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Subfossils of extinct and extant species of Simuliidae (Diptera) from Austral and Cook Islands (Polynesia): anthropogenic extirpation of an aquatic insect?

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Abstract

Subfossil head capsules of Simuliidae larvae have been recovered from swamps on Tubuai and Raivavae of the Austral Islands, and Atiu and Mangaia of the southern Cook Islands. For Tubuai and Raivavae it is likely that the simuliids are extinct, but a single simuliid species is extant on nearby Rurutu. For Atiu and Mangaia, extant simuliids have not been reported, but are known on Rarotonga. Well-preserved head capsules indicate that the Cook Islands subfossils are those of *Simulium (Inseliellum) teruamanga* Craig and Craig, 1986. For the Austral Islands, the simuliid from Tubuai is considered a variant of *Simulium (Inseliellum) rurutuense* Craig and Joy, 2000. That from Raivavae is morphologically distinct and is described here as a new species, *Simulium (Inseliellum) raivavaense* Craig and Porch. Humans arrived in Eastern Polynesia ca. 1,000 years ago resulting in the widespread destruction of lowland forest and conversion of wetlands to agriculture with implied consequences for the indigenous biota of these habitats. Here we consider that one such result was loss of freshwater aquatic biodiversity.

Key words: Pacific, Polynesia, Cook Islands, Austral Islands, Simuliidae, *Simulium*, *Inseliellum*, larvae, subfossil, taxonomy, biogeography, extirpation, anthropogenic

Introduction

Fossils of Simuliidae date back to Late Jurassic (ca. 209 mya) (Currie and Grimaldi 2000; Grimaldi and Engel 2005, Borkent 2012), but those of larvae are extremely rare as flowing water is generally not conducive to fossilization. The best example of fossilized larvae are the remarkably detailed remains from the Koonwara Fossil Bed, Victoria, Australia (Jell and Duncan 1986). These Lower Cretaceous (ca. 138.5 mya) larvae are of the whole body and show most structures. They were preserved in a fine mudstone derived from a lake bottom—suggested by other preserved fauna. It was assumed that the simuliid larvae were swept there by a flood.

The material in this study is considered to be subfossil, that is, the remains are unmineralized. Similar material, in particular those of larval chironomid head capsules, are commonly encountered in lake sediments. There are few other examples of subfossil simuliid larval material, mainly from lake deposits in British Columbia; summarized by Currie and Walker (1992). That material consisted of ecdysed head capsules, some complete, but more usually just the ventral surface with the hypostomal teeth—still of considerable diagnostic utility. In Norway, Heiri (2004) used subfossil chironomid head capsules to compare faunal assemblage variability within lakes. Simuliid head capsules were recovered, but no further details were given, except that the capsules were accompanied by those of running water chironomids, indicating that they had been deposited from a stream or river.

The subfossils in this study are of simuliid larvae from sites in the Cook-Austral Islands, Central South Pacific Ocean (Fig. 1).

It is well known that Simuliidae are capable of trans-oceanic dispersal (Crosskey 1990, Craig *et al.* 2000, Adler *et al.* 2004, Craig *et al.* 2012 and others). Except for the Hawai'ian archipelago and the Falkland Islands, simuliids are known from most oceanic islands with running water—the habitat of the immature stages. Dispersal by Simuliidae has been examined in detail by Spironello and Brooks (2003) in relation to the MacArthur-Wilson