



Multilocus phylogeny of Bornean Bent-Toed geckos (Gekkonidae: *Cyrtodactylus*) reveals hidden diversity, taxonomic disarray, and novel biogeographic patterns

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ABSTRACT

The gekkonid genus *Cyrtodactylus* is a highly diverse group of lizards (280 + species), which covers an expansive geographic range. Although this genus has been the focus of many taxonomic and molecular systematic studies, species on the Southeast Asian island of Borneo have remained understudied, leading to an unclear evolutionary history with cascading effects on taxonomy and biogeographic inferences. We assembled the most comprehensive multilocus Bornean dataset (one mitochondrial and three nuclear loci) that included 129 novel sequences and representatives from each known *Cyrtodactylus* species on the island to validate taxonomic status, assess species diversity, and elucidate biogeographic patterns. Our results uncovered a high proportion of cryptic diversity and revealed numerous taxonomic complications, especially within the *C. consobrinus*, *C. malayanus*, and *C. pubisulcus* groups. Comparisons of pairwise genetic distances and a preliminary species delimitation analysis using the Automatic Barcode Gap Discovery (ABGD) method demonstrated that some wide-ranging species on Borneo likely comprise multiple distinct and deeply divergent lineages, each with more restricted distributional ranges. We also tested the prevailing biogeographic hypothesis of a single invasion from Borneo into the Philippines. Our analyses revealed that Philippine taxa were not monophyletic, but were likely derived from multiple separate invasions into the geopolitical areas comprising the Philippines. Although our investigation of Bornean *Cyrtodactylus* is the most comprehensive to-date, it highlights the need for expanded taxonomic sampling and suggests that our knowledge of the evolutionary history, systematics, and biogeography of Bornean *Cyrtodactylus* is far from complete.

1. Introduction

The gekkonid genus *Cyrtodactylus* is a highly diverse group of geckos with over 280 recognized species, making it one of the most speciose lizard genera in the world (Uetz, 2019). The group spans a

broad geographic range extending from South Asia to Melanesia, with a particularly concentrated diversity in Southeast Asia (Bauer et al., 2003, 2002; Brennan et al., 2017; Grismer et al., 2018, 2016a, 2016b, 2014, 2012; Luu et al., 2016; Murdoch et al., 2019; Nazarov et al., 2018, 2008; Pham et al., 2019; Tri, 2011, 2008; Tri et al., 2010).

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