

Mindanao cross frog *Oreophryne anulata* found in a dormant pitcher of *Nepenthes copelandii* in the Philippines

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In the tropics, ecological interactions between animals and plants are complex. Many of these relationships are restricted to specific microhabitats, one of which is the water-filled cavities (phytotelmata) in plants. The fauna that uses phytotelmata has adapted their behaviours (i.e. foraging, refuging and breeding) to maximise their benefit from these

microhabitats. In south-east Asia, phytotelmata include the pitchers of the plant family Nepenthaceae, especially those of the genus *Nepenthes*, which have been reported to have associations with insects, mammals and anurans. In the case of anurans, these have been observed particularly in Peninsular Malaysia and the island of Borneo (Fig. 1).

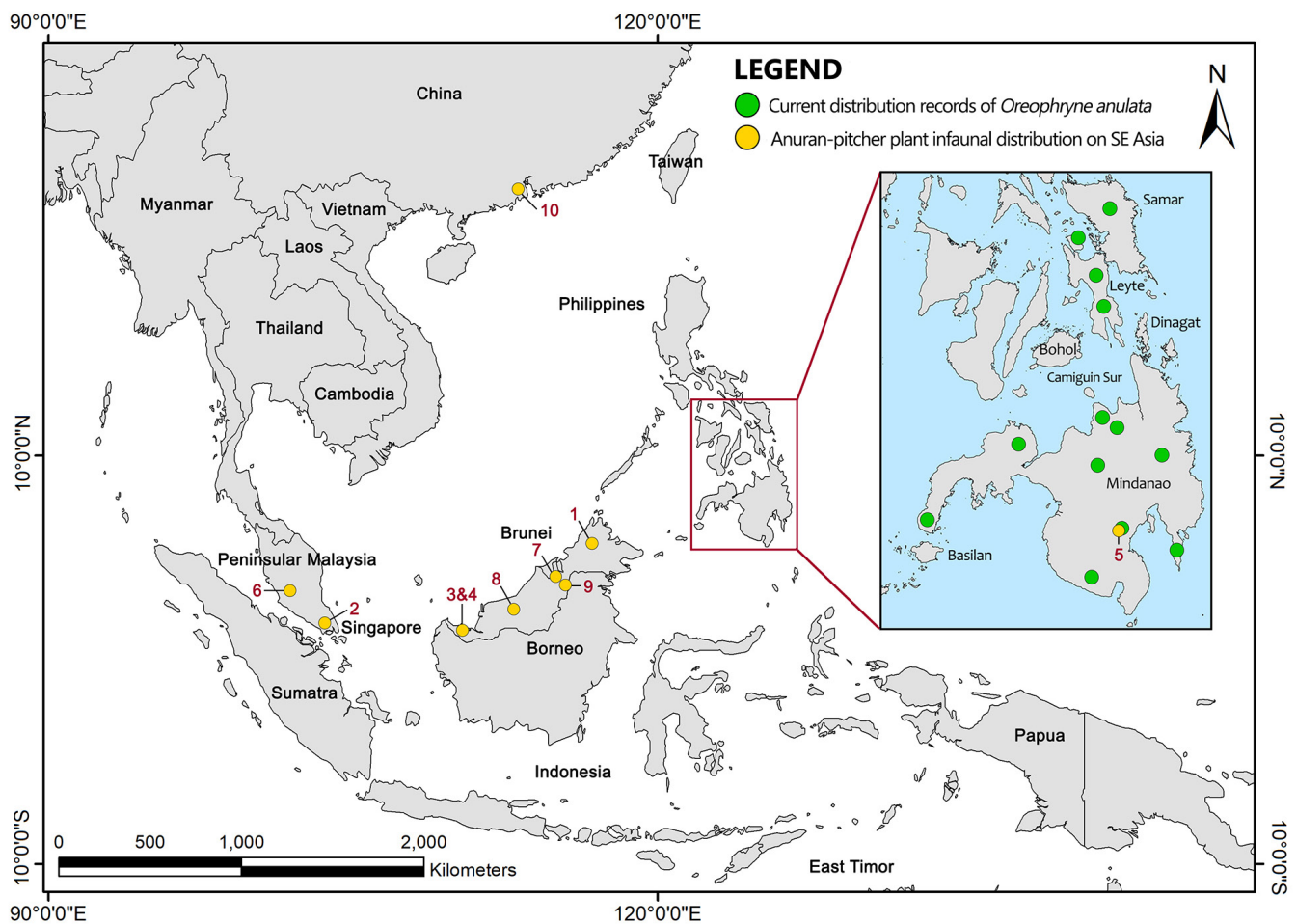


Figure 1. Distribution map of records of anuran associations with pitcher plants (*Nepenthes* spp.) in south-east Asia and the current distribution records of *O. anulata* in the Philippines. Anuran species and bibliographical references – **1.** *Kalophrynus heterochirus* Phillips et al., 2008; Das & Hass, 2010; **2.** *Kalophrynus pleurostigma* Lim & Ng, 1991; **3.** *Microhyla borneensis* Das & Haas, 2010; **4.** *Microhyla nepenthicola* Das & Haas, 2010; **5.** *Oreophryne anulata* This study; **6.** *Philautus aurifasciatus* Yong et al., 1988; **7.** *Philautus kerangae* Malkus & Dehling, 2008; **8.** *Philautus mjobergi* Phillipps & Lamb, 1988; **9.** *Philautus nepenthophilus* Etter et al., 2021; **10.** *Polypedates leucomystax* Hua & Lee, 2004



Figure 2. Observation of the frog *Oreophryne anulata* in a dormant pitcher of *Nepenthes copelandii* – **A.** Typical secondary montane forest habitat on Mt. Apo Natural Park, **B.** An active upper pitcher of *N. copelandii*, **C.** The dormant upper pitcher of *N. copelandii* in which *O. anulata* was found, **D.** *O. anulata* within the dormant pitcher, **E.** Close-up photo of *O. anulata* within the pitcher

In the Philippines, 115 species of anurans are currently recognised (Diesmos et al., 2015; 2020; Herr et al., 2021). Microhylid frogs are among these, and the genera *Chaperina* (Supsup et al., 2022) and *Kaloula* (Sanguila et al., 2016) are frequently linked to phytotelmata, but there are no previous reports of anurans using *Nepenthes* phytotelmata in the Philippines, apart from a dead toad *Pelophryne albotaeniata* that had probably drowned in a pitcher *Nepenthes leonardoii* on the island of Palawan (Sy & Tan, 2015).

From 19–23 March 2022, we conducted a rapid biodiversity assessment on Mt. Apo Natural Park. We used random visual surveys, microhabitat searches and opportunistic catching on pre-identified routes to assess the biodiversity in Sta. Cruz, Digos City, Davao del Sur of Mindanao Island (6° 59.0990' N, 125° 14.6780' E). Unexpectedly, we found a morphologically cryptic microhylid frog *Oreophryne anulata* (Stejneger, 1908) occupying the upper pitcher of *Nepenthes copelandii* in a montane secondary forest habitat (2,237 m a.s.l.; Fig. 2A). *Oreophryne anulata* is found on the islands of Biliran, Leyte, Samar, and Mindanao (IUCN SSC Amphibian Specialist Group, 2020); its known distribution in the greater Mindanao faunal region is shown in Figure 1. The frog was identified by its small size, well-developed disk on fingers and toes and faintly visible subarticular tubercles (Inger, 1954). Snout-vent length (21 mm) and weight (0.9 grams) were measured using a digital caliper and electronic scales (± 0.1 g). The specimen of *O. anulata* was collected and humanely euthanised with aqueous chloretone, then fixed with 10 % buffered formalin and subsequently preserved using 70 % ethanol (Simmons, 2002). It was deposited at the Central Mindanao University Zoological Museum (CMU MZ 3007.0). The pitcher plant species was recognised by its broad and robust leaves with canaliculate petioles and cylindrical and wholly infundibular upper pitchers (Gronemeyer et al., 2011; Pelser et al., 2011 onwards).

The measurements of the pitcher were length 134 mm and width of lips 45 mm.

We observed *O. anulata* positioned upright, unharmed and partly submerged in the fluid within the pitcher (Fig. 2B–E). Notably, we did not detect any viscid fluid in the digestive zone, suggesting that this pitcher was dormant/sedentary. We can only speculate on the relationship between *O. anulata* and *N. copelandii*. It is possible that the frog may have fallen into the pitcher plant by accident and was unable to escape. Alternatively, it may be that the frog was actually using the pitcher as a refuge during the day to reduce the risk of predation. If this were the case, then possibly the frog was unaffected by digestive fluid, as the pitcher, being dormant, may have lacked digestive fluid, any digestive fluid present may have become diluted with rainwater/dew, and/or the frog's own skin secretions may have conferred resistance to it. We recommend long-term and targeted field surveys to gain further insights into the relationship between *O. anulata* on *N. copelandii*.

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