



Uncovering karst endemism within Borneo: two new *Cyrtodactylus* species from Sarawak, Malaysia

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Abstract

The island of Borneo lies within one of the most biodiverse regions in the world. Despite this, its documented gekkonid diversity is not commensurate with other areas of Southeast Asia. The megadiverse genus *Cyrtodactylus* is especially underrepresented. Limestone-karst ecosystems, in particular, harbor many endemic *Cyrtodactylus* species, but only one karst-dwelling species is currently recognized from Borneo. This paper adds two additional karst-dwelling *Cyrtodactylus* species—*C. muluensis* **sp. nov.** and *C. limajalur* **sp. nov.**—from Sarawak, Malaysia. *Cyrtodactylus muluensis* **sp. nov.** is endemic to Gunung Mulu and is distinguished from its congeners by having a precloacal groove, 31–38 ventral scales, a maximum SVL of at least 88 mm, enlarged subcaudals, 19–20 subdigital lamellae, and a banded dorsal body pattern. *Cyrtodactylus limajalur* **sp. nov.** is endemic to the Serian region and is distinguished from its congeners by having 33–42 ventral scales, enlarged subcaudals, a precloacal pit, a maximum SVL of at least 94 mm, 5–6 enlarged femoral scales, 19–22 subdigital lamellae, and five distinct bands on the dorsum. Both species are phylogenetically distinct and deeply divergent from all other congeners. The description of two new karst-dwelling species highlights the need to conserve karst habitats and the endemic species they harbor.

Key words: Gekkonidae, squamate, biodiversity, limestone, karst, Borneo

Introduction

The genus *Cyrtodactylus* is the most speciose group of gekkonids globally, with over 250 species described. They occur as far north and west as Pakistan, Nepal, and India, and as far south and east as the Solomon Islands (Uetz 2018). The number of described species continues to rise with many recent *Cyrtodactylus* descriptions of species inhabiting limestone-karst ecosystems. Between 2016 and 2018, 34 new *Cyrtodactylus* species were described, of which 27 are endemic to karst ecosystems (Agarwal 2016; Grismer *et al.* 2016a; b; 2018a; b; Luu *et al.* 2016a; b; c; 2017; Mecke *et al.* 2016; Nazarov *et al.* 2018; Nguyen *et al.* 2017; Nielsen & Oliver 2017; Oliver *et al.* 2016; Pauwels *et al.* 2016; Riyanto *et al.* 2017). Despite the high number of *Cyrtodactylus* species recorded and the rapid rate at which new species are being described, the island of Borneo is largely underrepresented with a mere eight documented species (Das 2005). Hikida (1990) provided the most recent comprehensive study of Bornean *Cyrtodactylus* species, in which three new species were described. The reason for the underrepresentation of Bornean *Cyrtodactylus* species is unknown; however, we expect the apparent lack of diversity within the genus stems from either geographic constraints or insufficient sampling within the region. The recent focus on *Cyrtodactylus* outside of Borneo has demonstrated a high degree of unrecognized genetic and morphological diversity within the genus (Brennan *et al.* 2017; Grismer *et al.* 2018b; Oliver *et al.* 2018; Tallowin *et al.* 2018). This uptick in species recognition and phylogenetic analyses within the group indicates that further studies of Bornean *Cyrtodactylus* species may provide similar results.

The low *Cyrtodactylus* diversity within Borneo may result from the unique geographical history of the island and the associated limestone ecosystems. A terrestrial connection between East and West Malaysia was present