

GOURAMIES OF THE GENUS *TRICHOPODUS* IN SINGAPORE (ACTINOPTERYGII: PERCIFORMES: OSPHRONEMIDAE)

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ABSTRACT. — The local distribution and status for gouramies of the genus *Trichopodus* in Singapore are reviewed. Of the three species recorded, i.e., *Trichopodus trichopterus*, *Trichopodus pectoralis*, and *Trichopodus microlepis*, only *Trichopodus trichopterus* is native. It is also the most common and widespread. *Trichopodus pectoralis* is thriving but uncommon, and *Trichopodus microlepis* does not appear to have established populations.

INTRODUCTION

Gouramies are laterally compressed, deep-bodied fishes with a long-based anal fin and a pair of stiff but thread-like pelvic fins that function as sensory organs. They have a labyrinth organ situated in a cavity above the gills that absorbs oxygen from gulps of atmospheric air periodically taken at the water's surface. It supplements the oxygen obtained from the water through the gills which alone does not supply sufficient oxygen, even in water saturated with the gas. Hence, gouramies will drown if denied access to the water surface. However, this ability to breathe atmospheric air allows gouramies to survive, and even thrive in oxygen-deprived water (Tweedie, 1953; Pinter, 1986; Linke, 1991; pers. obs.).

The genus *Trichopodus* Lacepède consists of gouramies that share the following morphological characteristics: body relatively laterally compressed and deep-bodied; short-based dorsal fin inserted at the middle of the body, far behind the pectoral fin base; pelvic fin a long filamentous ray and two to three small rays in the axil; lateral line interrupted or complete; and caudal fin emarginated to forked with rounded lobes. Adult males can be readily recognised by their dorsal fins with elongated posterior fin-rays which form a posterior pointed profile that may reach the caudal fin base (Rainboth, 1996; Kottelat, 2001; as *Trichogaster*; pers. obs.).

Species of *Trichopodus* usually inhabit shallow, sluggish or standing freshwater habitats with lush growths of aquatic vegetation. These fish are omnivorous, feeding on small invertebrates and algae. They are largely gregarious, moving in groups, but mature males tend to be quarrelsome with each other (Linke, 1991; Rainboth, 1996; as *Trichogaster*; pers. obs.).

Breeding males build nests of mucous-coated bubbles at the water surface among floating vegetation into which the eggs are deposited during spawning. Courtship and spawning behaviour is elaborate and stereotyped, and occurs in discrete temporal phases. The onset of courtship is marked by increased territoriality, development of nuptial colouration, and nest-building in the male. Male's approach towards female is characterised by aggressive behaviour interspersed with lateral displays. Successful courtship concludes with the male leading the female back to the nest. Spawning is initiated by the female with a series of butts directed at the flank of the male. The male assumes a position beneath the female, and curves his body into a semicircle. When his mate enters the curve, the male clasps her by bringing his caudal fin and head together. This is superceded by the release of eggs and sperm, followed by a short period of swimming inhibition. When this is done, the male chases the female from the nest, and then retrieves eggs to be placed in the bubble nest. Spawning bouts are repeated until the eggs are exhausted. After which, male–female interactions descend into purely aggressive behaviour. The male stays on to guard the nest until the fry hatch (Miller & Robison, 1974; Robison, 1975; as *Trichogaster*).

Until recently, these gouramies were widely known as *Trichogaster* Bloch & Schneider, following the misinterpretation of the type species of the genus by Myers (1923a, 1923b). This apparently went un-noticed until pointed out by Derijst (1997) in an obscure Dutch publication. The type species for the genus *Trichogaster* should be what was known as *Colisa fasciata*, and what was known as *Trichogaster trichopterus* is the type species for the genus *Trichopodus* Lacepède (see summary by Britz, 2004). It turns out that *Trichopodus*, mistakenly considered a synonym of *Osphronemus* (the giant gouramies), is valid; and those gouramies long regarded as members of the genus *Colisa*, such as *Colisa lalia* (dwarf gouramy), *Colisa labiosa* (thick-lipped gouramy), and *Colisa sota* (honey gouramy), should belong under *Trichogaster*. Gouramies formerly known under the genus *Trichogaster*, i.e., *Trichogaster trichopterus*

(three-spot gouramy), *Trichogaster leerii* (pearl gouramy), *Trichogaster pectoralis* (snakeskin gouramy), and *Trichogaster microlepis* (moonlight gouramy) are presently in the genus *Trichopodus*. However, this revised classification was not widely adopted until the past few years.

The genus *Trichopodus* is distributed throughout most of Southeast Asia, from southern China, through Indochina and Myanmar, down the Malay Peninsula to Borneo, Sumatra and Java, and their adjacent islands. In the lower Chao Phraya and Mekong river basins of Thailand and Cambodia, three native species (*Trichopodus trichopterus*, *Trichopodus pectoralis*, and *Trichopodus microlepis*) are sympatric (Rainboth, 1996; Vidthayanon, 2008; as *Trichogaster*). Because of their commercial importance as food and aquarium fish, *Trichopodus* gouramies have been introduced to many areas outside their native range (Pinter, 1986; Linke, 1991; as *Trichogaster*).

Of the four valid species of *Trichopodus*, three have been recorded from Singapore. They are *Trichopodus trichopterus*, the three-spot gouramy; *Trichopodus pectoralis*, the snakeskin gouramy; and *Trichopodus microlepis*, the moonlight gouramy (Ng & Lim, 1996). This article reviews the status and local distribution of these three species in Singapore.

MATERIAL AND METHODS

In the next section, each species of *Trichopodus* is presented as follows:

Diagnosis. — A summary of the main characters that differentiate each species of *Trichopodus* from its congeners, the maximum known size, and its known geographic distribution.

Records in literature. — Publications that mention the occurrence of the species within Singapore are listed. The references are grouped according to the scientific names used in those citations, and then arranged in chronological order. The scientific names are listed in alphabetical order. Specific localities and general remarks on the distribution, habitat, status, and abundance of the species are included within parentheses at the end of each reference cited.

Material examined. — Specimens examined were collected from Singapore and are deposited in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR) at the National University of Singapore. Specimens are cited as follows—locality of collection: catalogue number (number of specimens), month and year of collection. The following abbreviations have been used: SL refers to standard length, between the tip of the snout and the base of the caudal fin; TL refers to total length, between the tip of the snout and the tip of the caudal fin.

Remarks. — General information and observations on the natural history, use by humans, status, and local distribution of each *Trichopodus* species in Singapore are included.

SPECIES ACCOUNTS

Trichopodus trichopterus (Pallas)
Common name: three-spot gouramy
Figs. 1–4

Diagnosis. — Dorsal fin with 6–8 spines; body greenish to brownish with numerous narrow and irregular, oblique, grey cross bars; one black blotch on middle of flank and another black blotch on caudal-fin base; in life, orange spots along margin of anal fin. Reaches a maximum size of 15 cm TL (about 11 cm SL). Native to southern China (Yunnan), Indochina, Thailand, the Malay Peninsula, Borneo, Sumatra, Java, and Madura. Introduced to Bali, Sri Lanka, India, New Guinea, north-western Australia, the Philippines, Taiwan, the U.S.A. in Florida, the Dominican Republic, Jamaica, Colombia, and Brazil (Courtenay et al., 1984; Tan et al., 1987; Welcomme, 1988; Juliano et al. 1989; Allen, 1991; Pethiyagoda, 1991; Kottelat & Whitten, 1993; Lever, 1996; Fuller et al., 1999; de Magalhaes et al., 2002; Daniels & Rajagopal, 2004; Webb et al., 2007; Chen et al., 2010; Geheber et al., 2010; as *Trichogaster trichopterus*).

Records in literature. — *Trichogaster trichopterus*—Hanitsch, 1901: 4 (Singapore); Hanitsch, 1904: 14 (Singapore); Herre & Myers, 1937: 73 (ponds on Singapore Island); Alfred, 1961: 17 (various localities including Kranji, Jurong and Seletar Rivers); Chia, 1962: 3–4 (ponds and ditch at Jalan Kuala Simpang, Sungei Simpang Kiri stream, ditch at 17th mile stone Jurong Road); Alfred, 1966: 52 (Sungei Ayer Tawar at Huat Choe, Sungei Seletar at Nee Soon Rifle Range, Serangoon, Jervois Road, Woodleigh, Sungei Tengeh, Serangoon Road at Alkaff Gardens, Sungei Kangkar at 17th mile Lim Chu Kang Road, Sungei Kallang outlet of Lower Peirce Reservoir, Sungei Seletar outlet of Upper Seletar Reservoir, Somerset Road); Johnson, 1973a: 112–120 (inhabits drinking water reservoirs, open country habitats, weedy ditches and ponds, fish ponds, water hyacinth ponds); Johnson, 1973b: 133 (occurs in oligohaline waters); Anonymous, 1988a: 9 (Bukit Timah Nature Reserve in Feb.1988, pond in Nee Soon swamp forest in Apr.1988, Senoko in



Fig. 1. *Trichopodus trichopterus*, male of 61.6 mm SL from Sungei Buloh Wetland Reserve. (Photograph by: Tan Heok Hui).



Fig. 2. *Trichopodus trichopterus*, female of 75.5 mm SL from Sungei Buloh Wetland Reserve. (Photograph by: Tan Heok Hui).

Mar.1988); Anonymous, 1989: 5 (brackish water pond at Woodlands Town Gardens in Feb.1989); Lim & Ng, 1990: 97 (rural and forest streams, ponds and reservoirs); Munroe, 1990: 112 (common in many rural and outlying streams in the Mandai, Nee Soon and other northern areas); Ng & Lim, 1992: 259 (Nee Soon Swamp Forest); Lim, 1995: 162 (Bukit Timah Nature Reserve in Catchment Pond); Ng & Lim, 1996: 114 (Jurong Road, ditches near Sembawang Hot Spring, West Coast Road, Sg. Kranji along Choa Chu Kang Road, Jurong Road, Mandai, adjacent streams of Upper Seletar Reservoir); Ng & Lim, 1997: 252 (Central Catchment Nature Reserve in exposed water bodies); Lim et al., 2000: 21–22 (pipeline pool and range area in Nee Soon Swamp Forest, freshwater pond at Sungei Buloh Wetland Reserve, streams and ponds at Ulu Sembawang and Lorong Gambas, streams at Upper Seletar Reservoir Park); Subaraj et al., 2000: 6

(rural stream at Lorong Danau); Anonymous, 2003: 95 (Sungei Buloh Wetland Reserve); Baker & Lim, 2008: 47, 158 (native, widespread and common). *Osphromenus trichopterus*—Duncker, 1904: 164 (Rochor River); Hanitsch, 1912: 27 (various localities within city area of Singapore). *Trichopodus trichopterus*—Fowler, 1938: 124 (Singapore); Tweedie, 1936: 23 (Singapore).

Material examined. — Sarimbun Reservoir: ZRC 51039 (1), May.2007. Sungei Buloh Wetland Reserve: ZRC 23020 (4), Jul.1992; ZRC 53311 (9), Dec.2011. Sungei Ayer Tawar at Huat Choe: ZRC 1040 (3), May.1958; ZRC 1021 (4), Mar.1958. Sungei Kangkar at 17th mile Lim Chu Kang Road: ZRC 1243 (40), May 1963. Sungei Kranji at 17.5 mile Choa Chu Kang: ZRC 8894 (2), Mar.1958. Jurong Road at 15.5 mile: ZRC 5780 (3), Jun.1961. Sembawang: ZRC 6016 (1), Oct.1957. Sungei Seletar: ZRC 805 (1), Feb.1966. Sungei Seletar at Nee Soon Rifle Range: ZRC 1035 (1), Feb.1958. Sungei Seletar outlet of Upper Seletar Reservoir: ZRC 1277 (7), Jan.1964. Lorong Banir stream: ZRC 37744 (1), Jun.1994. West Coast Road: ZRC 6517 (6), Feb.1962. Jurong Road, 17th mile: ZRC 10964 (29), Apr.1966. Buona Vista Road, fish ponds: ZRC 5670 (3), Nov.1957. Sungei Kallang, outlet of Lower Peirce Reservoir: ZRC 1265 (29), Jan.1964. Pulau Tekong, reservoir: ZRC 50913 (3), Mar.2007; ZRC 50967 (4), Mar.2007. Punggol Reservoir at Seletar Wet Gap: ZRC 53161 (3), Aug. 2011; ZRC 53214 (8), Apr.2011. Serangoon: ZRC 1102 (5), Aug.1898. Serangoon Road at Alkaff Gardens: ZRC 1179 (3), Jan.1964. Jervois Road: ZRC 1103 (2), May 1912. Somerset Road: ZRC 1289 (4), May 1912. Moulmein Road: ZRC 1104 (1), May 1912. Woodleigh: ZRC 1106 (6), 1900. Singapore (no other data): ZRC 1107 (2), 1934. Largest specimen: 81.8 mm SL (from ZRC 6517).

Remarks. — *Labrus trichopterus* was described in 1770 by P. S. Pallas based on specimens from an unknown locality in the East Indies. The specific epithet *trichopterus* is used as a noun, and will remain unchanged regardless of the gender of its genus (Ng & Lim, 1996). This species' occurrence in Singapore was first mentioned by Hanitsch (1901).

The three-spot gouramy occurs in weedy ponds, freshwater marshes and slow-flowing streams in the rural countryside of Singapore Island, particularly in the north and west, and also on Pulau Tekong off to the north-east. Owing to urbanisation and canalisation of waterways, this fish seems to have disappeared from localities within Singapore city where it was once present (Hanitsch, 1912). In addition to the localities listed in literature records and material examined, we have seen *Trichopodus trichopterus* in ponds at the Kranji Marshes off Neo Tiew Lane 2 in 2011 (Fig. 4), as well as in ponds and marshland adjacent to the Tengeh and Poyan Reservoirs in the Western Catchment Area in 2006. An educational signboard at the Lorong Halus Wetland clearly indicates the presence of this species in its polishing ponds, although we have not seen any example to verify this.

Trichopodus trichopterus is often difficult to detect in water bodies by observation alone, particularly if the clarity of the water is poor. Although individuals may be seen at night by torchlight along the water's edge, its habit of rising to the surface as a group to gulp air (Baker & Lim, 2008) is a good indication of its presence. *Trichopodus trichopterus* is tolerant of weed-choked waters with low oxygen content, and can even live in brackish water (Webb et al., 2007). Chia (1962) found that it can withstand waters with pH values ranging from an acidic 4.5 to a hyper-alkaline 9.5. At the Sungei Buloh Wetland Reserve and the Kranji Marshes, we have observed *Trichopodus trichopterus* in the same habitat as other air-breathing fishes such as *Anabas testudineus* (climbing perch), *Trichopsis vittata* (croaking gouramy), and *Channa striata* (paddyfield snakehead), as well as alien fishes like *Oreochromis mossambicus* (Mozambique tilapia), *Rasbora borapetensis* (red-tailed rasbora), and *Trichopodus pectoralis* (snakeskin gouramy).

In her study on the food and feeding habits of *Trichopodus trichopterus*, in Singapore and southern Peninsular Malaysia, Chia (1962) reported that juveniles 2.5 cm or smaller feed at the surface, largely on zooplankton. With growth and increasing relative gut length, they become bottom feeders to some extent, their diet consisting mainly of benthic algae. This does not mean that adult fish are herbivorous. They are opportunistic omnivores (Degani, 1991; Webb et al., 2007; as *Trichogaster trichopterus*), and in the aquarium have been observed feeding on bread and fish carcasses (pers. obs.). Fry raised in captivity have been observed to oppress and cannibalise their smaller siblings, and adults are celebrated among aquarium fish hobbyists for being one of the very few species that will eat hydroids (Petrovický, 1993, as *Trichogaster trichopterus trichopterus*). The three-spot gouramy will eat insect larvae (pers. obs.; Webb et al., 2007, as *Trichogaster trichopterus*), and its value in controlling mosquito breeding has been recognised by Hanitsch (1912).

The three-spot gouramy is a popular aquarium fish, and was imported alive into Europe as early as 1896. As it is not difficult to keep and breed, many colour variants have been developed. The three most popular colour variants are the 'Cosby', 'golden' and 'silver' forms. The 'Cosby' gouramy carries dark blue mottled patches on a light blue body, whereas the 'golden' and 'silver' varieties are an intense gold and silver, tinged with a green or sometimes red hue, respectively (Petrovický, 1993, as *Trichogaster trichopterus trichopterus*; Tweedie, 1953; Pinter, 1986; Linke, 1991; Elson & Lucanus, 2002; as *Trichogaster trichopterus*). *Trichogaster trichopterus sumatranus*, described by Ladiges in 1933, is a smaller blue variety thought to be a natural colour variant that is endemic to Sumatra (Linke, 1991). However, it is presently believed to be an artificially bred mutant as such blue fish have never been collected from the wild in Sumatra (Tan & Ng, 2005, as *Trichogaster trichopterus*).



Fig. 3. In situ underwater image of *Trichopodus trichopterus* of about 6 cm TL in a freshwater pond at Sungei Buloh Wetland Reserve. (Photograph by: Kelvin Lim).



Fig. 4. *Trichopodus trichopterus* of about 8 cm TL, at night in a pond at the Kranji Marshes. (Photograph by: Kelvin Lim).

In Singapore, the original wild form of *Trichopodus trichopterus* is very rarely offered for sale as aquarium fish, but the various artificial colour varieties are regularly sold (pers. obs.). In spite of this, we have yet to see examples of domesticated forms of the three-spot gouramy in the wild state in Singapore. Although *Trichopodus trichopterus* is eaten in neighbouring countries such as Indonesia and Malaysia, (H. H. Tan, pers. comm.), it does not appear to be used as a food fish in Singapore. On a trivial note, this is one of seven species of native fish featured on a Singapore stamp series issued on 31 Mar.1962 (Alfred, 1962, as *Trichogaster trichopterus*).

Trichopodus pectoralis Regan
Common name: snakeskin gouramy
Fig. 5

Diagnosis. — Dorsal fin with 7 spines; body olive brown with numerous oblique, grey cross bars; an irregular black stripe from eye across the flank, to mid caudal-fin base. Reaches a maximum size of 25 cm TL (about 19 cm SL). Native to the Chao Phraya and Mekong basins of Indochina. Introduced to Malaysia and Singapore, Indonesia, New Guinea, Sri Lanka, Hong Kong, the Philippines, New Caledonia, Pakistan, Japan, Columbia, Bangladesh, the Antilles and Haiti (Smith, 1933; Smith, 1945; Pinter, 1986; Welcomme, 1988; Allen, 1991; Linke, 1991; Pethiyagoda, 1991; Kottelat & Whitten, 1993; Barua et al., 2001; Tan & Ng, 2005; as *Trichogaster pectoralis*).

Records in literature. — *Osphromenus siamensis* (not of Günther)—Hanitsch, 1901: 4 (Singapore); Hanitsch, 1904: 14 (Singapore). *Trichopodus pectoralis*—Regan, 1910: 784, pl. 79 Fig. 1 (original description, type localities: Thailand and Singapore); Fowler, 1938: 123 (Singapore). *Trichogaster pectoralis*—Herre & Myers, 1937: 73 (pond on Singapore Island); Tweedie, 1952: 76 (established in Singapore); Alfred, 1961: 17 (Jurong and Kranji Rivers); Alfred, 1966: 51 (Woodleigh, ditch along Moulmein Road, Sg. Kallang outlet from Peirce Reservoir); Johnson, 1973a: 122 (introduced food fish well established in several localities); Tan et al., 1987: 22 (relatively uncommon in Singapore); Anonymous, 1988a: 9 (Singapore Botanic Gardens in Mar.1988; stream flowing from Upper Seletar Reservoir in Mar.1988); Anonymous, 1988b: 30 (rural Mandai in Apr.1988); Chou & Lam, 1989: 94 (well established in the wild in Singapore); Lim & Ng, 1990: 97 (feral, uncommon, inhabits rural streams and ponds); Munro, 1990: 112 (common in the Seletar area); Ng & Lim, 1992: 259 (Nee Soon Swamp Forest); Ng & Lim, 1996: 117 (Nee Soon Swamp Forest, rural Mandai, Sungei Buloh); Ng & Lim, 1997: 260 (Nee Soon Swamp Forest); Anonymous, 2003: 95 (Sungei Buloh Wetland Reserve); Baker & Lim, 2008: 165 (introduced, rare and restricted); Yeo & Chia, 2010: 34 (established in Singapore).

Material examined. — Mandai, in rural stream: ZRC 5635 (1), 1988; ZRC 6824 (1), Apr.1988. Nee Soon Swamp Forest: ZRC 19853 (1), Jan.1992. Sungei Buloh Wetland Reserve, fish ponds: ZRC 23017 (3), Jul.1992. Sungei Peng Siang: ZRC 804 (1), Oct.1966. Sungei Whampoa: ZRC 6462 (2), Jun.1961. Sungei Kallang, outlet of Lower Peirce Reservoir: ZRC 1264 (4), Jan.1964. Woodleigh: ZRC 1100 (1), undated. Sungei Punggol: ZRC 51388 (2), Oct.1965. Singapore (no other data): ZRC 1099 (1), 1934; ZRC 1101 (1), 1900. Largest specimen: 140.0 mm SL (from ZRC 804).



Fig. 5. *Trichopodus pectoralis*, male of 96.6 mm SL from Sungei Buloh Wetland Reserve. (Photograph by: Tan Heok Hui).

Remarks. — *Trichopodus pectoralis* was described from Siam (Thailand) and Singapore by C. Tate Regan in 1910. Alfred (1966: 52) selected as lectotype, one of the Thai syntypes and restricted the type locality of this species to Bangkok. Before the species was formally named, Hanitsch (1901, 1904) reported the snakeskin gouramy from Singapore as *Osphromenus siamensis*, which is actually a synonym of *Trichopodus trichopterus* (see Eschmeyer, 1998). According to Smith (1933), the snakeskin gouramy was introduced from Thailand to Singapore in 1898, and not in the 1930s as stated by Lim & Ng (1990).

Tweedie (1952) stated that the species had, by the 1950s, been established in Singapore. On the contrary, Alfred (1966: 52) was under the impression that the species was not well-established as he had collected only one series of 14 examples from the Sungei Kallang draining out of (Lower) Peirce Reservoir in Jan. 1964. Ng & Lim (1996: 117) stated that *Trichopodus pectoralis* was common only in the reservoirs (notably Seletar Reservoir) and found in some of their adjacent streams. However, this claim is not substantiated by museum collections at the ZRC, nor by Ng & Tan (2010), whose survey of the alien fish fauna in Singapore's reservoirs did not yield this species.

In recent years, the snakeskin gouramy has been collected locally only from the freshwater ponds at the Sungei Buloh Wetland Reserve (pers. obs.). An educational signboard at the Lorong Halus Wetland on the north-eastern part of Singapore Island indicates the presence of this species in the ponds at that locality. However, we are unable to verify the occurrence of this species on our visits there in Mar. and Oct. 2011. It is not known if the snakeskin gouramy is still present at the other localities where it had been obtained in the past, but we presume that it would be extinct in areas which has become urbanised, and their waterways concretised.

This is one of a few non-native fish species that have been known to penetrate into the waterways of the Nee Soon Swamp Forest, a location inhabited by the majority of Singapore's endangered native freshwater fish species, and therefore of high conservation significance (Ng & Lim, 1992). However, there has been only one record, and it has not been reported from that area since. We believe that the snakeskin gouramy does not typically inhabit forest streams, and is unlikely to have any noticeable influence on the native fish fauna in the Nee Soon Swamp Forest.

It has been suggested that the introduced *Trichopodus pectoralis* was displacing the native *Trichopodus trichopterus* in Peninsula Malaysia (Ang et al., 1989, as *Trichogaster pectoralis* and *Trichogaster trichopterus*). Ng & Lim (1996) expressed skepticism for they did not observe this trend in Singapore. Instead, they offered the general view that while the two species are sympatric, they appear to occupy different niches, with *Trichopodus trichopterus* preferring shallower waters with more shade and vegetation, and *Trichopodus pectoralis* occurring in open country habitats and larger water bodies. While *Trichopodus trichopterus* was observed being partial to weedy environments (Smith, 1945; Mohsin & Ambak, 1983; as *Trichogaster trichopterus*), adults of *Trichopodus pectoralis* tended to nest in shallow waters but generally preferred deeper waters (Heckman, 1979, as *Trichogaster pectoralis*). However, proper comparison studies have yet to be carried out to confirm these observations. Both *Trichopodus pectoralis* and *Trichopodus trichopterus* are native to the Chao Phraya and Mekong river basins of Thailand and Cambodia and occur together there (Rainboth, 1996; Vidthayanon, 2008; as *Trichogaster*), it is expected that they would be occupying different niches, and not be in direct competition for resources.

At the Sungei Buloh Wetland Reserve, staff members have related *Trichopodus pectoralis* as being more elusive than *Trichopodus trichopterus*. Nonetheless, juveniles and gravid females have been collected, confirming the presence of a breeding population. Juveniles have been observed to swim in a monospecific shoal of over 30 individuals, in response to human disturbance. However, by all accounts, *Trichopodus pectoralis* does not seem to be abundant there (pers. obs.).

In Singapore, *Trichopodus pectoralis* can sometimes be seen in the dried, salted form being offered for sale in dried foods retail shops (Lim & Ng, 1990). These are not obtained and processed locally, but imported from neighbouring countries. As food fish, the species is never sold live or fresh in Singapore (pers. obs.). It is occasionally offered as aquarium fish (Pinter, 1986; Linke, 1991; Rainboth, 1996; Elson & Lucanus, 2002; as *Trichogaster pectoralis*) but is too drab in appearance and large in size to be of any major ornamental value (pers. obs.).

***Trichopodus microlepis* (Günther)**
Common name: moonlight gouramy

Fig. 6

Diagnosis. — Dorsal fin with 3–4 spines; body plain silvery without dark markings; iris reddish; snout more pointed than *Trichopodus trichopterus* and *Trichopodus pectoralis*. To about 16 cm TL (13 cm SL). Native to Thailand, Laos, Cambodia, and Vietnam, in the Mekong and Chao Phraya basins (Kottelat, 2001, as *Trichogaster microlepis*).

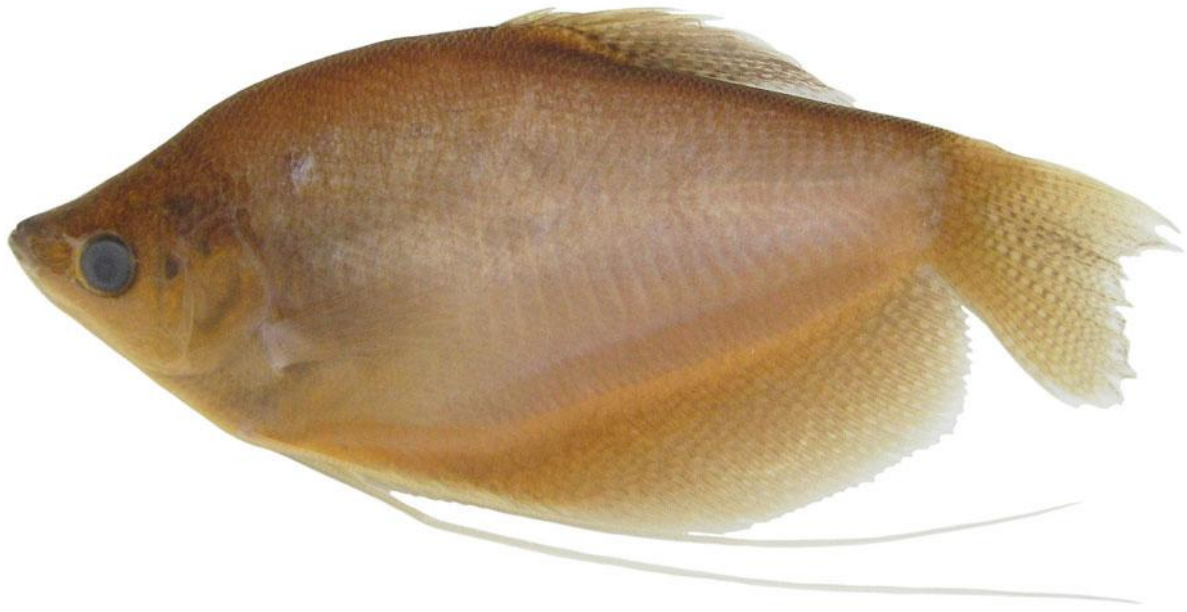


Fig. 6. *Trichopodus microlepis*, preserved male specimen of 114.1 mm SL (right side reversed) from Choa Chu Kang (ZRC 11680). Photo by Kelvin Lim.

Records in literature. — *Trichogaster microlepis*—Tan et al., 1987: 23 (introduced in Singapore through activities of tropical fish hobbyists); Anonymous, 1988a: 9 (stream in Mandai in Mar.1988); Lim & Ng, 1990: 146 (likely to become established); Munro, 1990: 112 (reports of presence in Singapore); Ng & Lim, 1996: 117 (Mandai, Jurong [= Choa Chu Kang]); Ng & Lim, 1997: 257 (possibly feral).

Material examined. — Mandai, stream from Upper Seletar Reservoir: ZRC 51387 (1), 1988. Jalan Ulu Sembawang intake station: ZRC 29112 (1), Apr.1992. Choa Chu Kang, fish ponds: ZRC 11680 (4), Apr.1990. Largest specimen: 114.1 mm SL (from ZRC 11680).

Remarks. — From the specimens taken in Singapore from three localities between 1988 and 1992, the moonlight gouramy was expected to have a very high likelihood of becoming established in the wild (Lim & Ng, 1990; Ng & Lim, 1996, 1997). However, it has not been observed or obtained recently from Singapore, and does not seem to have established itself there.

Trichopodus microlepis is a well-known ornamental fish (Pinter, 1986; Linke, 1991; Rainboth, 1996; Elson & Lucanus, 2002; as *Trichogaster microlepis*) and is occasionally sold in Singapore (pers. obs.). Specimens that were obtained locally from the wild are certainly released or escaped imported individuals, or perhaps descended from these. Even though it is not difficult to breed in captivity, there is no evidence that the moonlight gouramy is multiplying in the wild state. No spawning or juveniles have ever been observed in Singapore (pers. obs.).

DISCUSSION

Gouramies of the genus *Trichopodus* usually inhabit exposed biotopes with still or sluggish freshwater, and abundant growth of vegetation both in the water and along the shorelines. In Singapore, these are found mainly in the open countryside, largely in the north and west. They are rarely found in flowing streams in forest under tree canopies, and are absent in waterways that have been lined with concrete, cleared of vegetative cover, and with increased water flow. Many localities where these fishes have been recorded in the past, particularly those in the southern part of the island, have been developed for high-density housing estates and industries. Their streams and ditches have been canalised, and the ponds buried. The absence of records on the eastern part of the island is conspicuous but it is due to the lack of published information and observation. Suitable water bodies are present, such as in the Tampines Eco Green (park). The occurrence of gouramies there is highly likely, but this awaits verification (see Fig. 7).

Wild *Trichopodus* gouramies are not commercially exploited in Singapore. The aquarium trade utilises farmed fish, and salted fish for human consumption are imported. Therefore wild populations are not threatened by collection. The spread of urbanisation and industrialisation is the main cause of the decline in the populations of *Trichopodus* species in Singapore. However, the native *Trichopodus trichopterus* is still fairly widespread, and not considered a threatened

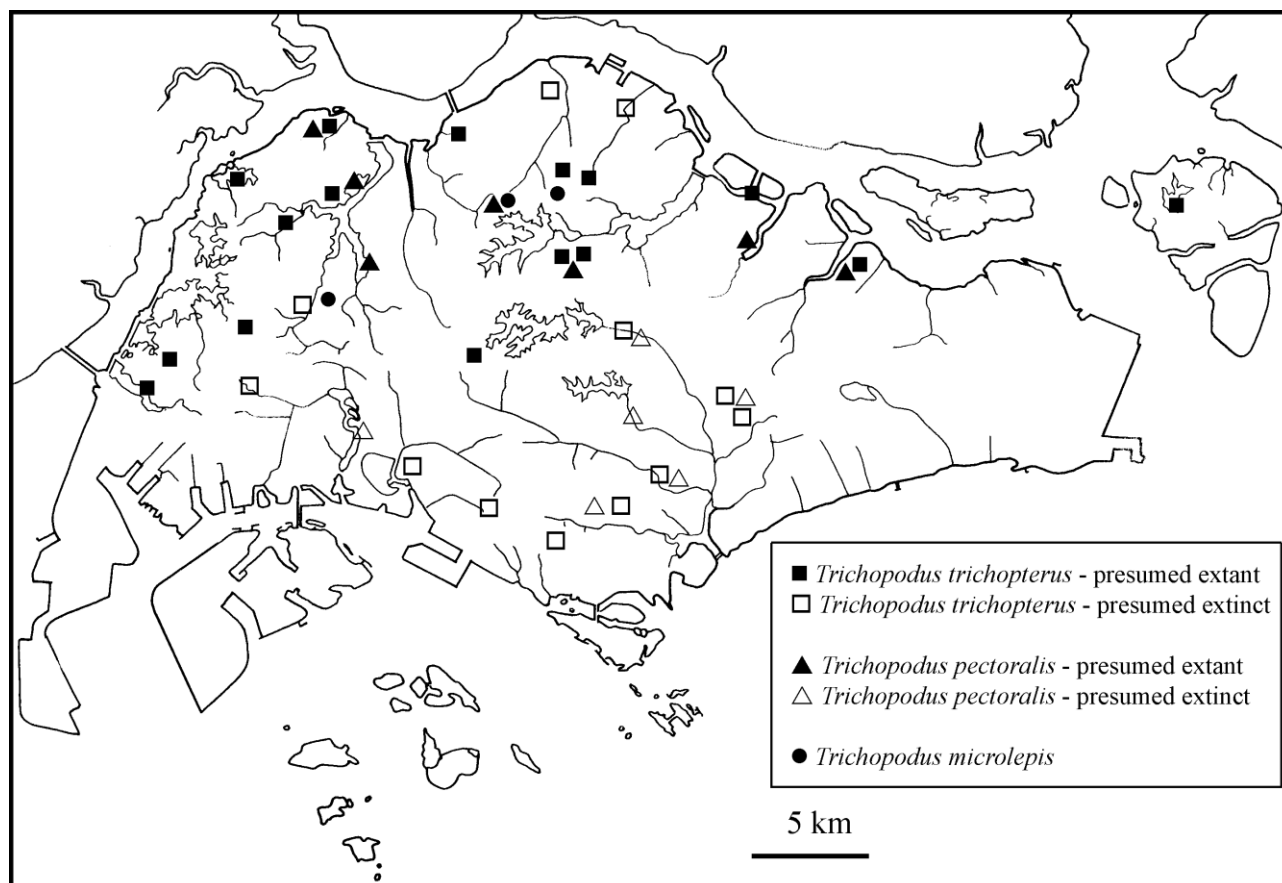


Fig. 7. Localities in Singapore where *Trichopodus* species have been recorded. Localities are listed in 'records in literature' and 'material examined' sections under the accounts for each species. Species are presumed nationally extinct in areas that have been heavily urbanised and their waterways concretised.

species. Existing wild populations of *Trichopodus* can be maintained within built-up areas in ponds if these water bodies retain their earth substratum and lush vegetation. New populations can even be established elsewhere if the new ponds are not concretised and cleared of vegetation. In recent years, government bodies overseeing the landscape and water resources in Singapore, in particular the National Parks Board and the Public Utilities Board, have tried to preserve the wild greenery and natural look of water bodies in urban parks. This is clearly demonstrated, for example, at Tampines Eco Green, Bishan Park, Punggol Reservoir, and Lorong Halus Wetland, creating more habitats for *Trichopodus* gouramies in Singapore.

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