

***Radima edmundsorum*, a new genus and species of Atalophlebiinae from Madagascar (Ephemeroptera: Leptophlebiidae)**

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**Abstract**

*Radima edmundsorum*, a new genus and species of Leptophlebiidae (Atalophlebiinae), is described from the male imago, female imago, and nymph from Madagascar.

**Keywords:** Leptophlebiidae, Atalophlebiinae, taxonomy, Madagascar, freshwater.

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**Introduction**

The streams and rivers of Madagascar include a highly diversified fauna of Leptophlebiidae (Atalophlebiinae) and most genera are endemic to the island. However, much of this diversity has yet to be described. To date, the major taxonomic papers include Peters and Edmunds (1964) for *Nesophlebia*, Demoulin (1966, 1969) for "*Ulmerophlebia?*", Demoulin (1973) for *Petersophlebia* and *Polythelais*, and the recent publication on spatial distribution of aquatic insects by Gibon *et al.* (1996).

The Ephemeroptera collection at Florida A&M University has received several leptophlebiid collections from Madagascar. The largest of these was made by Dr. and Mrs. George F. Edmunds, Jr. and F. Emmanuel in 1971 under a grant from the National Science Foundation, U.S.A. A second large collection from Dr. J. Fontaine (Lyons, France) includes material from the Verrier Collection made by various collectors in the 1940's and 1950's (R. Paulian, P. Griveaud, P. A. Robinson and P. Soga) and from Dr. F. Starmühlner in 1958.

In this paper, we describe *Radima edmundsorum*, a new genus and species from Madagascar based on reared material from these collections. Methods, terms and procedures used in this series are previously discussed by Peters *et al.* (1978, 1996). Foreleg ratios are calculated by comparing the length of other segments to that of the tibia (length of tibia given in parentheses).

The abbreviations for collections in which specimens are deposited are: FAMU, Florida A&M University; MNHN, Muséum National d'Histoire Naturelle, Paris; and MCZL, Musée Cantonal de Zoologie, Lausanne.

***Radima* new genus**  
(Figs. 1-3)

**Imago.** Length of ♂: body 8.2-10.0 mm; forewings 8.0-10.3 mm; length of ♀: body 7.4-8.9 mm; forewings 8.9 mm. Eyes of ♂ meet on meson of head as in Fig. 2E, dorsally upper portion circular-shaped, lateral margin of upper portion congruent with lower portion, medial and posterior margins of upper portion on short stalk, lower portion of eyes ½ length of upper portion; eyes of ♀ separated on meson of head by a distance 3-4 times maximum width of an eye. Wings (Fig. 2A-D): maximum width of forewings a little less than 1/3 maximum length of forewings; vein Rs of forewings forked a little less

than 1/4 of distance from base to margin; vein MA forked about 1/2 of distance from base to margin, fork symmetrical; vein MP<sub>2</sub> attached at base to veins MP<sub>1</sub> and CuA with a cross vein (Fig. 2A), attachment of vein MP<sub>2</sub> to MP<sub>1</sub> a little more than 1/4 of distance from base to margin, base of vein MP<sub>2</sub> nearer to vein CuA than vein MP<sub>1</sub>; vein ICu attached at base to vein CuA with a cross vein, remainder of CuA area as in Fig. 2A,D; cross veins numerous. Costal projection of hind wings broadly developed, apex located less than 1/2 distance from base to margin, apex rounded; apex of wings acute, rounded; cross veins few (Fig. 2B-C). Legs: ratios of segments in ♂ forelegs, 0.55: 1.00 (3.95-4.02 mm); 0.04-0.05; 0.46-0.47; 0.44-0.45; 0.30-0.31; 0.09-0.11. Claws of a pair dissimilar, one apically hooked (Fig. 2G), other obtuse, pad-like. Male genitalia (Fig. 2F): segment 2 of forceps a little longer than segment 3, segment 2 of forceps 1/5 length of segment 1, apex of segment 3 blunt, segmentation of forceps segments incomplete; base of forceps broad, its inner margin forming an angular bend near middle of forceps; length of styliger plate along median line a little less than 1/3 maximum width; penes fused, apical half slender, flat, apex rounded, basal half broad, bulbous (Fig. 2F); duct openings on dorsal surface. Ninth sternum of ♀ entire apically, acute (Fig. 2H); sternum 7 broadly rounded. Terminal filament a little longer than cerci.

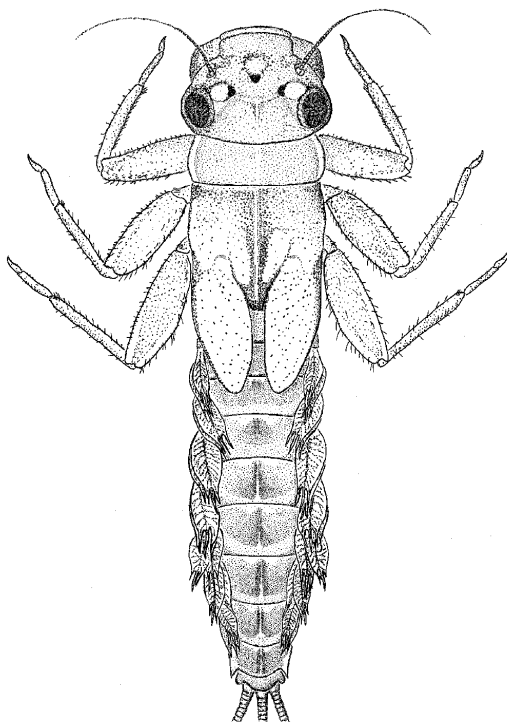


Fig. 1 - Mature female nymph of *Radima edmundsorum* n. sp.

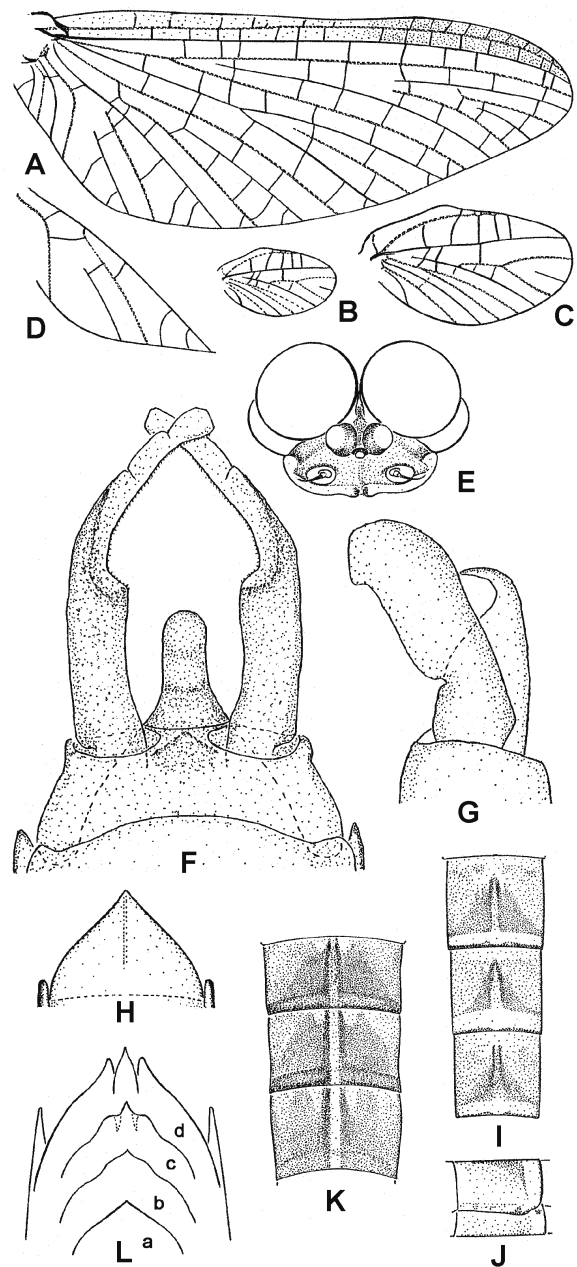


Fig. 2A-H - Imagos of *Radima edmundsorum* n. sp.: A, forewing (♂); B-C, hind wing (♂, enlarged in Fig. C); D, variation in cubital area (♀); E, head (♂); F, genitalia (♂, ventral view); G, foreclaw (♂); H, apex of 9<sup>th</sup> sternum (♀); I, terga 5-7 (♂); J, lateral view of abdominal segment 6 (♂); K, terga 5-7 (♀). Fig. 2L. Developmental changes of sternum 9 from partially grown (a) to pre-emergent ♂ nymph (d).

**Mature nymph.** Head prognathous. Antennae 2 1/2 times maximum length of head. Mouthparts (Fig. 3D-K): dorsal hair on labrum as in Fig. 3G, submedian areas of hair ventrally; anteromedian emargination with 5 small, rounded denticles (Fig. 3H). Clypeus as in Fig. 3G. Left mandible as in Fig. 3E. Lingua of hypopharynx with well-developed lateral processes, apex of submedian

lobes with short hair, anterior margin of lingua cleft; superlinguae as in Fig. 3D, with a row of hair along anterior margin, lateral margins rounded. Segment 2 of maxillary palpi a little longer than length of segment 1; segment 3 of palpi a little less than 3/4 length of segment 2, triangular; hair on maxillae as in Fig. 3I. Labium as in Fig. 3J-K; glossae curved over ventral to paraglossae; segment 2 of palpi a little longer than segment 1, segment 3 a little more than 1/2 to less than 3/5 length of segment 2. Legs (Fig. 3A, B): outer margin of femora with small indentation near apex so tibiae can draw partially into femora; tibiae and tarsi oval in cross section; apex of claws hooked and narrow, denticles on claws progressively larger apically (Fig. 3B). Gills (Fig. 3C): gills on segments 1-7 alike; dorsal and ventral portions of lamellae plate-like, terminated in 3 processes with median projection longer and narrower than laterals; main trunk of tracheae along median line of lamellae, tracheal branches present; main trunk of tracheae and lamellae darkly pigmented. Posterior margins of terga 1-10 with small spines (spinules). Posterolateral spines on abdominal segments 3, 4, or 5-9, spines progressively larger posteriorly. Ninth sternum acute (Fig. 2L). Terminal filament longer than cerci.

**Etymology.** *Radima*, an arbitrary combination of letters inspired by the name of former members of the royal family of Madagascar. Feminine.

**Type species.** *Radima edmundsorum*, new species.

**Species included.** *Radima edmundsorum*, new species.

**Discussion.** *Radima* can be distinguished from all genera of the Leptophlebiidae by the following combination of characters. In the imago: (1) base of vein  $MP_2$  of forewings is closer to vein  $CuA$  than vein  $MP_1$  (Fig. 2A); (2) costal projection of hind wings is broadly developed and apex is located less than 1/2 distance from base to margin (Fig. 2B, C); (3) claws of a pair are dissimilar; one is apically hooked, other is obtuse, pad-like (Fig. 2G); (4) penes are fused to apex; apical half is slender and flat with dorsal duct openings and basal half is broad as in Fig. 2F; and (5) 9<sup>th</sup> sternum of ♀ is entire and acute (Fig. 2H). In the nymph: (1) width of clypeus is subequal to width of labrum (Fig. 3G); (2) glossae are curved over ventral to paraglossae (Fig. 3J); (3) denticles on

claws are progressively larger apically (Fig. 3B); (4) abdominal gills are plate-like with both dorsal and ventral portions terminated in 3 processes and median projection longer and narrower than laterals (Fig. 3C); and (5) apex of developing 9<sup>th</sup> sternum is acutely pointed (Fig. 2L).

*Radima* appears most closely related to described genera from Madagascar (*Polythelais* and *Petersophlebia*) based on the derived, fused penes. This character is used with caution because imaginal characters of *Polythelais* and *Petersophlebia* are extracted from mature nymphs (Demoulin, 1973), and details are not present. *Radima* can be distinguished from *Polythelais* and *Petersophlebia* in the nymph by the following characters: (1) labrum subequal in width to clypeus (Fig. 3G); (2) mandible smoothly curved (Fig. 3E); and (3) dorsal and ventral portions of gill lamellae plate-like, terminated in 3 processes with median projection longer and narrower than laterals (Fig. 3C).

Relationships of *Radima* to genera outside Madagascar are not clear. Although *Radima* resembles the *Penaphlebia* lineage defined by Pescador and Peters (1979) based on plesiomorphies, no apomorphies tie the groups together. In fact, characters originally suggested as apomorphies in the *Penaphlebia* lineage by Pescador and Peters (1979) (pectinate spines on the inner margin of second segment of maxillary palpi, and presence of spines and long setae on posterior margins of abdominal terga) proved inconsistent as species revisions were completed (Pescador and Peters, 1990, 1991). The lack of recognized apomorphies is widespread in the Southern Hemisphere and in Madagascar, as in Australia, a majority of Leptophlebiidae are undescribed and attempts to assess relationships are problematic (Dean, 2000).

***Radima edmundsorum* new species**  
(Figs. 1-3)

**Male imago** (in alcohol). Upper portion of eyes light red-brown, lower portion dark blackish-brown. Head light yellowish-brown, carinae blackish-brown. Antennae light yellowish-brown, flagellum paler. Thorax yellowish-brown, mesonotum darker, sutures paler; anterior, lateral and median line of prothorax edged in blackish-brown. Legs: prothoracic legs brown; meso- and metathoracic legs yellowish-brown, tarsi darker. Wings (Fig. 2A-D): longitudinal and cross veins of fore- and hind wings brown; membrane hyaline with pale tan tint, except cells C and Sc of

forewings light brown, apical 1/3 of cells C and Sc of forewings translucent, membrane at base of fore- and hind wings light brown. Abdomen: yellowish-brown; a dark blackish-brown, narrow, transverse band on posterior margin of terga 1-7, band darker on posterolateral corners, band faded on terga 6 and 7; paired, longitudinal submedian dark blackish-brown lines on terga 1-8 (Fig. 2I,J), brown triangular marks lateral to median lines broader posteriorly; terga 8-10 with similar markings but darker and indistinct; spiracles yellowish-brown, tracheae lightly washed with grayish-brown; sterna yellowish-brown, sterna 8-9 a little browner. Genitalia (Fig. 2F): apex of forceps whitish, base of forceps and styliiger plate dark brown; penes dark at base, whitish at apex. Caudal filaments light yellowish-brown, annulations brown.

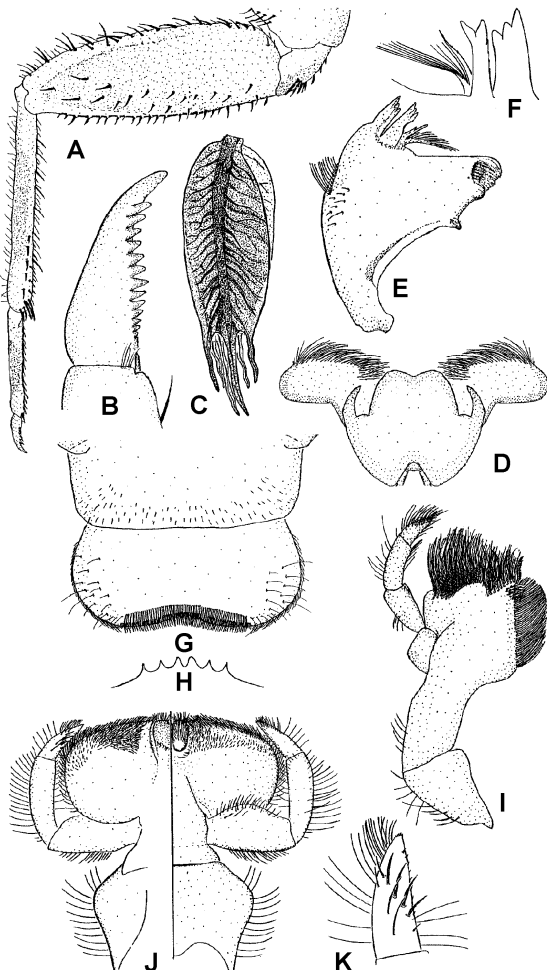


Fig. 3 - Nymph of *Radima edmundsorum* n. sp.: A, foreleg; B, foreclaw; C, gill 4; D, hypopharynx; E, left mandible; F, detail of incisors of right mandible; G, labrum and clypeus; H, enlargement of anteromedian emargination of labrum; I, maxilla (ventral); J, labium (dorsum on left, venter on right); K, dorsal detail of 3<sup>rd</sup> segment of labial palp.

**Female imago** (in alcohol). Head and thorax as in ♂, except posterior margin of head edged in blackish-brown; prolegs broken off and missing, meso- and metathoracic legs as in ♂ except a little darker. Wings as in ♂ (see discussion) except color membrane with a richer yellowish-brown tint in membrane and cells C and Sc. Abdominal terga and sterna as in ♂ except darker (Fig. 2K); caudal filaments missing.

**Subimagos.** Characters of imagos, except ♂ forelegs and genitalia not expanded. Wings grayish-brown with darker clouds around cross veins.

**Mature nymph** (in alcohol). Head: light brown, except blackish-brown pattern on vertex of head as in Fig. 1. Thorax: yellowish-brown, with darker marks as in ♂ and ♀ imago, base of fore- and hind wing pads browner. Legs: yellowish-brown to brown: femora with median areas a little paler, especially on mesothoracic legs; tibiae and tarsi with brown medial bands (Fig. 3A). Abdomen: color and marks as in imago (Fig. 1). Gills: (Fig. 3C): membrane gray, darker near middle; main trunk of tracheae light grayish-black, faded apically. Caudal filaments yellowish-brown.

**Etymology.** Species is named in honor of Dr. G. F. Edmunds, Jr. and Mrs. C. H. Edmunds, University of Utah.

**Material.** Locality labels are in several formats by many collectors. Additional or supplementary data (in italics) are from Viette (1991). When available, coordinates have been added from maps furnished by the collector (Edmunds) or from the U.S. Board on Geographic Names (1955).

Holotype ♂ imago, MADAGASCAR (Malagasy Republic): Pr. Tamatava, Anevoka Riv., 15 km E Perinet (=Andasibe), 16°C, 11-X-1971, G. F. & C. H. Edmunds, F. Emmanuel.

Allotype ♀ imago, Sahamaloto, 9-I-1949, P.C. [*Madagascar Est, S.-P. de Moramanga, région de Perinet, P. Cachan*].

Paratypes: 1 ♂ subimago, 2 nymphs, same data as holotype; 1 ♂ subimago (reared), 24 nymphs, Pr. Tamatava, Amboasary Riv., Perinet (=Andasibe), 13-X-1971, 18°56' S, 48°25' E; 3 ♂ subimagos, 5 nymphs, same data except 12-X-1971; 2 nymphs, Pr. Tamatava, 1 Amboasary Riv. 5 km E Perinet (=Andasibe), 10-X-1971; all above specimens collected by G. F. & C. H. Edmunds, F. Emmanuel; 1 ♂, Italaviana, N.O. Fanavana, VI-1956, P.G. [*Madagascar Est, S.P. de Moramanga,*

au N.-O. de Fanovana, chemin de fer Tananarive-Tamatava (forêt de la Compagnie coloniale), 730 m, P. Griveaud]; 1 ♀, Sandrangato (Cascade), Inst. Scient. Madagascar, 54 km Route Anosibe, Dis [S.-P.] Moramanga [Madagascar Est], IX-1953, J. Millot; 1 ♀, forêt nord de Anosibe, I-1951, no collector given [Madagascar Est, S.-P. de Moramanga, route d'Anosibe, nombreuses stations].

All types are in alcohol. Association of the nymph and ♂ adult is by rearing, and the ♀ is associated by color pattern and shape of the 9<sup>th</sup> sternum. All types are deposited in the following collections: holotype, allotype, 3 ♂ subimago and 12 nymphal paratypes at FAMU; 1 ♀, 1 ♂ subimago, and 9 nymphal paratypes at MNHN; 1 ♂, 1 ♀, 1 ♂ subimago and 10 nymphal paratypes at MCZL.

**Discussion.** Base color of imagos varies from light yellowish-brown to brown, and markings from grayish-brown to almost black, with darker coloration generally on smaller specimens. One variation in the wing is illustrated (Fig. 2D) for the right wing of the allotype, a smaller darker female, where an extra cross vein extends from the base of CuA<sub>2</sub> to CuP although the left wing of the specimen has the same cubital venation as the male. This variation occurs on wings of two other females not included in the type series. The apex of sternum 9 of one of these females from the Amboasary River, Perinet, is not as acute as that illustrated in Fig. 2H. Additional records for the genus include: Mt. d'Ambre, XII-1948, R. Paulian; Madagascar Est, det Sambava, Réserve nat. N° 12 Marojejy-Andrakata, II-1959, P. Soga; La Mandraka, X-1956, P. A. Robinson [Madagascar Centre, S.-P. de Manjakandriana] and the following collected by G. F. & C. H. Edmunds, F. Emmanuel: Pr. Tananarive, stream at Mandraka, 19-X-1971, 18°55' S, 47°56' E. Pr. Tananarive, Ankeniheny Riv. 4 km S Manjakatempo Forest Stn, 1-XI-1971, [approximate coordinates 19°19' S, 47°25' E]; Prov. Fianarantsoa (South), Tsaratango Riv., 9 km E Ranomafana, 6-XI-1971, 21°17' S, 47°32' E. The material from La Mandraka differs from *R. edmundsorum* only in minor details of color pattern and is probably the same species.

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