

THE FISH FAUNA OF BUKIT BROWN, SINGAPORE

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ABSTRACT. — Two streams at Bukit Brown, a traditional Chinese cemetery, were surveyed for fishes. Of the 11 species found, seven were from Bukit Brown Stream, and nine from Mount Pleasant Stream. Seven of these species are alien and likely to have been artificially introduced there. Feral populations of the zebra danio (*Danio rerio*) and the paradise fish (*Macropodus opercularis*) are reported from Singapore for the first time.

KEY WORDS. — Bukit Brown, stream, freshwater fish diversity

INTRODUCTION

Bukit Brown Cemetery is situated in the central part of Singapore Island surrounded by Lornie Road to the west and north, Caldecott Hill and Mount Pleasant housing estates to the east, and the Pan-Island Expressway to the south (Fig. 1A, B). This intensively used traditional Chinese graveyard reached its maximum carrying capacity in the 1970s. The area, presently overgrown with a mixture of parkland, scrub, and secondary forest vegetation, is drained by two streams. These streams are inhabited by fish and other aquatic fauna which have not been previously studied. A recent proposal by the Land Transport Authority to build an eight-lane expressway across the cemetery drew attention to this area, not just for its rich historical value, but also to its apparently rich biodiversity which was largely ignored in the past (Ho, 2012).

The streams at Bukit Brown can be classified as open-country aquatic habitats according to Johnson (1973; Fig. 2). They had in the past been concretised into drains to better control flooding in the area, but were subsequently (with neglect) reclaimed by nature. Sediment and dead leaves cover the substrates, and the shores are overgrown with grasses, semi-aquatic plants, and small trees such as *Macaranga* species. The roots of various trees have broken up much of the concrete embankments, and algae, moss, and riparian vegetation grow over these artificial structures, giving the waterways a natural look. The two streams drain beyond Bukit Brown Cemetery eastwards past the Caldecott Hill and Mount Pleasant estates, into the Whampoa Canal along Thomson Road. The Whampoa Canal is part of the Kallang River Basin which link to the sea has since been severed with the erection of the Marina Barrage.

The present article is a documentation of the fish species that inhabit the two streams in Bukit Brown Cemetery based on recent field studies.

MATERIAL AND METHODS

Abiotic data of the streams were obtained with a concave spherical crown densiometer, a portable dissolved oxygen meter and pH meter connected to a data logger, and a digital thermometer. The stream in the north next to Lornie Road, herein referred to as the 'Bukit Brown Stream', had a mean water depth of 44 cm and the following water parameters: mean pH 6.5, mean temperature 28°C, mean dissolved oxygen 7.4 mg l⁻¹. The stream in the south next to Gymkhana Avenue, herein referred to as the 'Mount Pleasant Stream', had a mean water depth of 34 cm and the following water parameters: mean pH 6.5, mean water temperature 28°C, mean dissolved oxygen 8.4 mg l⁻¹.

Surveys of Bukit Brown's fish species were spread out over four months from Jul.–Oct.2012. Each survey was carried out within three to five days. Three surveys were made at the Bukit Brown Stream, and four surveys were conducted at the Mount Pleasant Stream. The sampling sites (indicated on Fig. 1B) are within the Bukit Brown Cemetery. During the surveys, fishes were sampled with traps and nets. Vinyl-coated round minnow traps and funnel traps made from recycled 1.5-l plastic bottles, baited with dried fish pellets for feeding carnivorous fish, were used. Nets included a custom-made push net and aquarium hand nets. While most of the fish were released after identification, a few voucher specimens were selected and retained for preservation in 10% formalin. After about a week, they were transferred to

75% ethanol and deposited at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR) at the National University of Singapore.

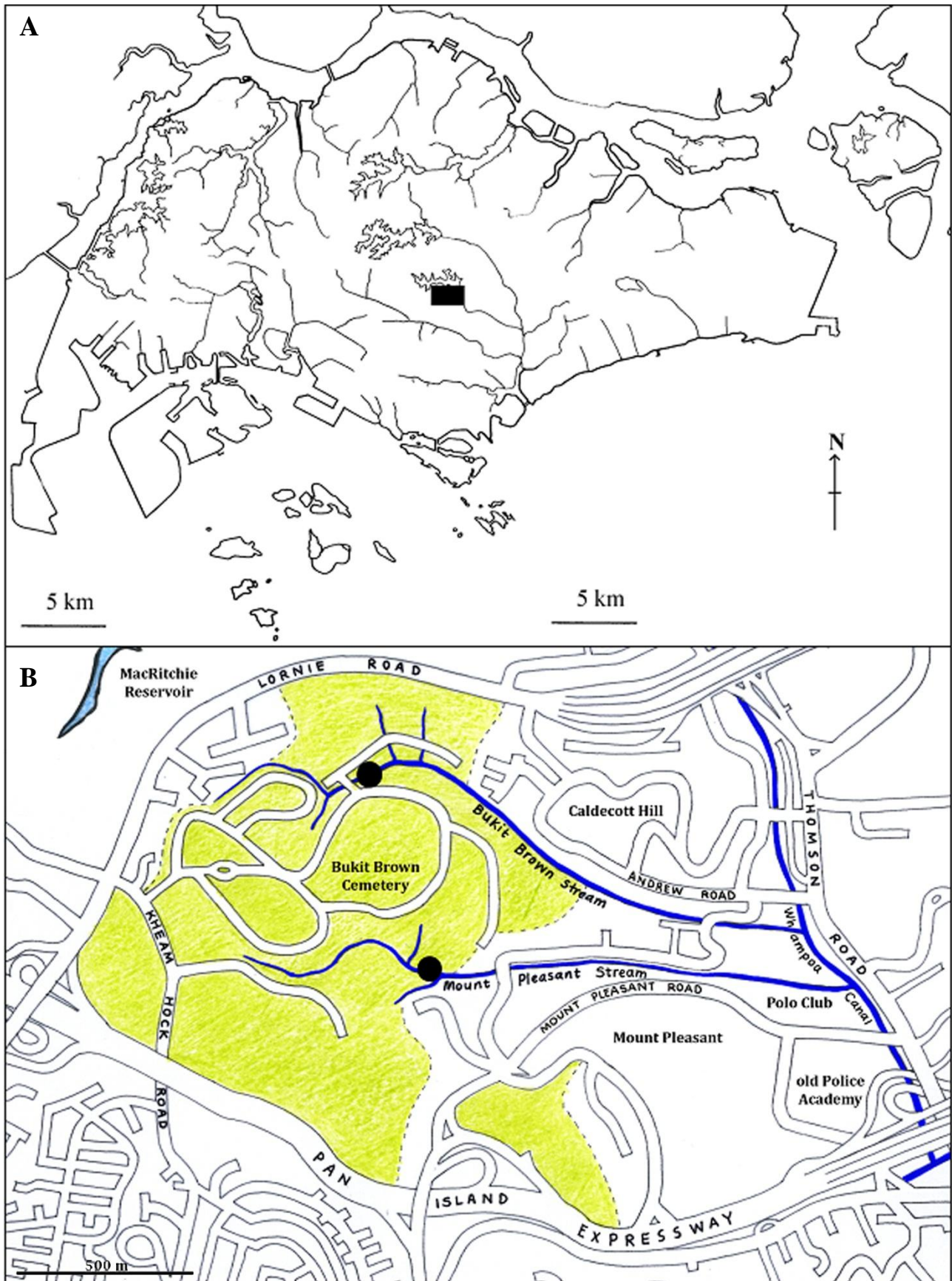


Fig. 1. Bukit Brown: A, its location on Singapore Island (solid rectangle); B, map of area (approximate area of cemetery in green) with drainage system (dark blue lines indicate waterways) and sampling sites are indicated by solid circles.



Fig. 2. Stream habitat at Bukit Brown (Jul.2012). (Photograph by: Heok Hui Tan).

SPECIES ACCOUNTS

The following fishes were collected from the two streams in Bukit Brown Cemetery.

Order Cypriniformes Family Cyprinidae

Danio albolineatus (Blyth), pearl danio (Fig. 3A)

First recorded from Singapore in the Mandai area by Lim & Tan (2011). This species is common in both Bukit Brown and Mount Pleasant streams.

Danio rerio (Hamilton), zebra danio (Fig. 3C, D)

Present only in the Mount Pleasant Stream. This is the first record of this popular and inexpensive aquarium fish species in Singapore. The species is native to northeastern India (Talwar & Jhingran, 1991). Apart from the typical form (Fig. 3C), an artificial 'frankei' variety or 'leopard danio' (Cottle, 2010) with interrupted longitudinal stripes (Fig. 3D) has also been found in the stream. In the Mount Pleasant Stream where the two *Danio* species occur together, an example bearing colour pattern intermediate between the two species is believed to be a natural hybrid of *Danio albolineatus* and *Danio rerio* (Fig. 3B).

Systomus rhombeus (Kottelat), Indochinese spotted barb (Fig. 4)

Recorded as *Puntius binotatus* and regarded as an introduced species by Ng & Lim (1996) with a specimen collected from a drain behind Andrew Road in Aug.1996. This species is subsequently listed as *Systomus rhombeus* by Baker & Lim (2012). There are large populations of this fish in both the Bukit Brown and Mount Pleasant streams, and in nearby stream systems (e.g., Venus Drive stream; H. H. Tan, pers. obs.). This species is morphologically very similar to the native *Systomus banksi*, but has a small round black blotch at the base of the dorsal fin, instead of a large dark grey triangular saddle blotch on *Systomus banksi* (Ng & Lim, 1996, as *Puntius binotatus*). While *Systomus banksi* appears to favour forest streams, this species has so far been found only in exposed habitats.

A



B



C



D



Fig. 3. *Danio* species from Bukit Brown: A, *Danio albolineatus*, 26.0 mm SL; B, possible hybrid of *Danio albolineatus* and *Danio rerio*, 27.2 mm SL; C, *Danio rerio*, 20.1 mm SL; D, *Danio rerio* ‘frankei’ variety, 39.1 mm SL. (Photographs by: Heok Hui Tan).



Fig. 4. *Systomus rhombeus* from Bukit Brown: A, adult, 56.4 mm SL; B, juvenile, 31.6 mm SL. Note the presence of a small black blotch at the base of the dorsal fin. (Photographs by: Heok Hui Tan).

Order **Siluriformes**
Family **Clariidae**

Clarias batrachus (Linnaeus), common walking catfish (Fig. 5)

This apparently native catfish is present in both Bukit Brown and Mount Pleasant streams. It is nocturnal and omnivorous, and inhabits open country waterways where large individuals are one of the major aquatic predators.

Order **Cyprinodontiformes**
Family **Poeciliidae**

Poecilia reticulata Peters, guppy

Introduced to Singapore since 1937 possibly for mosquito control, the guppy is common in many of Singapore's waterways (Lim & Ng, 1990). It is abundant in both Bukit Brown and Mount Pleasant streams.

Xiphophorus maculatus (Günther), southern platy (Fig. 6A)

Present in both Bukit Brown and Mount Pleasant streams where the populations appear to be self-sustaining. This Central American native is a popular and very inexpensive aquarium fish. It was previously recorded by Ng & Lim (1996) from a monsoon drain along Cluny Road.

Xiphophorus variatus (Meek), sunset platy (Fig. 6B)

One individual was collected at the Bukit Brown Stream. This popular ornamental fish, native to Central America, is listed as a feral species by Ng & Lim (1996; as *Xiphophorus variegatus* [sic]).

Order **Synbranchiformes**
Family **Synbranchidae**

Monopterus albus (Zuiew), Asian swamp-eel (Fig. 7)

Present in both Bukit Brown and Mount Pleasant streams. Of the 11 adults caught in traps in the Bukit Brown Stream, almost all were well over 40 cm in length, with the largest being 60 cm.



Fig. 5. *Clarias batrachus* juvenile from Bukit Brown, 24.4 mm SL. (Photograph by: Heok Hui Tan).

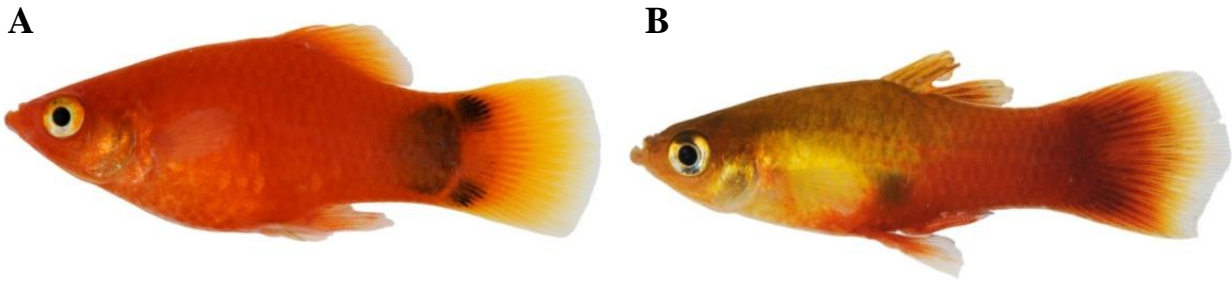


Fig. 6. *Xiphophorus* species from Bukit Brown: A, *Xiphophorus maculatus*, 27.3 mm SL; B, *Xiphophorus variatus*, 28.3 mm SL. (Photographs by: Heok Hui Tan).



Fig. 7. *Monopterus albus* from Bukit Brown, ca. 500 mm TL. (Photograph by: Heok Hui Tan).

Order **Gobiiformes**
Family **Eleotridae**

Oxyleotris marmorata (Bleeker), marbled gudgeon

One juvenile example obtained from the Mount Pleasant Stream. Although considered a native species, the populations that have colonised Singapore's freshwaters appear to be derived from stocks that were deliberately introduced (it is a highly esteemed food fish). The specimen could either be released at the site by people, or it could have originated from downstream.

Order **Anabantiformes**
Family **Osphronemidae**

Betta pugnax (Cantor), Malayan forest betta (Fig. 8)

Present in both Bukit Brown and Mount Pleasant streams. Typically an inhabitant of forest streams, it is of interest to note that there are thriving populations of this fish in the cemetery. However, it is likely that these are derived from stocks that were deliberately introduced recently (see Discussion).

Macropodus opercularis (Linnaeus), paradise fish (Fig. 9)

Found only at the Mount Pleasant Stream. This is the first record in Singapore of this popular ornamental fish which is native to subtropical East Asia (Freyhof & Herder, 2002). That more than two individuals were obtained during the surveys suggests the possibility of this alien species breeding in the stream.



Fig. 8. *Betta pugnax* from Bukit Brown, 29.6 mm SL. (Photograph by: Heok Hui Tan).



Fig. 9. *Macropodus opercularis* from Bukit Brown, 37.9 mm SL. (Photograph by: Heok Hui Tan).

DISCUSSION

A total of 11 species of fish were found in the streams at Bukit Brown. Of these, only four (*Clarias batrachus*, *Monopterus albus*, *Oxyeleotris marmorata*, and *Betta pugnax*) can be considered native. That seven out of 11 species are alien is indicative of high human impact on the habitat. Seven species of fish were recorded from the Bukit Brown Stream, while the Mount Pleasant Stream had nine. Four taxa were found from only either one of the streams: *Danio rerio* (Mount Pleasant), *Macropodus opercularis* (Mount Pleasant), *Oxyeleotris marmorata* (Mount Pleasant), and *Xiphophorus variatus* (Bukit Brown). All four species are of alien origin, with the possible exception of *Oxyeleotris marmorata*.

It is also of interest to note the apparent absence in Bukit Brown of a number of locally common native fish species that typically inhabit open-country habitats. These include *Dermogenys collettei* (Sunda pygmy halfbeak), *Aplocheilichthys panchax* (whitespot), *Channa striata* (paddyfield snakehead), *Anabas testudineus* (climbing perch), *Trichopodus trichopterus* (three-spot gourami), and *Trichopsis vittata* (croaking gourami), as well as the introduced *Oreochromis mossambicus* (Mozambique tilapia; see Johnson, 1973; Baker & Lim, 2012). It is highly likely that these species may have occurred in the waterways of Bukit Brown prior to their concretisation. That the walking catfish (*Clarias batrachus*) and the swamp-eel (*Monopterus albus*) are found and are the main piscine predators in the streams could mean that these fishes may have re-colonised these water bodies by their ability to survive out of water for a limited time and travel over land in search of new habitats. *Channa striata* and *Anabas testudineus* are also capable of doing the same. As such, their presence at Bukit Brown is possible but specimens were not obtained during our surveys.

As the waterways in Bukit Brown had been concretised, it is likely that the original fish fauna there had all been wiped out. The fishes that are presently found there would have gradually re-colonised the streams when conditions became habitable, as when the concrete embankments crumbled and vegetation overgrew the banks. Alternatively, they would have been deliberately introduced. The latter will apply to the seven non-native species. These non-native species were most likely released in large quantities, and intentionally, by people, possibly for the purpose of 'fang sheng' (see Ng & Tan, 2010).

The presence of *Betta pugnax*, a native fish that typically favours forest streams, is puzzling. It would not have survived the concretisation of the waterways. Unless there was an adjacent refuge habitat with a relict population that somehow survived the conversion of the original forest into a cemetery, it seems likely that the population of this species in Bukit Brown was introduced. The time of introduction would have to be recent, for the concrete embankments of the waterways would need to be broken and the riparian vegetation grown densely, to render the habitat suitable for this fish.

In the upcoming highway project, the plan is for the new eight-lane expressway to pass over the Bukit Brown Stream on a bridge (Ho, 2012). The ensuing construction work will inevitably have a certain amount of impact on the surrounding environment, and on the stream itself. Therefore, it is important that the Land Transport Authority takes steps to minimise damage to the stream by preventing excessive erosion and siltation, and by removing any disposed construction material and litter from the site. However, during this study, we have observed that part of the Bukit Brown Stream located next to a preliminary construction work site was already littered with plastic bottles and wrappers.

Unlike the rich cultural heritage and birdlife (Ho, 2012; Sharp, 2012), the fish fauna of Bukit Brown does not seem to warrant special attention. However, if the natural environment of the cemetery is to be preserved, these streams will need to be left undisturbed and measures need to be taken to prevent their pollution by litter from visitors and construction projects. It is hoped that this study will contribute to the appreciation of the rich fauna in Bukit Brown Cemetery, and that it may serve as a reference point for future studies after the completion of the road bridge project.

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