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A NEW LOCALITY OF THE SINGAPORE FRESHWATER CRAB, *JOHORA SINGAPORENSIS* (CRUSTACEA: BRACHYURA: POTAMIDAE)

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ABSTRACT. — A previously unknown population of the Singapore freshwater crab (*Johora singaporensis*), was discovered in a new hill-stream locality in a restricted area in Bukit Gombak, Singapore. This discovery highlights the value of hill-stream habitats and the important role that restricted security areas play in the protection of local biodiversity in Singapore.

KEY WORDS. — *Johora singaporensis*, decapod, endemic, military, natural heritage, security area

INTRODUCTION

Johora is a genus of 15 species of freshwater crabs characterised by their usually squarish carapace, with numerous short setae (Ng, 1988). Distributed from southern Thailand through Peninsular Malaysia to Singapore, they are generally associated with highlands (Ng, 1988; Yeo et al., 2007). Most species are predominantly aquatic and require fast-flowing and oxygenated waters (Ng, 1987, 1988; Yeo et al., 2007). As a result of their stenotopic requirements for hill streams, they are generally found in isolated drainages with very restricted distribution and many species are of conservation concern (Ng, 1988; Yeo et al., 2007; Cumberlidge et al., 2009).

The critically endangered Singapore freshwater crab, *Johora singaporensis* (Ng, 1986), is one of the top 100 species in danger of extinction (Esser et al., 2008; Baillie & Butcher, 2012). Endemic to Singapore, this species is of high significance as an icon of both national and natural heritage (Yeo et al., 2008b; Tan et al., 2010). The species has so far only been recorded in three hill-stream drainages in Bukit Batok, Bukit Gombak, and Bukit Timah (Ng, 1986, 1990; Yeo et al., 2008b; Ng et al., 2014). Aspects of the habitat have only recently begun to be characterised (Chua et al., 2015); otherwise, little else is known about its ecology or life history (Ng & Yeo, 2013; Chua et al., 2014).

Here, we present the first record of *Johora singaporensis* from a new stream locality outside of its previously known distribution, but which is part of a series of low hills still in the general vicinity in central Singapore. This latest record is within a restricted military area at Bukit Gombak. Although this stream is less than 500 m away from the previously known locality in Bukit Gombak and part of the same overall drainage, it is nevertheless treated as separate because the low order hill streams are not directly connected, and therefore their respective populations of crabs, which are poor dispersers (Yeo et al. 2008a), likely to be isolated from one another. This locality had not been previously surveyed, but was regarded as a potential site for *Johora singaporensis* owing to the postulated presence of hill streams (Yeo et al., 2008b); a prediction that was validated with this new record.

OBSERVATIONS

During a preliminary reconnaissance of freshwater streams at Bukit Gombak (exact geographical coordinates not revealed as this area is a gazetted military area) on 22 Jul.2013 (ca. 1500 hours), several individuals of *Johora singaporensis* were observed hiding under small rocks and leaf litter in a stream. Follow-up night surveys on 23 Jul.2013 and 31 Jul.2013 (both ca. 2100 hours) revealed more individuals of *Johora singaporensis* in the same stream foraging for food (Fig. 1). A brooding female crab was also observed on 31 Jul.2013 (Fig. 2).

The habitat surrounding the stream is young secondary forest dominated by *Artocarpus elasticus*, with mosses and tree ferns common along the stream bank (Fig. 3). Typical of hill streams in Singapore, canopy cover is high (>80%) and the gradient of the slope is relatively gentle. Similar to other hill streams in Bukit Batok where *Johora singaporensis* has been reported from, the stream is shallow (<5 cm) and relatively fast flowing (~0.2 m s^{-1}), with high dissolved oxygen (8 mg L^{-1}) with circumneutral pH (~7.5). The substrate is sandy with boulders along the stream bank (Fig. 4).

From night quadrats searches, the population density of *Johora singaporensis* is moderate (~7 ± 2 individuals m^{-2}). Two other crab species (*Geosesarma nemesis* Ng, 1986, and *Parathelphusa maculata* De Man, 1879) as well as one hitherto unreported species of freshwater prawn (Cai et al., in prep.) were also observed to occur syntopically in the stream.

Fig. 1. Frontal view of a Singapore freshwater crab, *Johora singaporensis*, in a new locality at Bukit Gombak. (Photograph by: Daniel Jia Jun Ng).

Fig. 2. Brooding female in Bukit Gombak, with well-camouflaged crablets nearby (circled). (Photograph by: Daniel Jia Jun Ng).

Fig. 3. The bank vegetation along the new locality of *Johora singaporensis*. (Photograph by: Daniel Jia Jun Ng).

Fig. 4. Photo of the shallow flowing stream at Bukit Gombak. (Photograph by: Daniel Jia Jun Ng).

DISCUSSION

The discovery of this new population of *Johora singaporensis* in a previously unsurveyed stream in Bukit Gombak is unsurprising because the locality is part of a series of low hills that include known sites of the species (Ng et al., 2014), and was postulated to contain similar hill stream habitats. The preliminary (pre-survey) reconnaissance of the sites confirmed the presence of such streams along with observations of a few individuals of *Johora singaporensis.* Follow-up night surveys quantified their relative distribution and abundance.

Given the rarity of the habitat and therefore extremely restricted distribution of *Johora singaporensis*, the discovery of this previously unknown population is highly significant for its conservation. In addition, the population density at this site appears to be moderately high in relation to other known sites, suggesting that a healthy population exists, and further underlining the importance of the new site as a refuge for this species. The additional discovery of *Geosesarma nemesis* in this stream is also of significance as the species is locally threatened due to its restricted distribution (Yeo et al., 2008b).

The high biodiversity conservation value of this hill stream in Bukit Gombak certainly warrants the continued protection from anthropogenic disturbance of this rare habitat type in Singapore, and of its forest catchment, which will be essential for the long-term survival of *Johora singaporensis.* This could be a very achievable target considering the site's location within a restricted area, which highlights the importance of security areas for biodiversity conservation (Chang, 2006; Stein et al., 2008). As restricted areas are protected and not frequented by people, they are generally less exposed to anthropogenic disturbance. With minimal disturbance, native flora and fauna are often able to thrive in such protected areas (Benton et al., 2008). In addition to protecting the nation, the Singapore military therefore has also contributed to safeguarding rare and/or imperiled local biodiversity, as has been seen in other local security areas such as Pulau Tekong and Nee Soon Swamp Forest (Chang, 2006; Lim et al., 2011; Yeo & Lim, 2012). While not specifically planned for, Singapore presents a good case study of effective biodiversity conservation from military land use. Although conflicts can occur between the military land usage and protection of threatened species, a balance of both agendas can be reached as such natural environments have been increasingly regarded as essential to train personnel in realistic conditions (Leslie et al., 1996; Benton et al., 2008).

Singapore is one of the most densely populated and land-scarce nations in the world (Tan, 2006). Given the projected population growth (MND, 2013), there will be intensification of land usage and greater pressure on existing natural habitats to be developed. As a result, security areas are likely to perform an increasingly significant role in maintaining the nation's natural heritage in the future. Although security areas are not the sole solution to maintaining Singapore's flora and fauna, how such areas are managed will certainly play an important role in the success of conserving rare or threatened species.

CONCLUSION

The discovery of a new locality for the critically endangered Singapore freshwater crab, *Johora singaporensis*, in another stream at Bukit Gombak further validates anecdotal reports of its association with hill stream habitats, a rare habitat type in Singapore. This discovery contributes significantly to conservation of the species, and also highlights the importance of security areas for local biodiversity.

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