

## Establishing the presence of marbled bent-toed gecko, *Cyrtodactylus quadrivirgatus* (Reptilia: Squamata: Gekkonidae), in Singapore

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**Abstract.** *Cyrtodactylus quadrivirgatus* is among five species of bent-toed geckos known to occur in Singapore. It was first recorded there based on photographs of a specimen at Upper Seletar Reservoir Park in July 2016. There are presently seven additional photographic records of this species obtained from 2011 to 2020, all from freshwater swamp forest and secondary forest in the Central Catchment Nature Reserve and Admiralty Park. All previous records of *Cyrtodactylus quadrivirgatus* from Singapore Island appear to be based on the syntopic *Cyrtodactylus majulah*, and those from Pulau Tekong, on *Cyrtodactylus pantiensis*.

**Key words.** *Cyrtodactylus majulah*, *Cyrtodactylus quadrivirgatus*, gecko, Singapore

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### INTRODUCTION

Prior to being formally described as a unique species, the Singapore bent-toed gecko, *Cyrtodactylus majulah*, was known as *Cyrtodactylus quadrivirgatus* (Grismer et al., 2012: 490). Grismer (2011: 431) first mentioned differences in colour pattern (i.e., dorsal pattern with large spots in Singapore population vs. blotches in populations elsewhere) and suspected the Singapore population could represent a new species. A year later, Grismer et al. (2012: 491) presented molecular evidence revealing that the Singapore population was indeed distantly related to *Cyrtodactylus quadrivirgatus*, and named it *Cyrtodactylus majulah*. After being split, the distribution of the marbled bent-toed gecko, *Cyrtodactylus quadrivirgatus*, was delimited to the Isthmus of Kra in Thailand, southward through Peninsular Malaysia to Sumatra, excluding Singapore (Grismer et al., 2013: 249). The known range of *Cyrtodactylus majulah* is restricted to Singapore and Pulau Bintan, Indonesia (Grismer et al., 2012: 495). In his description of *Cyrtodactylus majulah*, Grismer et al. (2012: 495) noted that the populations from Bukit Timah Nature Reserve (BTNR) and Pulau Tekong were not conspecific with *Cyrtodactylus majulah*. Grismer et al. (2012: 495) based their comment about the BTNR record on a record from Teo & Rajathurai (1997: 390) of an unidentified species from Gunung Panti in Johor, Peninsular Malaysia, that was declared to have hitchhiked into Singapore on 26 August 1995 (Lim, 1995: 18; Teo & Thomas, 2019: 157). There is currently only one reported record of *Cyrtodactylus majulah* from BTNR, of one individual observed during the BTNR comprehensive surveys in 2019 (Teo & Thomas, 2019: 156). The Pulau Tekong population was subsequently rediagnosed as *Cyrtodactylus pantiensis*, the Panti Mountain bent-toed gecko, by L. L. Grismer (Lim et al., 2016: 176). This record extended the range of *Cyrtodactylus pantiensis* from Tasik Chini, Pahang; Sungai Udang Recreational Forest, Malacca; and Gunung Panti Forest Reserve, Johor, in Peninsular Malaysia (Grismer, 2011: 413), to include Pulau Tekong, Singapore.

On 25 October 2007, a *Cyrtodactylus* photographed at Rifle Range Forest, in the western part of the Central Catchment Nature Reserve (CCNR), was identified by L. L. Grismer as the peninsular bent-toed gecko, *Cyrtodactylus semenanjungensis* (Baker, 2014: 331). Similar to *Cyrtodactylus pantiensis*, this record extended the range of *Cyrtodactylus semenanjungensis* from southeastern Johor (Grismer, 2011: 434) to CCNR, Singapore. Subsequently, Grismer recognised another *Cyrtodactylus*, photographed along a stream at Upper Seletar Reservoir Park (USRP) on 17 July 2016, as *Cyrtodactylus quadrivirgatus* (Law et al., 2016: 117). This record now adds Singapore to the range of *Cyrtodactylus quadrivirgatus*, giving it a continuous distribution from Isthmus of Kra in Thailand to Sumatra (Grismer et al., 2013: 249). With the addition of *Cyrtodactylus quadrivirgatus*, five species of *Cyrtodactylus* are presently known to occur in Singapore. *Cyrtodactylus majulah*, *Cyrtodactylus pantiensis* and *Cyrtodactylus semenanjungensis* belong to a swamp-dwelling clade of bent-toed geckos that comprises nine species (Grismer & Davis, 2018: 371), whereas *Cyrtodactylus quadrivirgatus* belongs to a lowland forest-dwelling clade (Grismer et al., 2012: 491). All four of these species are easily distinguished from *Cyrtodactylus consobrinus*, which is much larger, has a cross-banded body pattern (Grismer, 2011: 389), and is restricted in Singapore to BTNR and Dairy Farm Nature Park (Baker & Lim, 2012: 79; Teo & Thomas, 2019: 156).

In this note, we present photographic evidence consisting of seven additional observations of specimens that match the colour pattern of *Cyrtodactylus quadrivirgatus*, which comprises a Y-shaped marking on the nape, dorsum with four longitudinal stripes to broken bands (or combination of both), and a wide, dark, postorbital stripe extending past the armpits (Grismer et al., 2012: 496). *Cyrtodactylus quadrivirgatus* represents a species complex with cryptic species from distinctive geographic regions and habitats that differ in colour pattern (Sumontha et al., 2015: 114), and so the identifications herein are regarded as tentative. As *Cyrtodactylus* is the most diverse gekkonid genus and exhibits considerable cryptic species diversity (Davis et al., 2020: 1), detailed morphological and molecular analyses are needed to conclusively determine the specimen's specific status. Nonetheless, the photographs establish that *Cyrtodactylus quadrivirgatus* does occur in Singapore and is syntopic with *Cyrtodactylus majulah*, and possibly with *Cyrtodactylus semenanjungensis*.

While reviewing old photographs, we came across two images of *Cyrtodactylus quadrivirgatus* that had been obtained in Singapore before the species was first reported in the country in 2016 (Law et al., 2016: 117). Both photographs were taken at the Nee Soon Swamp Forest (NSSF), one from 2011 (Fig. 1a), and the other from 2014 (Fig. 1b). The first record was made prior to the description of *Cyrtodactylus majulah*, but the second one was made after and was regarded as a variant of *Cyrtodactylus majulah*.

## MATERIAL & METHODS

The records that form the basis of this article are of individuals that were photographed alive in situ at five general locations on Singapore Island—NSSF, Upper Seletar Reservoir Park, CCNR and Admiralty Park. No specimens were collected, and no tissues were sampled.

## OBSERVATIONS

A total of eight separate *Cyrtodactylus quadrivirgatus* individuals were photographed on Singapore Island between 2011 and 2020 (Fig. 1).

- 1) One adult of about 6.5 cm snout-vent length (Fig. 1a) was photographed on a leaf in NSSF on 17 February 2011, at 2021 hours, by Anne Devan-Song.
- 2) An adult example of about 7 cm snout-vent length (Fig. 1b) was found on soil of a collapsed slope in mature secondary forest at NSSF on 1 December 2014, at 2110 hours, by Alex Figueroa, Mary-Ruth Low, Holly Siow and Ryan J. R. McCleary.
- 3) A single adult of about 6 cm snout-vent length (Fig. 1c) was observed on a large palm frond along a freshwater stream at Upper Seletar Reservoir Park, on 17 July 2016 at 2117 hours, by Law Ing Sind, Law Ing Thong and Serin Subaraj. This particular individual was reported by Law et al. (2016: 117).
- 4) One adult of around 6 cm snout-vent length (Fig. 1d) was found on the ground in mature secondary forest in the central part of CCNR, on 27 October 2017 at 2200 hours, by Robin Ngiam and Shaun Spykerman.
- 5) One adult of about 7 cm snout-vent length (Fig. 1e) was found on low vegetation in NSSF on 15 July 2018, at 0034 hours, by Shivaram Rasu and Law Ing Sind.
- 6) One adult of about 7 cm snout-vent length (Fig. 1f) was observed clinging to trailing *Ficus* sp. aerial roots at about 1 m off the ground in secondary forest, along Mandai Track 15, on 31 August 2018 at 2045 hours, by Shivaram Rasu.
- 7) An adult example of about 6 cm snout-vent length (Fig. 1g) was observed moving on the trunk of a tree in young secondary forest at Admiralty Park, on 14 August 2020 at 2154 hours, by Richard Lee.
- 8) An adult individual of around 7 cm snout-vent length (Fig. 1h) was found on vegetation in mature secondary forest at the edge of freshwater swamp forest, at Upper Seletar Reservoir Park, on 30 November 2020 at 2046 hours, by Spencer Jia Ming Yau.



Fig. 1. Photographic records of *Cyrtodactylus quadrivirgatus* in Singapore from 2011 to 2020. a, NSSF on 17 February 2011; b, NSSF on 1 December 2014; c, Upper Seletar Reservoir Park on 17 July 2016; d, CCNR on 27 October 2017; e, NSSF on 15 July 2018; f, Mandai Track 15 on 31 August 2018; g, Admiralty Park on 14 August 2020; h, Upper Seletar Reservoir Park on 30 November 2020. (Photographs by: a, Anne Devan-Song; b, Alex Figueroa; c, Law Ing Thong; d, Shaun Spykerman; e, Law Ing Sind; f, Shivaram Rasu; g, Richard Lee; h, Spencer Jia Ming Yau).

## RESULTS & DISCUSSION

While the first three records originated from neighbouring localities in the northeastern section of CCNR, the fourth record comes from the central portion of CCNR. This record is of an individual that was seen on 27 October 2017 in mature secondary forest (Fig. 1d). The fifth observation was once again from NSSF, on 15 July 2018, of an individual sitting on a leaf (Fig. 1e). The sixth record was from a new locality, Mandai Track 15, situated at the northwestern portion of CCNR. Here, an individual was photographed perched on a thin, decaying palm frond on 31 August 2018 (Fig. 1f). The next observation is notable because it emerges from Admiralty Park, an isolated, urban park consisting of young secondary forest and a small patch of degraded freshwater swamp surrounding remnant mangroves. The discovery of one individual there on 14 August 2020 (Fig. 1g) indicates that a disjunct, relic population survives there where previously three individuals of *Cyrtodactylus majulah* were also found on 3 May 2017 (Law, 2017: 77). Given the presence of *Cyrtodactylus majulah* and *Cyrtodactylus quadrivirgatus* at Admiralty Park, and the park being small, urban, and its habitats degraded, we urge habitat enhancement and conservation efforts be made to sustain the populations of these two species. The eighth record we have is of another individual from Upper Seletar Reservoir Park, photographed on 30 November 2020 perched on vegetation (Fig. 1h).

As mentioned earlier, the photographic evidence presented here, involving seven additional observations of *Cyrtodactylus quadrivirgatus*, establishes that *Cyrtodactylus quadrivirgatus* is native to Singapore and is syntopic with *Cyrtodactylus majulah*. In Peninsular Malaysia, *Cyrtodactylus quadrivirgatus* is common and readily found in a range of habitats (Grismer, 2011: 432). However, *Cyrtodactylus quadrivirgatus* was only recently discovered in Singapore, and the fact that it is known only from these eight records suggests that it is rare there. As a habitat generalist, *Cyrtodactylus quadrivirgatus* should conceivably be found throughout Singapore, but thus far, has only been found around swampy habitats and mature secondary forest. One possibility is that *Cyrtodactylus quadrivirgatus* is being outcompeted by *Cyrtodactylus majulah*, although this should not be the case in upland habitats. Clearly, explicit surveys are required to find additional specimens of *Cyrtodactylus quadrivirgatus*, confirm its specific status, and establish its occurrence and distribution within Singapore. This rings true for all five species of *Cyrtodactylus* in Singapore as not much is known of each species, particularly *C. semenanjungensis*, which is only known from one record (Baker, 2014: 331).

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