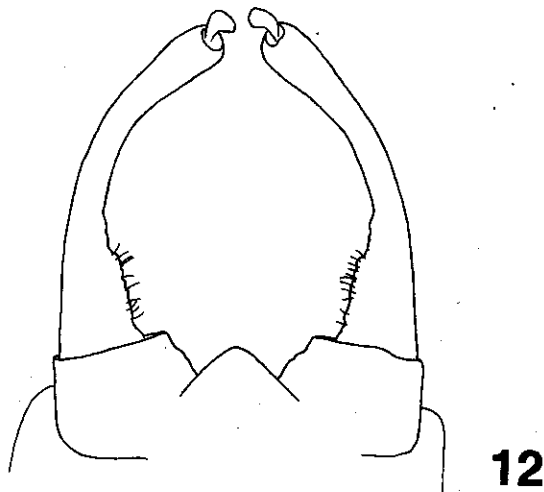
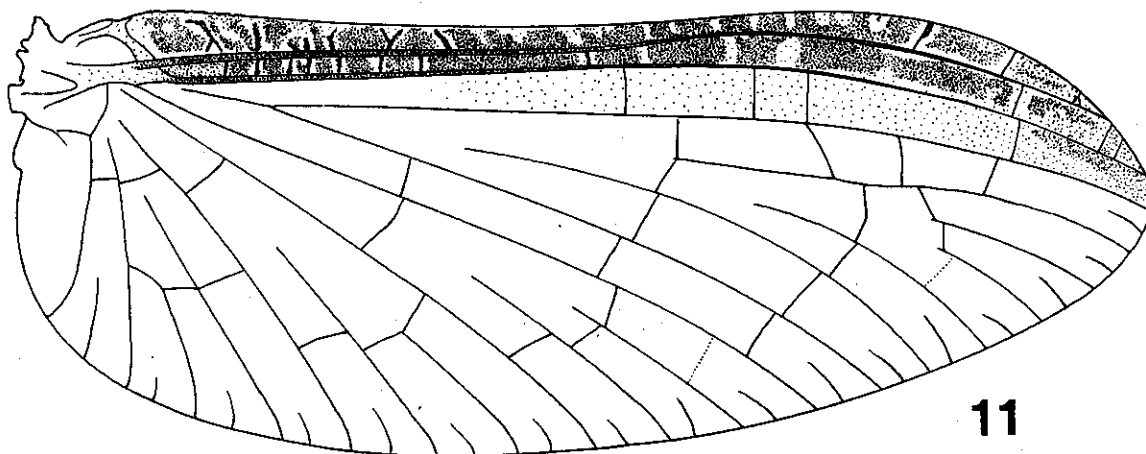
Length: body 5.2 to 6.9 mm (average length 6.0 mm); forewings 5.8 to 6.5 mm (average length 6.1 mm); cerci >13.5 mm.

HEAD. Turbinate eyes honey brown in recently emerged specimens, dark brown in older specimens. Antennae light brown.

THORAX. Forewings hyaline except two brown spot on costal brace; pterostigma with 2 to 3 cross-veins. Legs uniformly light yellow.

ABDOMEN. Tergal and sternal coloration similar to female, but faded. Cerci similar to female.

GENITALIA (Fig. 12) with three-segmented gonopods, first and second segments almost fused, inner margin of first segment with thin setae; third segment minute, globular; well-developed triangular sclerotized process between bases of forceps.



Figs 11, 12. *Cloeon smaeleni*, imago. 11: female forewing. 12: male genitalia.

Material examined. AMPANGALANA bas., Ampangalana riv., Anosy near Manakara <48°03'28" E, 22°03'37" S> 5 m (P0235) 24.04.1994, ORSTOM (Antananarivo), 1 larva. ANTONGOMBATO bas., Lac Vert (Montagne d'Ambre) <49°10'36" E, 12°32'02" S> 1050 m (P832) 27.03.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 larva; between Diégo Suarez and Namakia <49°16'50" E, 12°19'40" S> 40 m (P0834) 30.03.1999, J.-L. Gattolliat and Z. Rabeantoandro, 6 larvae; same data, but <49°15'50" E, 12°19'23" S> 20 m (P0835) 30.03.1999, 5 larvae; Antongombato riv., Namakia <49°14'37" E, 12°19'32" S> 20 m (P0836) 30.03.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 836b (on slide) and 8 larvae. BETSIBOKA bas., Lake Ambohibao <47°28'34" E, 18°50'32" S>, 1250 m (P0188) 21.02.1994, ORSTOM (Antananarivo), 184 male imagos; same data, but (P0244) 17.04.1994, 1 female imago 244-1 (on slide), 4 female and 50 male imagos; Ambohitrarabaha (near Antananarivo), 1250 m (P3022) 01.05.1997, J.-L. Gattolliat, 7 female imagos; 5km Ambohitrarabaha (near Antananarivo), 1250 m (P3003) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 male larva 3003b (on slide) and 73 larvae; Androhibe, Laboratoire LRSAE (near Antananarivo), 1250 m (P3021) 16.05.1997, J.-L. Gattolliat, 11 female and 3 male imagos; Anosy Avaratra (near Antananarivo), 1250 m (P3004) 18.05.1999, Z. Rabeantoandro, 1 female imago 3004a (on slide), 1 male imago 3004b (on slide), 2 female and 1 male imagos, all with corresponding larval and subimaginal exuviae; same data, but (P3005) 19.05.1999, 1 male imago 3005a (on slide), 3 male sub imagos, 1 male and 1 female imagos, all with corresponding larval exuviae; same data, but (P3006) 20.05.1999, 1 male imago with corresponding larval and subimaginal exuviae, 1 male and 1 female subimago with corresponding larval exuviae; same data, but (P3009) 05.06.1999, 1 male subimago with corresponding larval exuviae and 1 larva; Antandrano (near Antananarivo), 1250 m (P3014) 08.06.1999, Z. Rabeantoandro, 3 larvae; same data, but (P3015) 09.06.1999, 1 larva; Antanetibe, rice fields (near Antananarivo), 1250 m (P3000) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 3000a (on slide) and 54 larvae; Ivato Antanetibe <47°28'09" E; 18°50'11" S> 1250 m (P0026) 28.03.1991, ORSTOM (Antananarivo), 9 female imagos; same data, but (P0059) 05.05.1991, 4 female imagos; Lake Antanetibe (near Antana-

narivo), 1250 m (P3001) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 6 larvae; Lake Mahamamba (near Antananarivo), 1250 m (P3002) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 5 larvae.

MANAMBOVO bas., Sakamasy riv., Manambovo <45°33'04" E, 25°17'27" S> 60 m (P0566) 29.01.1996, F.-M. Gibon, D. Randriamasimanana and Z.P. Andriambelo, 1 male larva 566a (on slide) and 3 larvae.

MANAMPATRANA bas., Manandavana tributary of Manapatrana riv., Evato <47°41'50" E, 22°37'45" S> 45 m (P0437) 14.06.1995, A. Ralaiteferana, 1 female imago and 1 female subimago.

MANDRARE bas., Esomony riv., Esomony <46°37'28" E, 24°30'53" S> 475 m (P0568) 01.02.1996, F.-M. Gibon, D. Randriamasimanana and Z.P. Andriambelo, 1 larva.

MANGORO bas., Manjakatomp Ankaratra Reserve <47°19'11" E, 19°21'00" S> 1800 m (P0271) 08.03.1995, T. Pilaka and L. Blanc, 1 larva.

MATITANANA bas., Manakamboza riv., bridge near Nato <47°50'00" E, 22°18'02" S> 20 m (P0455) 19.06.1995, A. Ralaiteferana, 1 larva.

ONILAHY bas., tributary of Ihazofotsy riv., Ambatofotsy (Horombe) <45°40'43" E, 22°30'49" S> 910 m (P0439) 01.06.1995, J.-M. Elouard, 1 female imago.

RIANILA bas., Andasibe (pound) <48°25'00" E, 18°55'00" S> 900 m (P0866) 10.04.1999, J.-L. Gattolliat and N. Raberiaka, 1 male larva 866a (on slide), 1 female larva 866b (on slide) and 45 larvae.

TSIRIBIHINA bas., Ivato <47°13'39" E, 20°34'18" S> 1300 m (P0036) 07.04.1991, ORSTOM (Antananarivo), 4 female and 2 male imagos.

Cloeon durani NAVAS, 1926

Cloeon durani NAVAS, 1926, *Broteria (Ser. Zool.)* 23: 101 (terra typica: Antananarivo, Madagascar); DEMOULIN, 1970 *S. Afr. Animal Life* 14: 55; LUGO-ORTIZ & McCAFFERTY, 1998, *Entomol. News* 109: 360.

Cloeon waterloti DEMOULIN, 1966, *Ann. Soc. Entomol. France (N.S.)* 2: 711 (terra typica: Antananarivo, Madagascar); DEMOULIN, 1970, *S. Afr. Animal Life* 14: 59. **syn. nov.**

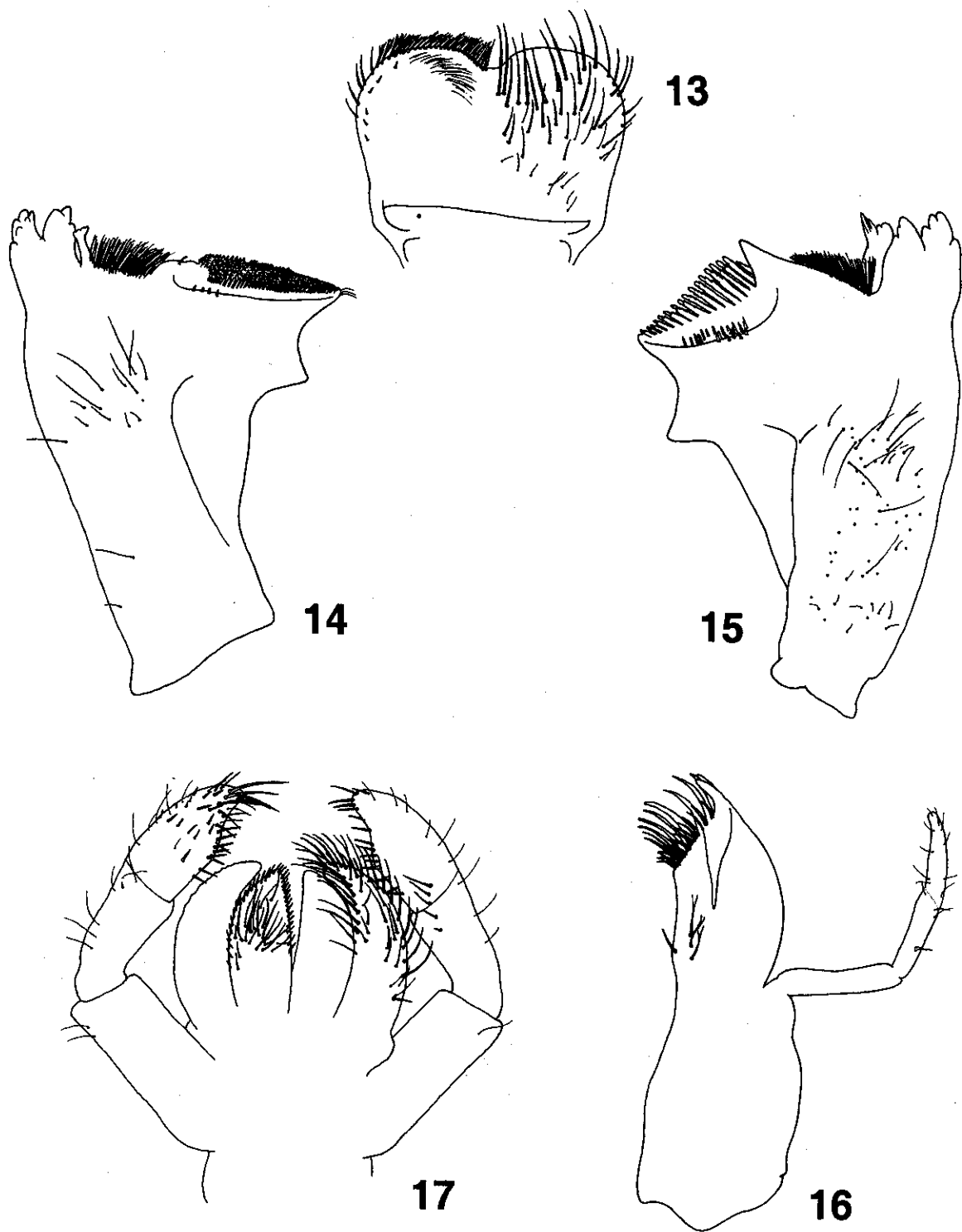
Larva

Maximum length: body 5.9 mm; cerci 5.2 mm; median caudal filament 4.5 mm.

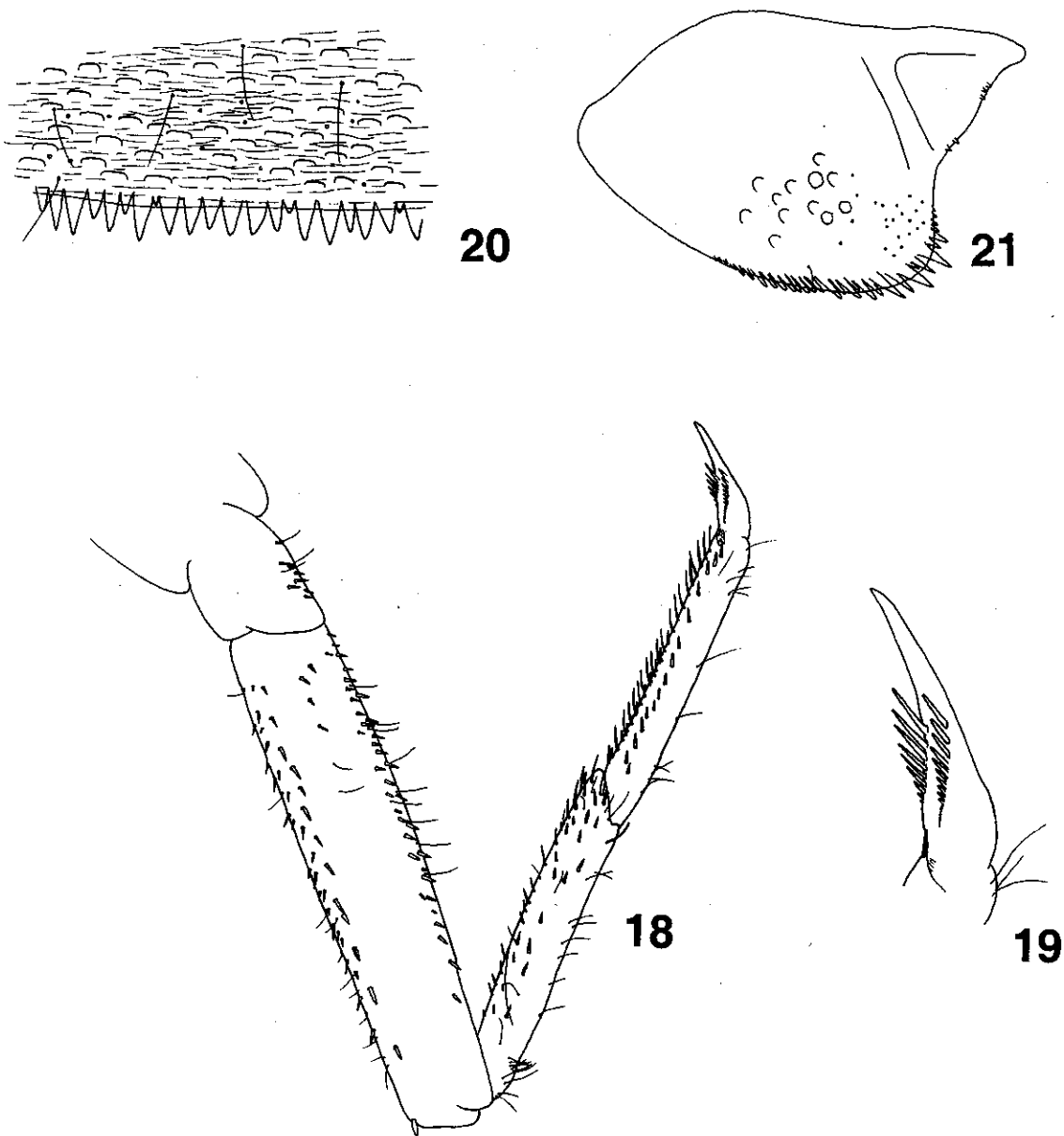
HEAD. Uniformly medium amber brown. Antennae yellow. Dorsal surface of labrum (Fig. 13) with abundant long, stout setae apically, setae not arranged in a row, fine setae proximally; ventral surface with row of 6 small pointed setae; distal margin bordered with feathered setae. Hypopharynx similar to Fig. 2. Right mandible (Fig. 14) with two sets of incisors, outer with 4 denticles and inner with 3 denticles; prostheca with poorly defined denticles; tuft of very abundant long, subequal setae between prostheca and mola; tuft of setae at the apex of the mola reduced to two or three setae; basal half with few thin and long setae. Left mandible with one set of incisors with about 7 denticles (Fig. 15); prostheca with 3 poorly developed teeth and a comb-shaped structure; tuft of feathered setae between prostheca and mola decreasing in length toward the apex; tuft of setae at apex of mola absent; basal half with long and thin setae dorsally. Maxillae (Fig. 16) with 4 teeth, none of them opposed to others; one row of short, subequal setae and one row of spine-like setae sometimes longer than apical teeth; row of 3 bifid setae at basis of galea; one single stout seta perpendicular to margin of galea; palp 3-segmented with a few thin setae, segment 1 approximately 0.7 x as long as combined length of segment 2 and 3, segment 2 subequal to segment 3. Labium (Fig. 17) with glossae subequal to paraglossae; margin of glossae with short and stout setae, ventrally with long and thin setae; paraglossae falcate covered with numerous, long and stout setae roughly arranged in rows; labial palp 3-segmented; segment 1 subrectangular, 0.7 x as long as combined length of segment 2 and 3; segment 2 not expanded apically, with a dorsal longitudinal row of 5 pointed setae progressively longer api-

cally; segment 3 not broader than the second, apically falcate, distal margin with stout pointed setae, the apical ones very long.

THORAX. Amber brown. Legs uniformly light yellow, except femora 2 and 3 with a brown transverse subdistal stripe. Forelegs as in Fig. 18. Coxae with 6 stout setae and several thin setae. Femora dorsally with two rows of about 10 small and pointed setae, row of about 13 small pointed setae subparallel to dorsal margin; dorsoapical setal patch reduced to a single small seta; lateral margin with a few small and pointed setae proximally; ventral margin with numerous short and pointed setae. Tibiae dorsally with only a few thin setae, apically with one long curved seta; sub-



Figs 13-17. *Cloeon durani*, larva. 13: labrum (left: ventral; right: dorsal); 14: right mandible, ventral; 15: left mandible, ventral; 16: left maxilla; 17: labium.



Figs 18-21. *Cloeon durani*, larva. 18: foreleg; 19: tarsal claw; 20: distal margin of fourth abdominal tergum; 21: paraproct.

proximal arc of about 8 thin setae; ventral and lateral margins with short and pointed setae; tibiopatellar suture present. Tarsi with only a few thin setae dorsally; ventral margin with one row of about 20 medium pointed and one row of about 10 short pointed setae; one row of short and pointed setae laterally; tarsal claws (Fig. 19) approximately 0.4x as long as tarsi, with 2 rows of about 15 teeth the proximal ones extremely reduced and the apical ones well-developed; subapical setae absent.

ABDOMEN. Coloration amber brown with two yellow sublateral spots more or less well defined; well developed on terga 4 and 5, smaller and more central on terga 6 to 8, fused on tergum 9, tergum 10 yellow; terga 4 and 5 generally with an additional brown central spot. Terga (Fig. 20) shagreened with scales bases and a few setae; posterior margin with pointed spines. Sterna without scale bases; posterior margin smooth, without spines. Lateral margin of abdominal segment 8 with 3 to 4 spines; lateral margin of abdominal segment 9 with 6 to 8 spines; other lateral margins without spines. Gills 1 to 6 with two lamellae, gill 7 single, tracheation dark brown. Paraproct (Fig. 21) with about 12 scale bases, sometimes scales also present, margin with about 25 spines, blunt except apical spines pointed; posterolateral

extension without scale bases, margin smooth with few spines. Cerci yellow with abundant thin setae on the inner margin in basal half, apical half extremely thin and without setae on inner margin, brown annulations every four segments; median caudal filament similar to cerci except thin setae on both margins.

Female imago

Length: body 4.4 to 6.7 mm (average length 5.8 mm); forewings 4.8 to 6.2 mm (average 5.8 mm); cerci >10.5 mm.

Coloration of head and thorax similar to *Cloeon smaeleni*.

THORAX. Forewings with costal and subcostal areas uniformly brown, subcosta darker than costa; veins and cross vein coppery brown, except cross veins of the costal and subcostal area hyaline; pterostigma with 3 cross-veins (Fig. 22). Legs uniformly light yellow.

ABDOMEN. Terga amber brown with a yellow broad longitudinal stripe, generally within a brown central interrupted line, coloration fading through the apex. Sterna uniformly yellow.

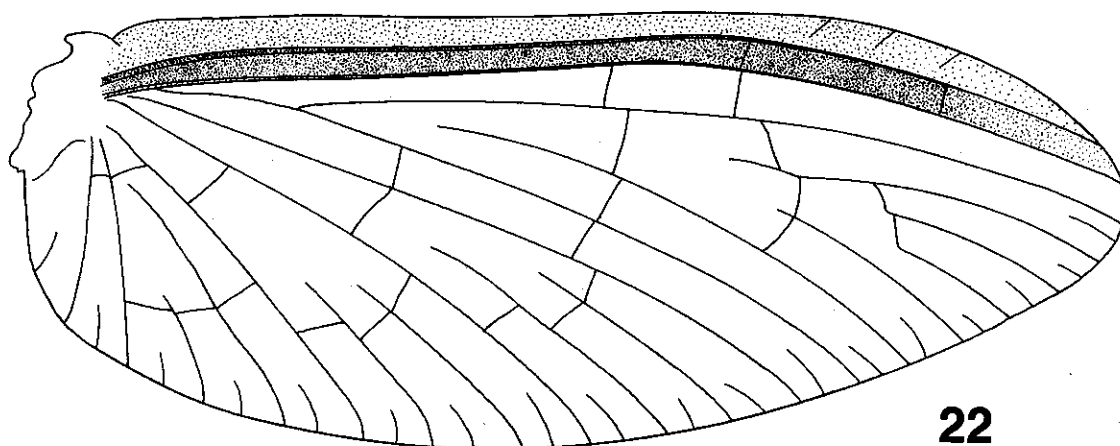


Fig. 22. *Cloeon durani*, forewing of female imago.

Male Imago

Length: body 4.4 to 5.9 mm (average length 5.4); forewings 4.7 to 6.2 mm (average length 5.6 mm); cerci >12.0 mm.

HEAD. Turbinate eyes honey brown. Eyes black in recently emerged specimens, gray with a black broad transverse stripe in older specimens. Antennae light brown except base of scape and pedicel yellow.

THORAX. Forewings hyaline without brown spot on costal brace; pterostigma with 3 cross-veins. Legs uniformly light yellow.

ABDOMEN. Terga amber brown with a yellow broad longitudinal stripe, terga 9 and 10 yellow.

GENITALIA similar to Fig. 12.

Material examined: ANTONGOMBATO bas., Antongombato riv., Namakia <49°14'37" E, 12°19'32" S> 20 m (P0836) 30.03.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 836a (on slide) and 18 larvae.

BETSIBOKA bas., 5km Ambohitrarabaha (near Antananarivo), 1250 m (P3003) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 3003a (on slide) and 2 larvae; Androhibe, Laboratoire LRSAE (near Antananarivo), 1250 m (P3021) 16.05.1997, 11 female and 3 male imagos; Antan-

drano (near Antananarivo), 1250 m (P3010) 04.06.1999, Z. Rabeantoandro, 1 female imago 3010a (on slide), 1 male imago 3010b (on slide) and 4 female imagos all with corresponding larval and subimaginal exuviae, 1 female and 1 male subimagos with corresponding larval exuviae; same data, but (P3011) 05.06.1999, 1 female subimago with corresponding larval exuviae and 5 larvae; same data, but (P3012) 06.06.1999, 2 female imagos with corresponding larval and subimaginal exuviae, 3 male subimagos with corresponding larval exuviae; same data, but (P3013) 07.06.1999, 1 male subimago with corresponding larval exuviae; same data, but (P3014) 08.06.1999, 2 female subimagos with corresponding larval exuviae and 11 larvae; same data, but (P3015) 09.06.1999, 1 female imago with corresponding larval and subimaginal exuviae and 5 larvae; same data, but (P3016) 10.06.1999, 1 female imago with corresponding larval and subimaginal exuviae and 1 larva; Antanetibe, rice fields (near Antananarivo), 1250 m (P3000) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 male larva 3000b (on slide) and 9 larvae; Lake Antanetibe (near Antananarivo), 1250 m (P3001) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 larva; Ikopa riv., Ankadindratombo <47°33'28" E, 18°55'48" S> 1255 m (P0056) 03.05.1991, ORSTOM (Antananarivo), 10 female imagos; Ikopa riv., Anosizato <47°29'55" E, 18°56'11" S> 1250 m (P0069) 28.05.1991, ORSTOM (Antananarivo), 3 female imagos; Ivato, Antanetibe (near Antananarivo) <47°28'09" E, 18°50'11" S> 1250 m (P0026) 28.03.1991, ORSTOM (Antananarivo), 30 female imagos; same data, but 05.05.1991 (P0059) 16 female and 15 male imagos, 7 female and 3 male subimagos; Lake Mahamamba (near Antananarivo), 1250 m (P3002) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 3002a (on slide) and 9 larvae. FIHERENANA bas., Voandelaka <44°35'03" E, 22°51'35" S> 530 m (P0134) 19.04.1993, ORSTOM (Antananarivo), 1 female larva 134a (on slide) and 9 larvae. MANAMPATRANA bas., Manambavana riv., Evato <47°41'18" E, 22°36'32" S> 45 m (P0440) 14.06.1995, M.R. Andriamihaja, 2 female imagos. MANDRARE bas., Marotoko riv., 2 km after Mananara <46°38'50" E, 24°44'02" S> 275 m (P0341) 03.06.1994, ORSTOM (Antananarivo), 2 female imagos; trib. of Abetolo riv., Esira <46°41'07" E, 24°18'00" S> 400 m (P0416) 28.04.1995, J.-M. Elouard and T. Pilaka, 1 male imago with corresponding larval and subimaginal exuviae, 1 male and 1 female subimagos with corresponding larval exuviae. ONILAHY bas., trib. of Ihazofotsy riv., Ambatofotsy (Horombe) <45°40'43" E, 22°30'49" S> 910 m (P0439) 01.06.1995, J.-M. Elouard, 1 female imago.

Cloeon emmanueli LUGO-ORTIZ & McCAFFERTY, 1998

Cloeon emmanueli LUGO-ORTIZ & McCAFFERTY, 1998, *Entomol. News* 109:3581 (terra typica: Nosy Be, Madagascar).

Larva

See LUGO-ORTIZ & McCAFFERTY (1998).

Female imago

Length: body 5.7 to 6.8 mm; forewings 6.1 to 6.5 mm; cerci >9.5 mm.

Coloration of head and thorax similar to *Cloeon smaeleni*

THORAX. Forewings with costal and subcostal areas brown, subcosta proximally darker and costa proximally lighter; cross veins of costal, subcostal and first radial interspaces bordered with a white opaque area; dark brown patch on the costal brace; other areas of forewing slightly pigmented; pterostigma with 2 cross-veins (Fig. 23). Forefemora brown with dark brown stripes apically and subapically, tibiae yellow with a proximal dark brown spot, tarsi yellow; middle and hindlegs similar, but faded.

ABDOMEN. Terga 1 and 2 amber brown, terga 3 and 4 yellow with lateral and distal margin amber brown, tergum 5 yellow, terga 6 to 8 yellow with an amber brown broad W-shaped mark, tergum 9 similar but W-shaped mark much faded, tergum 10 yellow anteriorly and amber brown posteriorly. Sterna yellow with a brown median longitudinal continuous stripe, stripe broader on sterna 7 to 9; all sterna proximolaterally with a brown spot.

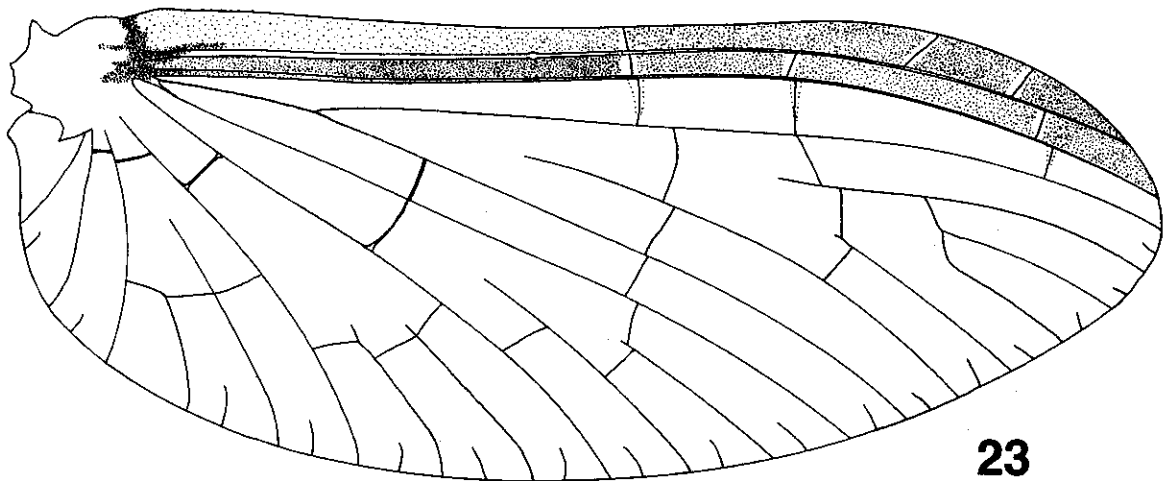


Fig. 23. *Cloeon emmanueli*, forewing of female imago.

Male imago

Unknown.

Material examined: ANTONGOMBATO bas., Lac Vert (Montagne d'Ambre) <49°10'36" E, 12°32'02" S> 1050 m (P0832) 27.03.1999, J.-L. Gattolliat and Z. Rabeantoandro, 10 larvae. BETSIBOKA bas., Antanetibe, rice fields (near Antananarivo), 1250 m (P3000) 16.04.1999, J.-L. Gattolliat and Z. Rabeantoandro, 1 female larva 3000c (on slide) and 2 larvae; Anosy Avaratra (near Antananarivo), 1250 m (P3006) 20.05.1999, Z. Rabeantoandro, 1 female subimago with corresponding larval exuviae; same data, but (P3007), 21.05.1999, 2 female imagos with corresponding larval and subimaginal exuviae; same data, but (P3008) 23.05.1999, 1 female imago with corresponding larval and subimaginal exuviae.

DISCUSSION

Many of the specimens collected around Antananarivo and from different regions of Madagascar clearly belong to *C. smaeleni*. In the imaginal stage the coloration of the female forewing (DEMOULIN 1957: Fig. 9, GILLIES 1980: Fig. 2) and the abdominal color pattern (GILLIES 1980: Fig. 13) and in the larval stage the labial palp, the segmentation of the maxillary palps (GILLIES 1980: Fig. 30) and the number of spines along the lateral margin of abdominal segments (GILLIES 1980: Fig. 19) are identical between the material collected in Madagascar and in Africa. These characters are considered diagnostic for identification of Afrotropical *Cloeon* (GILLIES 1980, 1985, 1988). As noted by GILLIES (1980), *Cloeon* is among the rare baetid genera for which the coloration of the abdomen and wings are reliable features to determine female imagos (and sometimes male imagos) to species.

With a broad labial palp and elongated tarsal claws with a double row of minute teeth, the larva of *C. smaeleni* differs notably from *C. durani* and *C. emmanueli*. The female of *C. smaeleni* can be easily distinguished by the color pattern of the abdominal terga and sterna and the coloration of costal and subcostal areas of the wing.

Cloeon smaeleni is one of the most widespread and common species in Afrotropical region. Its distribution includes the whole of Sub-saharan Africa (DEMOULIN 1970). GILLIES (1985) even mentioned four females from South Yemen. Ovoviviparity has been reported in four African species of *Cloeon*, among them *C. smaeleni* (GILLIES 1985). Ovoviviparity implies a relatively long imaginal stage. This biological element could have important implications in the wide distribution of this

species. The long imaginal stage may have allowed colonisation of Madagascar after its separation from Africa.

Cloeon smaeleni abounds in temporary ponds, rice fields, dams, slow moving streams and the margins of lakes (GILLIES 1980). In Madagascar, imagos are extremely abundant around rice fields, especially in May and June. They can be found frequently in houses quite far from wet areas, resting on walls.

Although the description of *C. durani* is succinct and the figure limited to the apical area of the forewing (NAVAS 1926), a part of the material collected can be assigned without doubt to this species. The coloration of the costal and subcostal areas and the tergal coloration are identical between our material and figure 14 in NAVAS (1926). Moreover, a great part of our material comes from the type locality (Antananarivo). Finally, contrary to what LUGO-ORTIZ & MCCAFFERTY (1998) stated, *C. durani* was not originally described from female sub imagos, but from female imagos. Consequently, we reinstate *C. durani* as a bona fide species.

Cloeon durani has been found in the same localities as *C. smaeleni*, but it is never as abundant.

In the larval stage, *C. durani* can be easily distinguished from other Malagasy and most African species by the highly developed teeth on the tarsal claws. The shape of the labial palp is similar to that of *C. emmanueli* and other African species such as *C. elevatum* AGNEW and *C. gambiae* GILLIES (AGNEW 1961; GILLIES 1980). The coloration of the abdomen and of the forewings of the female is also characteristic for this species.

DEMOULIN (1966) described *C. waterloti* from Antananarivo. This description was based on one single male imago. The male imagos obtained by rearing larvae of *C. durani* correspond exactly to the description of *C. waterloti*, indicating that *C. waterloti* is effectively a junior synonym of *C. durani*, as suggested by DEMOULIN (1966).

Cloeon emmanueli was originally described from the larval stage. It can be distinguished from *C. smaeleni* by the relatively narrow third segment of labial palp and from *C. durani* by the poorly developed teeth on the tarsal claws. The female imago is distinguished by the contrasting coloration of the abdomen and the forewing color: the costal and subcostal areas are brown and cross veins are bordered by white opaque areas (Fig. 23).

Cloeon emmanueli was first reported from Nosy Be Island (North-West of Madagascar). Our material comes from rice fields and pounds around Antananarivo and from a volcanic lake in the Nature Reserve of the Amber Mountain (North of Madagascar). It has been always found with *C. smaeleni*. Despite extensive sampling, very few larvae were caught. No imagos were found in house or light traps: all female imagos were obtained by rearing.

The description of *Cloeon cambouei* NAVAS, (1930) is rather succinct, the figure extremely rough and the measures of length unreliable. Moreover, there is no indication of the type locality other than Madagascar. Although this species may be a junior synonym of *C. durani*, there is insufficient data to consider the two species as synonyms. *C. durani* could just as easily be a senior synonym of *C. emmanueli*. At present, we concur with LUGO-ORTIZ & MCCAFFERTY (1980) and recognize *C. emmanueli* as a valid species and consider *C. cambouei* a *nomen dubium*.

The third species of Malagasy *Cloeon* described by NAVAS (1936), *C. irretitum*, clearly does not belong to the genus *Cloeon*. The abdominal coloration, the shape of the forewing, and the numerous cross veins of the pterostigma are conspicuously different from those of *Cloeon*. Except for unusual species, it is extremely difficult to determine baetid imagos to genus, so the generic assignment of *Cloeon irretitum* remains uncertain.

KEY TO LARVAE

- 1 Third segment of labial palp broad (Fig. 6); tarsal claws with two rows of minute teeth in basal third (Fig. 8); abdomen coloration generally well contrasted.....*Cloeon smaeleni* LESTAGE
- Third segment of labial palp narrow (Fig. 17); tarsal claws with two rows teeth in at least basal half (Fig. 19); abdomen coloration almost uniform.....2
- 2 Tarsal claws with two rows of well developed teeth (Fig. 17); right mandible with well developed tuft of setae between prostheca and mola, reaching the mola (Figs 14, 15).....*Cloeon durani* NAVAS
- Tarsal claws with two rows of poorly developed teeth; right mandible with tuft of setae between prostheca and mola less developed, not reaching the mola.....*Cloeon emmanueli* LUGO-ORTIZ & MCCAFFERTY

KEY TO FEMALE IMAGOS

- 1 Abdominal terga amber brown with a yellow broad longitudinal stripe, generally within a brown median interrupted line; abdominal sterna uniformly yellow.....*Cloeon durani* NAVAS
- Abdominal terga and sterna yellow with well marked brown pattern..... 2
- 2 Costal and subcostal areas of forewing brown with cross veins bordered with opaque white (Fig. 23); abdominal terga 6 to 9 yellow with a amber brown broad W- shaped mark, sterna yellow with a brown median longitudinal continuous stripe.....*Cloeon emmanueli* LUGO-ORTIZ & MCCAFFERTY
- Costal and subcostal areas of forewing brown with dark brown and hyaline markings (Fig. 11), color spreading distally into the first radial interspace; abdominal terga yellow with a symmetrical dark red brown λ -shaped mark, laterally; sterna yellow with a brown median longitudinal interrupted strip.....*Cloeon smaeleni* LESTAGE

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REFERENCES

- DEMOULIN, G. 1970. Ephemeroptera des faunes Ethiopiennes et malgaches. *S. Afr. Anim. Life* 14: 24-170.
- GILLIES, M.T. 1979. *Cloeon pusillum* NAVAS, a species of *Afrobaetodes* DEMOULIN (Ephemeroptera: Baetidae). *Ent. mon. Mag.* 114: 153-154.
- GILLIES, M.T. 1980. An introduction to the study of *Cloeon* LEACH (Baetidae, Ephemeroptera) in West Africa. *Bulletin I.F.A.N.* 42A: 135-156.
- GILLIES, M.T. 1985. A preliminary account of the East African species of *Cloeon* LEACH and *Rhithrocloeon* gen. n. (Ephemeroptera). *Aquatic Insects* 7: 1-17.
- GILLIES, M.T. 1988. Descriptions of the nymphs of some Afrotropical Baetidae (Ephemeroptera). I. *Cloeon* LEACH and *Rhithrocloeon* GILLIES. *Aquatic Insects* 11: 49-59.
- GILLIES, M.T. 1990. A new genus for the Afrotropical mayfly, *Cloeon dentatum* KIMMINS (Ephemeroptera: Baetidae). *Ent. mon. Mag.* 126: 207-208.
- GILLIES, M.T. 1997. A new species of *Procloeon* BENGTTSSON from the forest zone of West Africa (Ephem., Baetidae). *Entom. mon. Mag.* 133: 247-250.
- LUGO-ORTIZ C.R. & McCAFFERTY W.P. 1998. New species of *Cloeon* and *Demoulinia* (Ephemeroptera: Baetidae) from Madagascar. *Entomol. News* 109: 357-362.
- NAVAS, L. 1926. Algunos insectos del Museo de Paris (3a serie). *Broteria, Zool.* 23: 95-115.
- NAVAS, L. 1930. Insectos del Museo de Paris (VIa serie). *Broteria, Zool.* 26: 120-144.
- NAVAS, L. 1936. Comunicaciones entomologicas. 19. Insectos de Madagascar. 3a Serie. *Rev. Acad. Ci. exactas, fisico-quimicas y naturales de Zaragoza* 19 (1935): 100-110.
- ULMER, G. 1909. Ephemeriden von Madagaskar und den Comoren. *Voelzkow's Reise in Ostafrika, 1903-1905* II: 365-368.

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