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Inocellia rara sp. nov. (Raphidioptera: Inocelliidae), a new snakefly species from Taiwan, with remarks on systematics and biogeography of the Inocelliidae of the island

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Abstract

A new species of the snakefly genus *Inocellia* Schneider, 1843 from Taiwan is described: *Inocellia rara* **sp. nov.** It represents the third species in the family Inocelliidae and the first record of the *Inocellia fulvostigmata* species group from Taiwan.

Key words: snakefly, *Inocellia*, new species, Taiwan, China

Introduction

The Inocelliidae is one of the two families of the endopterygotan insect order Raphidioptera (commonly known as snakeflies), which is one of the smallest insect orders comprising altogether about 240 valid species. Hitherto, there were 39 valid species of Inocelliidae in the world (H. Aspöck *et al.* 2012; Liu *et al.* 2012a, 2012b; H. Aspöck & U. Aspöck 2013; Liu *et al.* 2013). It is remarkable that 17 of the species, which represent ~45% of the world's Inocelliidae, were discovered and described in the past five years, and all of them come from China and Thailand (U. Aspöck *et al.* 2011; Liu *et al.* 2009a, 2009b, 2010b, 2010c, 2012a, 2012b). This indicates the presence of a diverse fauna of this family in East and Southeast Asia. Taiwan is the largest island of China and harbours six endemic species of Raphidioptera (H. Aspöck & U. Aspöck 1985; U. Aspöck *et al.* 2009; Liu *et al.* 2010a), among which only two species belong to Inocelliidae, namely *Inocellia taiwana* H. Aspöck & U. Aspöck, 1985 and *Inocellia shinohara* U. Aspöck, Liu & H. Aspöck, 2009. These two species belong to the *Inocellia crassicornis* species group, in which the male gonocoxite 9 is wider than long, and they are distributed in adjacent localities of Nantou County, central Taiwan. In the present paper, we describe a new inocelliid species based on a single specimen collected in northern Taiwan in the early 1940s. This new species is the third endemic species of Inocelliidae from Taiwan and represents the first record of *Inocellia fulvostigmata* species group in this island.

Material and methods

The type specimen of the presently described new species is deposited in the National Institute for Agro-Environmental Sciences, Tsukuba, Japan (NIAES). Genitalic preparations were made by clearing the apex of the abdomen in a cold saturated KOH solution for 6–8 h. After rinsing the KOH with acetic acid and water, the apex of the abdomen was transferred to glycerin for further dissection and examination. The terminology of the genitalia generally follows that of H. Aspöck *et al.* (1991) and U. Aspöck and H. Aspöck (2008).

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The species of the *fulvostigmata* group have so far only been found in the mainland of Asia, namely in Afghanistan, Pakistan, India (Kashmir), Bhutan, northern Thailand, and eastern parts of China: *Inocellia fulvostigmata fulvostigmata* U. Aspöck & H. Aspöck, 1968 (Afghanistan, Pakistan, Kashmir), *I. fulvostigmata nigrostigmata* H. Aspöck, U. Aspöck & Rausch, 1982 (Kashmir), *I. bhutana* H. Aspöck, U. Aspöck & Rausch, 1991 (Bhutan), *I. bilobata* U. Aspöck, Liu, Rausch & H. Aspöck, 2011 (northern Thailand), *I. cornuta* U. Aspöck, Liu, Rausch & H. Aspöck, 2011 (northern Thailand), *I. longispina* U. Aspöck, Liu, Rausch & H. Aspöck, 2011 (northern Thailand), *I. striata* U. Aspöck, Liu, Rausch & H. Aspöck, 2011 (northern Thailand), *I. cheni* Liu, H. Aspöck, Yang & U. Aspöck, 2010 (southern China), *I. hainanica* Liu, H. Aspöck, Bi & U. Aspöck, 2013 (southern China), *I. hamata* Liu, H. Aspöck, Yang & U. Aspöck, 2010 (eastern China), *I. obtusangularis* Liu, H. Aspöck, Yang & U. Aspöck, 2010 (southwestern China), *I. sinensis* Navás, 1936 (eastern China). Of these *I. sinensis* is the most closely related species to *I. rara* **sp. nov.** by sharing more similar characters than with other *Inocellia* species, e.g. the similar male genitalia with the gonocoxite lacking inner bristle tuft, the fused parameres bearing long distal projection, and the double protruding gonarcus. Most probably these two species form the sister group to *I. hamata*.

So far, all six species of Raphidioptera known from Taiwan – four species of *Mongoloraphidia* (Raphidiidae) and two species of *Inocellia*—are apparently endemic to this island, and most probably also the new species, *I. rara*, is endemic to Taiwan. This is surprising since throughout the whole glacial period there were frequent broad connections between Taiwan and the Asian mainland. During the Pleistocene the sea level dropped repeatedly by 130 m (possibly even 140 m) compared to the present sea level. This led to an extension of the coast lines of the east of Asia by 600 to 1000 km eastwards. Such events occurred at least one million years, 500 000 years, and 300 000 years B.P., and also during the last glacial period the sea level dropped by 120 m during the maximum of glaciation (ca. 21 000 years B.P.), which led to a broad connection of Taiwan with the mainland of China (Smith *et al.* 1995, Zhuo *et al.* 1998, Keally 2005, Liu *et al.* 2010a). With respect to the marked morphological differences in the male genitalia it is likely that the three species of Inocelliidae (and also the four species of Raphidiidae) of Taiwan are to be traced back to early immigrations, possibly even in the early Pleistocene. The strong orographic structure of the island with its high isolated mountains was undoubtedly a significant precondition for the genetic isolation of the invaders with subsequent endemism. Climate changes resulted in shifts of vertical distributions and enabled species to survive during unfavorable periods due to the possibility of inhabiting optimal altitudes.

We must, however, admit that the Raphidioptera fauna of the mountains opposite of Taiwan on the mainland of China is still almost unknown so that definite biogeographical conclusions must await sufficient exploration of these regions of the mainland of China.

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