



<http://dx.doi.org/10.11646/zootaxa.3745.5.6>

<http://zoobank.org/urn:lsid:zoobank.org:pub:6C0F2375-365B-42C2-98B6-34C399BC91F0>

Notes on the genus *Libellulosoma* Martin, 1906, and related genera (Odonata: Anisoptera: Corduliidae)

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Abstract

The holotype of *Libellulosoma minuta*, until now regarded as the unique specimen of this monotypic genus and considered lost for half a century, was found again in the dragonfly collection of the Muséum National d'Histoire Naturelle in Paris. A second specimen, also from Madagascar (probably East Madagascar) was found in the collection René Martin together with the holotype. A redescription, including the structure of the secondary copulatory apparatus, is provided. The genus *Libellulosoma* is closely related to the genera *Pentathemis* and *Aeschnosoma*, and its membership in the clade Aeschnosomata is well supported. Evidence from biogeography, the fossil record, and phylogeny indicates that this group, possible sister group of remaining Corduliidae s.s., was probably already present in the Early Cretaceous.

Key words: *Libellulosoma minuta*, *Pentathemis*, *Aeschnosoma*, Aeschnosomata, Madagascar, dragonfly, phylogeny, biogeography

Introduction

Libellulosoma minuta Martin, 1906, the only known species of the genus, is an enigmatic and particularly poorly known taxon. Firstly, literature relating to the species is extremely limited, with only three publications so far: Martin (1906) provided the original diagnosis and description, Fraser (1956) essentially recapitulated Martin's work, and Pinhey (1962) provided putative generic characters, some of them erroneous or ambiguous (see remarks below). Secondly, the female and larva are unknown. The publication by Martin implies that the description is based on a single male specimen designated by the author as the type “[**L. minuta**] nov. spec. (fig. 76, 77). (Planche II, fig. II.) type ♂, coll. R. Martin”; Fraser (1956) stated clearly that the type is the sole known specimen and claimed that it could not be found in the collections of the Muséum National d'Histoire Naturelle in Paris (MNHN), and considered it as lost (“Le TYPE, seul exemplaire connu de cette intéressante espèce figurait dans les collections du Muséum de Paris, mais n'a pu être retrouvé et a sans doute été perdu.”); Pinhey (1962) does not mention the presence of additional material and indicates simply “Type ♂ in Paris Mus.”. Thirdly, the species, which was apparently never collected again in more than a century, was reported from Madagascar without further information, and the exact locality and habitat remain completely unknown (Martin 1906; Fraser 1956; Pinhey 1962; Fig. 1a). This caused Fraser (1956) to question the status of Madagascar as its *terra typica*, suggesting a possible mislabelling and a South American origin for *Libellulosoma minuta*, since the species seems morphologically extremely close to some *Aeschnosoma* species.

After more than a half century during which it was apparently lost, we rediscovered the type of *Libellulosoma minuta* in Martin's Odonata collection housed in the MNHN. Unexpectedly, in the same box we found also a second male of this interesting species. This specimen was probably known to Martin but never mentioned, since the figure of the wings published in the original description is of this second specimen, and since the figured anal appendages possibly also belong to it (the last abdominal segments of the holotype are somewhat compressed laterally with the anal appendages slightly deformed). Furthermore, the second specimen seems to have been apparently labelled by the same hand (that of Martin?) as that of the holotype. The label is inscribed “E. Madagascar” (Fig. 1b), probably for “East Madagascar” and thus narrows down the possible site of the type

* Polarization of characters is determined from direct observations on various outgroup taxa [Libellulidae (*Libellula quadrimaculata*, *Crocothemis erythraea*, *Orthetrum brunneum*), Synthemistidae (sensu Fleck; see Fleck & El Adouzi 2013) (*Gomphomacromia paradoxa*, *Synthemis serendipita*, *Eusynthemis nigra*), Macromiidae (*Macromia splendens*), Corduliidae s.s. (*Cordulia aenea*, *Somatochlora alpestris*, *Hemicordulia asiatica*), basal “Corduliidae” (*Lauiromacromia dubitalis*, *Oxygastra curtisii*, *Idomacromia proavita*)] and using relevant literature (Garrison *et al.* 2006; Pfau 2011; Theischinger & Watson 1978; etc.).

** Many Libellulidae do not have a bilobed hamulus, and the urothemistines considered by some authors as sister group of the “true” Libellulidae have a simple hamulus very similar to that of Corduliidae s.s. (except Aeschnosomata) and Macromiidae (a simple leaflike, backward-directed and pointed hamulus seems to be in the ground plan of Corduliidae s.s. + Libellulidae). Thus a bilobed hamulus is probably not in the ground plan of Libellulidae and appeared by convergence in some Libellulidae and Aeschnosomata. Furthermore the lobes are not homologous. In Aeschnosomata the *lobus interioris* (sensu Lieftinck 1970) is clearly a median lobe (sensu Garrison *et al.* 2006), primitively strongly erected perpendicular to the longitudinal axis or forward directed and wearing a well-developed brush of long and robust setae, whereas in Libellulidae it is the posterior base of the inner lobe (sensu Garrison *et al.* 2006), clearly becoming more and more specialised until becoming a distinct outer lobe (sensu Garrison *et al.* 2006).

Estimated age of Corduliidae s.s.

The Aeschnosomata have a disjunct Gondwanan distribution, occurring in northern Australia (*Pentathemis*), Madagascar (*Libellulosoma*) and northern South America (*Aeschnosoma*). Madagascar has occupied its present position relative to Africa since the Early Cretaceous, about 120–130 Ma (Rabinowitz *et al.* 1983; Rabinowitz & Woods 2006), and the India-Madagascar continent began its separation from Antarctica-Australia also during the Early Cretaceous (about 120 Ma), making biogeographic connections more and more tenuous and became completely isolated during late Early Cretaceous (about 100 Ma) (Chatterjee & Scotese 1999; 2010). The long isolation of the India-Madagascar continent, the fact that the Aeschnosomata are the probable sister group of the remaining Corduliidae s.s. (Fleck 2012), and the fact that the true Libellulidae, sister group of the Corduliidae s.s., are dated from Turonian (early Upper Cretaceous, ca 90 Ma) (Fleck *et al.* 1999), strongly suggest that the Corduliidae s.s. (see Bechly 1996; Fleck 2012), at least the Aeschnosomata, were already present in the late Early Cretaceous.

Fleck & Legrand (2006) consider *Nesocordulia* from Madagascar and *Idomacromia* from Central Africa as sister genera. This old group of “Corduliidae” of forest-dependent species with limited dispersal powers occupies a more basal phylogenetic position than Corduliidae s.s. and is supposed to have been already present in the Early Cretaceous, at least 120–130 Ma. This is supported by fossil records such as *Juracordulia* from Germany, considered sister taxa of remaining Eurypalpida (Bechly 1998), and dated from the uppermost Jurassic (Tithonian, ca 151–145 Ma). All these ages are compatible with an emergence of Corduliidae s.s. during the Early Cretaceous.

Acknowledgments

GF thanks the Queensland Parks and Wildlife Service (Australia) for a Scientific Purposes Permit which has allowed him to collect *Pentathemis membranulata*, a rare species essential for this study. A.G. Orr (Australia) improved the language.

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