Distribution and Behavior of Dennys' Treefrog (*Rhacophorus dennysi*) in Guangdong Province, China

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Vogt (1914) reported Dennys' Treefrog, *Rhacophorus dennysi* (Rhacophoridae), for the first time from Guangdong Province (as *Polypedates*), as later did Mell (1922). The range of *R. dennysi* was given as from southern China and westward to Burma in the Oriental Zone by Zhao and Adler (1993), but their records were not on or south of the Tropic of Cancer (TOC, ca. 23°26'). The previous southernmost record was Dayao Shan of Guangxi Province, bordering western Guangdong but still north of the TOC (Chen 1929; Ahl 1930, mistaken as "Vogt 1930" in Pope 1931). However, the range has been expanded due to more field surveys in recent years. These have generated new records from Guangdong (5 sites) and many provinces north and east of Guangdong, all north of the TOC, as well as Hainan, Guangxi, and northeastern Vietnam, all south of the TOC (Fei et al. 2009). The latter expansion is an unexpectedly southward trend in a reverse trajectory of the global warming phenomenon.

Dinghushan is located in central Guangdong Province, China, at 23°09'21"~23°11'30"N by 112°30'39"~112°33'41"E, just south of the TOC, a United Nation's Man and Biosphere (MAB) site. It is a remnant of old growth monsoonal hardwood forest. Although overlooked in the abovementioned new Guangdong records, *R. dennysi* was first reported from Dinghushan by Xu (2001), but the lack of voucher specimens was cause for concern (Li et al. 2009). On 21 and 23 July 2010, N. Qing with G.-H. Lin and W.-H. Lu with X. Qin, respectively, collected a male (Fig. 1) and an adult female, each during a typhoon rainy night, both at low elevation (~30 m) near the MAB headquarters. The male was ~4 m high

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Fig. 1. Dennys' Treefrog (*Rhacophorus dennysi*) from Dinghushan, south of the Tropic of Cancer. Collected in July 2010 in Guangdong Province, China.

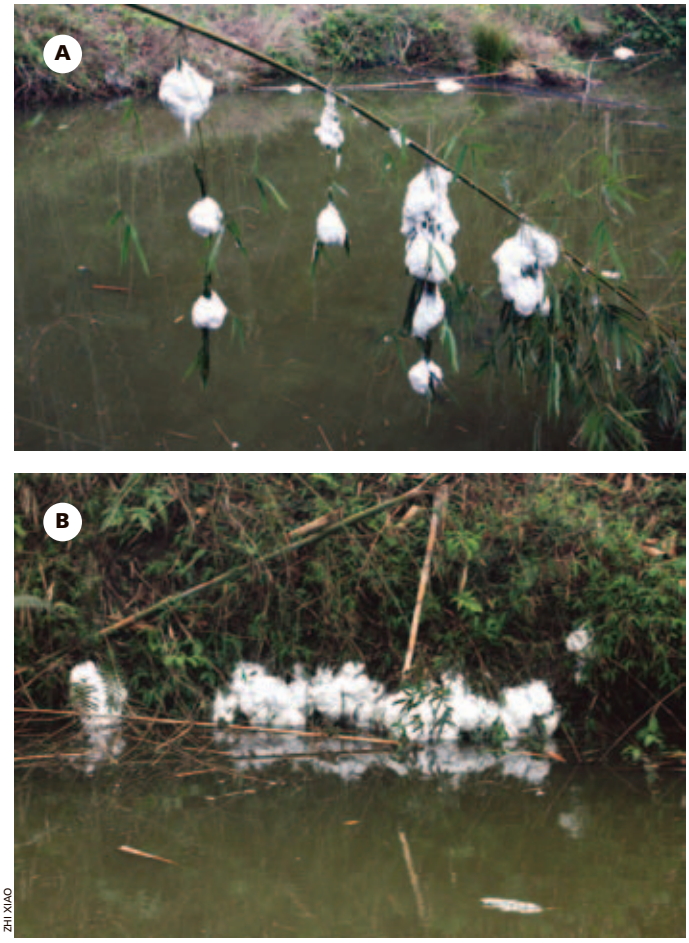

Fig. 2. Amplexing clumps of *Rhacophorus dennysi* hanging over (A) or near (B) water at Conghua, ~150 km northeast of Dinghushan in March 2008, Guangdong Province, China.

on a tree above a bridge (~7 m above the stream); it was not calling. The female was 3 m high on a banana leaf next to a shallow stream, typical of its habitat; no egg froth was found. On 21–22 February 2011, we heard numerous males calling from bushes surrounding a small fishpond near the MAB and caught amplexing pairs, but found no eggs. This is the earliest recorded mating behavior for the species.

Aggregative mating behavior is often observed in *R. dennysi*, with many amplexing pairs seen from March to May (Pope 1931, Li and Xiao 2011). On 18–19 March 2008 at Conghua, ~150 km northeast of Dinghushan, >2,000 individuals aggregated at four different sites near hillside streams or ponds in close proximity to a small mountain village (23°42'55"~23°44'14"N by 113°43'40"~113°51'46"E) (Fig. 2), ~500 m above sea level with trails to a nearby peak of >1,000 m. The frogs form clusters composed of as few as two pairs to 50 or more individuals (Fig. 3). Within these clumps, individuals can be in amplexus (one male on one female) or not. In the latter instance, multiple males (group amplexus) often are attempting to mate with one or a few females.

The frogs do not seem to be affected by onlookers. At one of the four sites, ~500 individuals each of *R. dennysi*, *Hylarana latouchii* (Brown Wood Frog), and *Bufo melanostictus* (Asian Common Toad) occurred in an artificial pond 30–50 m^2 in the center square of the village of Conghua (Fig. 4). The water in the pool was shallow at the time, despite a small feeder stream entering from the uplands, and full of garbage, but the density of frogs was so great that individuals of multiple species were amplexing in large groups. This is apparently a well-known spectacle that attracts tourists every March. However, we observed no frogs on 26 February 2011.

Additionally, *R. dennysi* engages in an interesting behavior, using its forelimbs to cover its eyes when disturbed at night and at times peeking out through the digits (Fig. 5), as if it is shy or does not like the light.

These distributional data confirm the 2001 record at Dinghushan and other records of 23°27'N by 111°53'E (Chang et al. 1997), 23°13'~23°23'N by 114°19'~114°27'E (Yang et al. 2001), 23°10'~25°31'N by 111°55'~114°50'E (Wen et al. 2002, Liang 2003), and 23°30'~23°95'N by 113°40'~114°38'E (Gu et al. 2007) from Guangdong Province. Our data are the southernmost for this species in Guangdong Province. All are close to either side of the TOC.

The Guangxi records and those from more southerly countries (e.g., Vietnam) in Fei et al. (2009) should be reexamined to be certain that they do not refer to *R. leucofasciatus*. This species was originally described by Liu and Hu (1962), but later synonymized with *R. dennysi* by Hu herself (Frost 1985). However, Fei et al. (2009) resurrected it based on fresh material from Fangcheng, Guangxi, at approximately 21°40'53"N by 107°50'50"E, south of the TOC. The range of this species is disjunct, with two sites in Guangxi and one in Sichuan Province. If Fei et al. (2009) examined all the relevant specimens and records to define the distribution of both species, these recent records are evidence of the southward expansion of *R. dennysi*. Interestingly Chen (1929) described "*Polypedates*" *feyi* from Yaoshan, a site north of the TOC in Guangxi and also the type locality for *R. leucofasciatus*, but the species was synonymized with *R. dennysi* by Pope (1931) without examining the type specimen — and his synonymy has been accepted.

We further question whether the Hainan Island record (recently supplemented by several additional unpublished reports from different nature reserves) is the result of an introduction attributable to economic expansion

Fig. 3. Group amplexing of *Rhacophorus dennysi* in a small cluster of >4 individuals (as seen here) or large clusters of >20 individuals (as on p. 74) at Conghua, ~150 km northeast of Dinghushan in March 2008, Guangdong Province, China.

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Fig. 4. An artificial pond in Conghua (~150 km northeast of Dinghushan, Guangdong Province, China) where >1,500 individual frogs (~500 each of *Rhacophorus dennysi*, *Rana latouchii*, and *Bufo melanostictus*) congregated and formed multi-species amplecting masses in March 2008.

ZHEN-CHANG LI

Fig. 5. Light-shielding behavior of *Rhacophorus dennysi* from Xinfeng County (23°53'~23°59'N, 113°55'~114°03'E) in July 1996, Guangdong Province, China.

and tourism. Shi and Meng (2001) were the first to list it from Hainan, but we could not verify the "historical" record. Not until the 21st century was it collected at an altitude of 900 m around a guesthouse complex (Wang et al. 2007), which is the likely source for Fei et al. (2009). This species is seldom kept as a pet in China, and therefore is unlikely to be released to the wild. Although it is found in well forested, mountainous areas, where only a small number of tourists visit, the construction and landscaping of hotels and guest houses in these nature reserves are possible explanations for the presence of these frogs in Hainan, which might have been inadvertently introduced with building materials and horticultural plants, such as banana and bamboo varieties. Furthermore, another green treefrog (*R. yinggelingensis*) was recently described from Hainan (Chou et al. 2007). It closely resembles *R. dennysi*, and can be distinguished only by outer finger webbing. Careful examination of future records from that province will be necessary.

The discovery of *R. dennysi* at Dinghushan, Guangxi, Hainan, and other Asian countries south of the TOC could all be anthropogenic. First, this range expansion reverses that expected from global warming. Second, that this species was overlooked in the past is unlikely because early investigators found it abundantly in other areas of southern China and the sites of these new records within China had been visited by them. Such a sudden abundance is often typical of recent introductions. On the other hand, climatic changes might include factors unknown to us that favor the southward expansion of this treefrog. A molecular test among these populations of *R. dennysi* could reveal their origins. In the interim, however, with global climatic change and ecotourism-related development in mind, surveys documenting the apparent range expansion of this species in Guangdong Province are ongoing.

Acknowledgments

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Abronia frosti is one of several species in the genus thought to have become extinct soon after its discovery.