



Taxonomy and nomenclature of some mainland SE-Asian *Coeliccia* species (Odonata, Platycnemididae) using micro-CT analysis

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Abstract

The taxonomic status of some mainland Southeast Asian *Coeliccia* species is evaluated. The following synonymies are presented: *C. acco* is a junior synonym of *C. pyriformis*; *C. tomokunii* that of *C. scutellum*; *C. onoi* that of *C. cyanomelas*. *C. scutellum hainanense* is promoted to species level, *C. hainanense*. Redescriptions of the holotype of *C. pyriformis* and of the lectotypes of *C. scutellum* and *C. hainanense* are presented with illustrations. The male genital ligulae were examined by means of non-destructive X-ray micro-computed tomography (micro-CT) and subsequent 3D-reconstruction. The advantage of virtual types generated by micro-CT analysis, particularly for the examination of internal structures, is discussed.

Key words: *Coeliccia scutellum*, *hainanense*, *tomokunii*, *acco*, *pyriformis*, *cyanomelas*, *onoi*, new synonymy, new status, Micro-Computed Tomography Analysis, micro-CT, cybertype

Introduction

The genus *Coeliccia* Kirby, 1890, is the largest within the family Platycnemididae, comprising over 60 known species (Schorr & Paulson 2013). Species of the genus occur from Japan in the east to India in the west and southwards to Java. Since the last revision of the genus (Laidlaw 1932), which considered 27 species and one subspecies, more than 30 species have been described (e.g. Lieftinck 1940, Asahina 1984, 1997, Xu 2006, Do 2007, 2009). Among those are some synonyms, e.g. *Coeliccia megumii* Asahina, 1984, was recently placed in synonymy with *Coeliccia kazukoae* Asahina, 1984 (Kosterin 2011, see supplementary table 1 for a list of actual and potential synonyms). Recently Dow (2010) revised the *Coeliccia borneensis*-group of species from Borneo, and Steinhoff & Do (2013) reviewed four Vietnamese *Coeliccia* species. However, the status of many other species in the genus still remains unclear, particularly since some descriptions and drawings of *Coeliccia* species are of inadequate quality for reliable identification (cf. Asahina 1997). Recent morphological and genetic analyses suggest a paraphyly of the genus *Coeliccia* (Gassmann 2004, Dijkstra *et al.* 2014). Consequently, detailed redescription and illustration of the species are a prerequisite of a future comprehensive revision.

Here, we review the taxonomic status of some *Coeliccia* species that occur in mainland Southeast Asia and that have been described from Vietnam and southern China. Since the type specimens of the species described by Asahina (1997) from Vietnam are not accessible and may be lost, our re-evaluation is based on the original descriptions and on the investigation of specimens collected later at the type localities or at nearby sites. For those cases for which type specimens are available, we applied X-ray micro-computed tomography (micro-CT) to inspect and illustrate the shape of the male genital ligulae. This approach pays tribute to the uniqueness of the holotype and the often very small number of paratypes by avoiding the extraction of the ligulae from the abdomens (cf. Orr and Hämäläinen 2013). Micro-CT has enhanced research on insect anatomy considerably since it offers a non-destructive way of scrutinizing and visualizing internal morphological characters (e.g. Beutel & Friedrich 2008, Friedrich *et al.* 2013). Micro-CT has been used for anatomical and phylogenetic research on Odonata (e.g. Blanke *et al.* 2012, 2013, 2015 Büsse *et al.* 2013, 2015, Büsse & Hörschemeyer 2013, McPeck *et al.* 2010,