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STATUS AND DISTRIBUTION OF *FAUNUS ATER* (LINNAEUS, 1758) (MOLLUSCA: CERITHIOIDEA) IN SINGAPORE

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INTRODUCTION

The genus *Faunus* Montfort 1810 is monotypic (Brandt, 1974; Houbrick, 1991), comprising of a single species, *Faunus ater* (Linnaeus, 1758). Its higher classification is confusing, and *Faunus ater* has been placed in the families Cerithiidae (Way & Purchon, 1981), Thiaridae (Solem, 1953; Janaki Ram & Radhakrishna, 1984), Melanopsidae (Houbrick, 1988; Lydeard et al., 2002; Tan & Woo, 2010), Potamididae (Brandt, 1974; Sri-aroon et al., 2005), Melaniidae (Garg et al., 2009), and Pachychilidae (Dharma, 2005; Strong, 2011; Strong et al., 2011). Very recent studies using expanded morphological data as well as molecular data sets such as 16S and 28S rRNA sequences provide strong evidence that *Faunus* belong in the family Pachychilidae (Köhler et al., 2004; Strong, 2011; Strong et al., 2011).

Faunus ater is a common, usually locally abundant, relatively large, aquatic snail found in fresh to slightly brackish water in the Indo-West Pacific, with fossil records indicating a Tethyan origin (Houbrick, 1991). It is widely distributed in India, Sri-Lanka, Andaman Islands, Myanmar, both sides of the Thai and Malay Peninsula, Singapore, Indonesia, the Philippines, New Guinea, western and southern Pacific Islands, northern Australia and China (Solem, 1953; van Benthem Jutting, 1956; Brandt, 1974; Way & Purchon, 1981; Janaki Ram & Radhakrishna, 1984; Springsteen & Leobrera, 1986; Houbrick, 1991; Swennen et al., 2001; Sri-aroon et al., 2005, 2006; Tan & Woo, 2010; Yap et al., 2010; Strong, 2011). Its smooth, slender, high-spired, black shell is very similar to some thiarid genera such as *Melanoides* and *Stenomelania*. However its unusual aperture with two deep sinuses consisting of anterior and anal canals distinguishes it from other cerithioidean species (Houbrick, 1991). This combination of an anal sinus and a deep notch formed by the anterior siphon along the apertural edge do not occur on any other freshwater Cerithioidea, making the shell of *Faunus ater* unique. Nevertheless, many synonyms are known (see Houbrick, 1991), and as an interesting side note, one of the synonyms, *Nerita lineata* Müller, 1774, is the senior homonym of *Nerita lineata* Gmelin, 1791, a junior homonym which is a rejected name that should not be used, but which is still often used as though it is valid (for the neritid taxon *Nerita articulata* Gould, 1847).

The ecology of this species is poorly known. Published data from museum records indicate that this species lives in mouths and lower reaches of freshwater streams and rivers with a brackish influence (Houbrick, 1991). Brandt (1974) reported this taxon as inhabiting both freshwater as well as slightly brackish water near the coast in creeks, small rivers and lagoons, while Janaki Ram & Radhakrishna (1984) reported it from lotic habitats. Van Benthem Jutting (1956) reported this taxon in freshwater ponds, ditches and river mouths in Java and Sumatra, and in shallow rivers and estuaries well behind the beach in New Guinea (van Benthem Jutting, 1963). In Java, this species occurs on exposed tidal mudflats during low tide (van Benthem Jutting, 1963). Museum records from Cayangan Lake in Palawan, the Philippines, have described this species occurring in 1–1.5 m water depth in a clear brackish lake on substrates such as sand and rock, and numbering in the millions (Houbrick, 1991). Swennen et al. (2001) have also reported this species from shallow rivers and ditches with running brackish water, where it occurs in restricted localities in densities of tens to hundreds per square metre. *Faunus ater* shells are frequently covered with *Neritina* egg masses and those living in brackish water are frequently found with oysters attached to their shells (Houbrick, 1991). The thick dark brown periostracum protects the shell from the acidic environment of its habitat, except when it is abraded and severe erosion sets in. The broad, muscular snout, large buccal mass and robust radula indicate that this species grazes on coarse substrata. The reproductive biology of *Faunus ater* is also largely unknown although they are known to be oviparous (Houbrick, 1991; Köhler et al., 2004). Their large geographical distribution suggests an extended free-swimming larval stage (Houbrick, 1991).

Predation on this taxon is also not known, except for a few individuals from museum collections with shell scars, which are indicative of attacks by crabs. This species is however known to be consumed by humans in the Philippines and Thailand where they are sold in markets (Houbrick, 1991).

Fig. 1. Habitat of *Faunus ater* at West Coast Park. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 2. Concretised drain leading from the pond at West Coast Park out to the sea. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 3. Concretised drain harbouring large concentrations of *Faunus ater*. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 4. *Faunus ater* concentrated in the deeper channel of the concretised drain at West Coast Park. (Photograph by: Alvin Francis Lok Siew Loon).

Faunus ater has a relatively large, dark-brown to black shell, reaching to 90 mm in length but usually averaging about 50–60 mm (Fig. 5 & 6). The shell is elongate and comprises of around 20 straight-sided to slightly inflated whorls which seem to vary geographically and current consensus recognises the occurrence of morphological variations from straight-sided to inflated whorls. Both Brandt (1974) and Houbrick (1991), for example, regarded the four *Pirena* species described by Reeve (1859) to be synonyms to *Faunus ater*, thus mere variations. Of the four species proposed by Reeve (1859), *Pirena pagodus* has even more inflated whorls than any shell we have examined and appear to be a monstrosity. All specimens found here have weak to moderately inflated whorls. The adult shells are often decollate with eroded apical whorls (Fig. 7). In general, the whorls of the shells here seem to be weakly convex, some individuals showing increased inflation with increase in size, with smooth but weakly sculptured with a subsutural band of weak, concave plicae and very fine colabral lines. The aperture is white, ovate and is about one-fifth the length of the shell (Fig. 8). The aperture also has a smooth outer lip with a strongly concaved columella with weakly calloused parietal wall (Fig. 8). The anterior canal is absent, which is replaced with a deep wide sinus. The anal canal is marked by a deep sinus where the outer lip joins the suture (Fig. 9). The periostracum is thick, dark-brown to black and the shell beneath the periostracum is white. The operculum is corneous, ovoid, thick and dark-brown, paucispiral with eccentric nucleus, with a large attachment scar on the internal surface.

PAST AND PRESENT RECORDS

Faunus ater was first collected on 23 Apr.2001 from West Coast Park by S-Y. Chan (S.-Y. Chan, pers. comm.). It was later collected in 2007 by WFA at the same locality and again on 3 and 14 Mar.2011 by WFA and AFSLL. The habitat at West Coast Park where this species occurs is an artificially created pond (Fig. 1) adjacent to a canal with an overflow mechanism and sluice gate (Fig. 2) where the water level in the pond is controlled and periodically emptied into the sea via a concretised drain (Fig. 3). The substrate in the pond is mainly a mixture of mud and fine sand, with dispersed rocks. The population densities of *Faunus ater* appears to be rather low within the pond, although they seem to aggregate at very high concentrations outside the sluice gates and in the concretised drain leading to the sea. The concentrations within the concretised drain seem to vary.

Fig. 5. Dorsal view of *Faunus ater*. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 6. Ventral view of *Faunus ater*. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 7. Shells showing eroded apices. (Photograph by: Alvin Francis Lok Siew Loon).

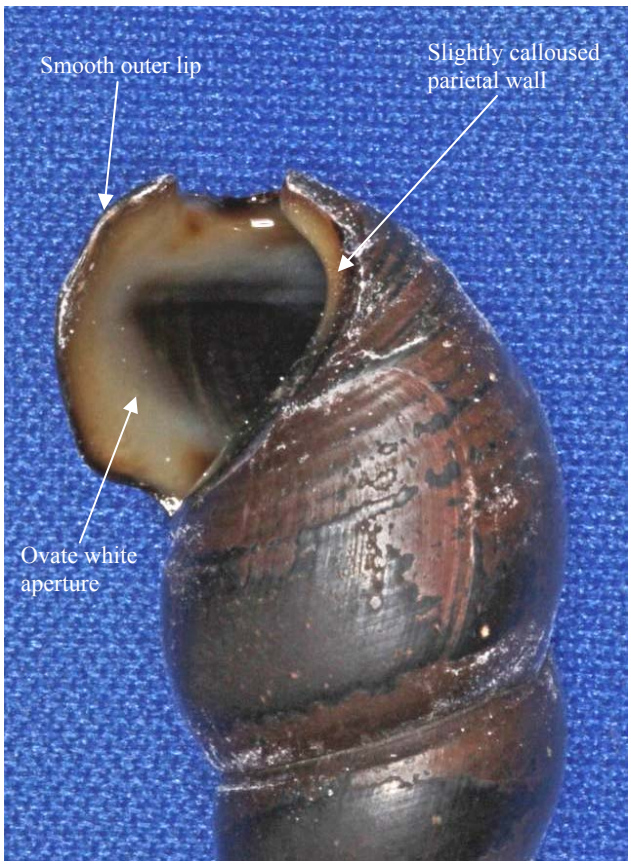

Fig. 8. Close-up of the aperture of the shell. (Photograph by: Alvin Francis Lok Siew Loon).

Fig. 9. Side view of the aperture. (Photograph by: Alvin Francis Lok Siew Loon).

In 2007, WFA observed that the side berms and entire deeper central channel of the drain were covered with *Faunus ater* individuals to a depth of around 10 cm (≈ 6200 individuals m^{-2}), while a visit on 3 Mar.2011, WFA and AFSLL observed *Faunus ater* only covering the side berms and entire deeper central channel of the drain to a depth of about 5 cm (≈ 5800 individuals m^{-2}). However on 14 Mar.2011, WFA and AFSLL observed that individuals concentrated to the deeper central channel of the drain to a depth of about 5 cm rather than the entire drain bottom (≈ 6700 individuals m^{-2}) (Fig. 4). We are unclear of the reasons for these population fluctuations of *Faunus ater* around and in the drain, although the period during Mar.2011 did coincide with high levels of rainfall. This period of high rainfall could have affected the temperature and other physicochemical characteristics of the water which has been suggested by Garg et al. (2009) to cause fluctuations in abundance and density of many freshwater mollusc species, including *Faunus ater*. The increase in freshwater discharge via the drain could have also led to a fraction of the population being washed out to sea.

The salinity of water in the pond where *Faunus ater* is found, ranges from low- to mid-salinity, brackish water (specific gravity: 1.002–1.008), while the salinity in the drain ranges from low-salinity, brackish water to full strength seawater (specific gravity: 1.002–1.025). The salinity varies considerably. During spring tides, saltwater influx is expected at the overflow areas of the sluice gates with total seawater inundating the drain, although gradual dilution is expected to occur following a drop in the tide levels as well as increased rainfall, which leads to the influx of freshwater.

Interestingly, this pond and canal happens to be the only yet known locality for this species in Singapore. It is curious that a species so apparently abundant, at least in this location, was not recorded by earlier workers (e.g., Chuang, 1973; Way & Purchon, 1981), and the first published record of this species appear to be by Tan & Woo (2010). The West Coast Park area was reclaimed and modified only a few decades ago and could have created a suitable habitat where there was previously none. A natural colonisation would be plausible as a marine larval phase has been suggested for this species (Houbrick, 1991) and Singapore is well within the known natural distribution of this species. There is also the possibility that larvae could have been transported here via ballast water of ships as the port area is nearby. Even an accidental or intentional release by pet owners from the aquarium trade cannot be ruled out, although we consider this most unlikely as this species has never been recorded for sale in the local aquarium retail shops and from fish importers. Questions such as whether *Faunus ater* is native to Singapore or a recent introduction, and whether an introduction is natural or anthropogenic, remain unanswered and require further study.

CONCLUSIONS

Faunus ater is tentatively considered native to Singapore as it is within the known natural distribution of this species. Since this species is very common in our region, it is at no immediate regional risk of extinction. However, owing to the very limited distribution of this species in Singapore, a mere loss or disturbance of this single habitat at West Coast Park could result in the local extinction of this species. To ensure the continued presence of this species, it would therefore be of utmost importance that this habitat is not developed or disturbed, which might result in the extirpation of the single-known local population. Because of the sheer number of individuals and the uncertainty of its origin, we refrain from proposing a national conservation status of "Vulnerable" to be assigned to *Faunus ater*, even though its entire population may be extirpated in a single instance owing to habitat degradation or destruction. Other populations may be recruited in the future if suitable habitats are created in the process of coastal redevelopment and construction.

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