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SOME CICHLID FISHES RECORDED IN SINGAPORE

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ABSTRACT. — Six species of cichlid fishes: *Apistogramma borellii*, *Astronotus ocellatus*, *Cichla temensis*, *Herichthys carpintis*, *Maylandia estherae*, and *Pterophyllum scalare*, and an artificial hybrid, the 'blood parrot', are recorded from Singapore based on single or few specimens. They are believed to be discarded pets or escapees, and there is as yet no evidence of them having established self-sustaining populations in Singapore's waterways.

KEY WORDS. — introduced species, Cichlidae, ornamental fish, fresh water, estuarine

INTRODUCTION

The perciform family Cichlidae is one of the largest vertebrate families (Stiassny, 1991). Many members of this family are commercially important in aquaculture and the ornamental fish trade (Pullin, 1991). One major contributing factor to their popularity in the trade is their general hardiness as well as their tendency to feed on micro-organisms, which lowers the cost of housing and feeding them (Pullin, 1991). Given their ubiquitous presence in international trade, it is not surprising that many cichlids are now found in the feral state in many countries (Williams et al., 1998; Bergman & Motta, 2005; Linde et al., 2008; Ng & Tan, 2010). The traits that make them attractive commercially are often beneficial to their survival in novel habitats, and their generalist diets (Bergmann & Motta, 2005; Rebeiro et al., 2007) in particular, favours their successful establishment in a wide range of habitats.

Cichlids were first introduced in Singapore as food fish. The Mozambique tilapia, *Oreochromis mossambicus* (Peters) was imported, apparently in 1944, for aquaculture when the supply of carp fry ceased during the Japanese Occupation (Alfred, 1966, as *Tilapia mossambica*). It is presently well-established in the wild. Since then, at least 14 cichlid species have established self-sustaining populations in Singapore (Ng & Tan, 2010). The majority of these fishes are currently thought to be restricted to artificial freshwater habitats which are largely accessible by the public, such as reservoirs and storm-water ponds. A few cichlid species were reported in literature as having been collected from Singapore, but without evidence of them having been established in the wild.

1. In 1961, a batch of fingerlings of *Tilapia zillii* (Gervais) was released into the lake at the Singapore Botanic Gardens for an aquaculture experiment. Although this African native did not become established, and there have been no records thereafter from Singapore, it is questionably cited as a feral species by Ng & Lim (1996, 1997).

2. Ng & Lim (1996) recorded a specimen of *Thorichthys meeki* Brind, the Central American firemouth cichlid, which they regard as an escapee. This 69.5 mm SL individual (ZRC 10421) was collected from a monsoon drain along Cluny Road on 19 Jan.1990.

3. The Israeli tilapia, *Oreochromis aureus* (Linnaeus) was recorded as an 'escapee' in Singapore by Ng & Lim (1997), but they did not cite specific records or specimens.

4. A specimen of *Heros severus* (Heckel) obtained from the Bedok Reservoir was treated as a discarded aquarium fish by Ng & Tan (2010). This species is also cited by Yeo & Chia (2010).

Six species of cichlid, as well as an artificial cichlid hybrid, are herein recorded for the first time in Singapore, based on single or few specimens. There is no evidence that these taxa have established populations in the wild state.

MATERIAL AND METHODS

Specimens cited in this article are stored in 75% ethanol at the Zoological Reference Collection (ZRC), Raffles Museum of Biodiversity Research (RMBR) of the National University of Singapore. Standard length (SL) is measured

from the tip of the snout to the base of the caudal fin. Total length (TL) is the distance between the snout to the distal margin of the caudal fin. All specimens cited were collected in Singapore.

RECORDS AND OBSERVATIONS

Apistogramma borellii (Regan), umbrella dwarf cichlid

Diagnosis. — Body elongate and laterally compressed, with rounded caudal fin. Dorsal and pelvic fins often with elongated protruding rays in larger individuals. Males usually blue, females yellow; a black bar beneath the eye, and a lateral black bar along the length of the body. A large ocellus present on the caudal peduncle of some individuals. Grows to 39 mm SL, males usually larger than females (Kullander, 2003). Native to South America in the Paraguay River basin and Argentina's lower Parana River where it inhabits cool, soft waters (Kullander, 2003).

Records. — 3: 25.2–34.3 mm SL (ZRC 46393), Singapore: stream in Upper Seletar Reservoir Park, outflow of Nee Soon Swamp Forest, coll. H. H. Tan et al., 8 Sep.1999 (Fig. 1).

Remarks. — Listed by Yeo & Chia (2010, as *Apistogramma* sp.) as an introduced species with uncertain status. The specimens were identified by Sven Kullander of the Swedish Museum of Natural History in Sep.2003. As this species is a fairly well-known ornamental fish, it is likely that the individuals originated from the aquarium trade. The species is known to be intolerant of poor water quality, and thus, does not seem likely to become established in urban freshwaters. Conversely, natural freshwater habitats with good water quality are dominated by native fish biota, which is likely to act as biological barrier in the form of competitive exclusion.

Fig. 1. *Apistogramma borellii*, 34.3 mm SL ethanol-preserved specimen (ZRC 46393; right side reversed) from a stream at Upper Seletar Reservoir Park. (Photograph by: Kelvin Lim).

Astronotus ocellatus (Agassiz), oscar

Diagnosis. — Body oval-shaped, laterally compressed, with rounded caudal fin. Wild forms are blackish-brown with red markings and black blotches on the sides; black dorsal, anal and caudal fins; and a small, black, ocellus at the upper caudal base. Domesticated varieties are available in colours ranging from orange and gold to red. Maximum known size 470 mm SL (Beeching, 1992). Native to the Amazon floodplains of South America, and known to be tolerant of hypoxic conditions (Almeida-Val et al., 2000).

Records. — 1: c. 20 cm TL, Singapore: Singapore Botanic Gardens, Swan Lake, photo: Kelvin Lim, 5 Jun.2004 (Fig. 2).

Remarks. — This is one of the fishes that Lim & Ng (1990) believed would become established in Singapore. *Astronotus ocellatus* was cited by Ng & Lim (1997) as an escapee, but they did not cite observations or specimens. Given that this is a popular ornamental fish in Singapore, it is fortunate that individuals have not been more frequently released or released in large numbers, for its tolerance of low oxygen levels is likely to favour its establishment in the wild.

Fig. 2. *Astronotus ocellatus*, c. 20 cm TL example photographed in the Swan Lake at the Singapore Botanic Gardens on 5 Jun.2004. (Photograph by: Kelvin Lim).

Cichla temensis Humboldt, speckled pavon

Diagnosis. — Body slender and laterally compressed with emarginate to truncate caudal fin. Ventral ends of the pelvic, anal and caudal fins distinctly orange. Sides with broad black bars and a black ocellus at the caudal peduncle. *Cichla temensis* is polychromatic but this does not represent sexual dimorphism. This plasticity in colour morph is a secondary sexual characteristic which changes in response to seasonal changes in sexual maturity (Reiss et al., 2012). It is native to South America in the Amazon and Orinoco river basins, and attains a maximum size of 75 cm TL (Kullander, 2003). *Cichla orinocensis*, which has established populations in many reservoirs in Singapore (Ng & Tan, 2010), is differentiated from *Cichla temensis* in having a distinctly deeper body.

Records. — 1: 16.2 cm SL (ZRC 53378), Upper Seletar Reservoir, coll. Y. G. Yi, 9 Jul.2011 (Fig. 3); 1: c. 20 cm TL, Upper Seletar Reservoir, near the roundabout at far end of reservoir park, caught with goldfish bait by an angler, obs. B. W. Low, morning of 18 Sep.2011; 1: c. 20 cm TL, Upper Seletar Reservoir, near the roundabout at far end of reservoir park, caught with *Clarias* fingerling bait by an angler, obs. K. K. P. Lim, afternoon of 29 Oct.2011.

Remarks. — This is a popular game fish in its native range, prized for its size and ferocity. It is the largest among its congeners which are collectively known as 'peacock basses' (Jepsen et al., 1999). Like *Cichla orinocensis*, which is believed to have been introduced by angling fans (Ng & Tan, 2010), *Cichla temensis* was probably brought into Singapore via the same pathway. Conversely, individuals found in the wild could also be escapees from the ornamental fish trade given that juveniles are sold as pets (pers. obs.). Should this species be present in sufficiently large numbers, it is likely to form feral populations. However, there is yet no evidence of this being so.

Fig. 3. *Cichla temensis*, 16.2 cm SL specimen (ZRC 53378) from Upper Seletar Reservoir. (Photograph by: Tan Heok Hui).

Herichthys carpintis (Jordan & Snyder), green Texas cichlid

Diagnosis. — Body oval-shaped and laterally compressed with rounded caudal fin. Body mottled blue with distinct irregular black blotches along the lateral line and a large ocellus at the caudal peduncle. Mature males often with a nuchal hump. Native to the Atlantic slopes of Central America and known to attain a maximum size of 170 mm SL (Kullander, 2003).

Record. — 1: 210.0 mm SL (ZRC 51179), Sungei Buloh Wetland Reserve, coll. T. H. Ng, 5 Nov.2007 (Fig. 4).

Remarks. — The specimen cited here is most likely an escapee from a nearby ornamental fish holding facility in Lim Chu Kang. Cichlids are secondary freshwater fishes, and many species, including this one, are tolerant of high levels of salinity (Concheiro Pérez et al., 2007). Known to be highly resilient and aggressive in captivity, these two traits are likely to favour its establishment in the wild if large numbers of individuals are simultaneously introduced.

Fig. 4. *Herichthys carpintis*, 210.0 mm SL specimen (ZRC 51179) from the Sungei Buloh Wetland Reserve. (Photograph by: Tan Heok Hui).

Maylandia estherae (Konings), red zebra mbuna

Diagnosis. — Body elongate and laterally compressed, caudal fin emarginate. Female bright orange dorsally and laterally, fading to white ventrally; male usually blue. Anal fin white with bright orange egg spots, which were also present at the posterior ends of both dorsal and caudal fins; pectoral fins with irregular black bands. Maximum size 125 mm SL (Konings, 1995). Endemic to Lake Malawi in Africa where it inhabits alkaline waters (pH 7.7–8.6) with low turbidity (Fryer & Iles, 1972).

Record. — 1: 115 mm SL (ZRC 53247), Pandan canal at Clementi, coll. Y. Kwang et al., 13 Sep.2011 (Fig. 5).

Remarks. — *Maylandia estherae* is a popular ornamental fish that has been captive bred since the mid-1970s (Harrington, 2011). The present record from the Sungei Ulu Pandan is likely to be a stochastic event and the specimen was likely to have been intentionally released. The probability of a future establishment is remote as habitat preferred by this species (water with low turbidity and rocky, sediment free bottom) is scarce in Singapore.

Fig. 5. *Maylandia estherae*, 115.0 mm SL specimen (ZRC 53247) from Sungei Ulu Pandan. (Photograph by: Tan Heok Hui).

Pterophyllum scalare (Lichtenstein), angelfish

Diagnosis. — Body deep and laterally compressed with truncate caudal fin. Spiny rays in the dorsal and anal fins increase in length with an anterior to posterior directionality. Pelvic fins highly elongated with protruding rays. Wild forms silver with blackish vertical bars (Planquette et al., 2000), domesticated varieties developed in the ornamental fish industry can be uniformly black or gold. This species is native to tropical South America, in the Amazon basin and the Oyapock and Essequibo rivers in Guyana. Maximum size about 75 mm SL (Kullander, 2003).

Records. — 1: 74.5 mm SL (ZRC 53407), Bukit Panjang: Pangsua Pond, coll. J. T B. Kwik, 16 Jan.2012 (Fig. 6a); 1: 55.4 mm SL (ZRC 53410), Bukit Panjang: Pangsua Pond, coll. J. T. B. Kwik, 31 Jan.2012 (Fig. 6b).

Remarks. — The angelfish is one of the most popular aquarium fish species in the world. The two specimens cited here were most likely intentionally released. This species seems to be capable of establishing feral populations in Singapore as it is bred in large quantities and in many artificial varieties by local ornamental fish farms. However, it does not appear to have been frequently released. A number of cichlids with wild breeding populations in Singapore, viz., *Geophagus altifrons*, *Cichla orinocensis*, and *Satanoperca jurupari* (Ng & Tan, 2010) are syntopic with the angelfish in its native range.

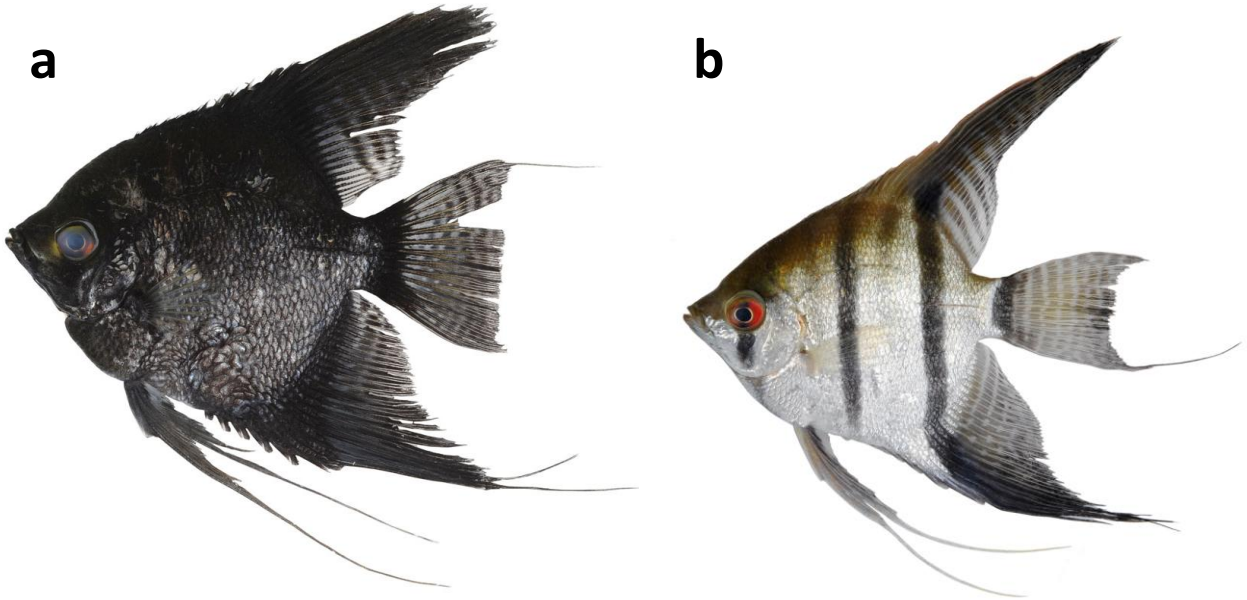

Fig. 6. *Pterophyllum scalare* from Pangsua Pond: (a) 74.5 mm SL specimen (ZRC 53407); (b) 55.4 mm SL specimen (ZRC 53410). (Photographs by: Tan Heok Hui).

Amphilophus citrinellus* × *Paraneetroplus melanurus, blood parrot

Diagnosis. — Body rounded with truncate caudal fin, mouth shaped like a beak and cannot be fully closed. Most individuals are uniformly bright orange (thus the trade name). This fish does not display sexual dimorphism. It thrives in waters of around neutral pH and attains a maximum size of 250 mm TL (Oc, 2011).

Record. — 1: 88.0 mm SL (ZRC 53382), Bukit Panjang: Pangsua Pond, coll. J. T. B. Kwik, 10 Jan.2012 (Fig. 7); 1: 70.8 mm SL (ZRC 53411), Bukit Panjang: Pangsua Pond, coll. J. T. B. Kwik, 26 Jan.2012.

Remarks. — This hybrid cichlid was created in Taiwan in the 1980s, from the cross breeding of different species and genera of American cichlids (Oc, 2011), which some believe to be *Amphilophus citrinellus* and *Paraneetroplus melanurus*. The specimen cited here is most likely an abandoned aquarium pet. This hybrid is unlikely to be established in the wild state given that males are usually infertile. Several physical deformities that characterise this hybrid are unlikely to favour its survival in the wild. This is in contrast to another cichlid hybrid, the flowerhorn, which is able to form breeding populations (Ng & Tan, 2010) as both sexes are fertile. Additionally, the blood parrot is also susceptible to diseases caused by exposure to water of poor quality (Chen & Chen, 2011) which can result in mortality rates of about 50% in juveniles and 35% in adults (Chen, 1998).

Fig. 7. Blood parrot, 88.0 mm SL specimen (ZRC 53382) from Pangsua Pond. (Photograph by: Tan Heok Hui).

DISCUSSION

The six species and one hybrid cichlid featured in this article do not appear to have established breeding populations in Singapore. It appears that they were introduced randomly as individuals or in numbers not large enough to start a breeding population. Consistent with trends observed in many other parts of the world, cichlids are widely traded in the ornamental fish industry in Singapore, and it is believed to have resulted in the introduction of several species that are currently established (Ng & Tan, 2010). The importance of the ornamental fish trade as a mode of introduction is an established fact, and is the source of an estimated 33% of the world's most invasive species (Padilla & Williams, 2004). It is perhaps not surprising that all the seven species discussed here are popular ornamental fishes imported by the trade.

Despite their wide availability in the retail market and their general hardiness, cichlids are not the easiest fishes to rear in the aquarium. Apart from *Apistogramma borellii* and perhaps *Pterophyllum scalare*, the other species featured here are highly territorial and pugnacious, and will intimidate and even harass other fishes to death. *Astronotus ocellatus* and *Cichla temensis* are predatory and grow too large to be comfortably housed in an average home aquarium. Fishes that become unmanageable are often abandoned by their owners in the nearest accessible water bodies. As the legal guidelines for the importation of fishes in Singapore is less strict compared to other taxa (Tan et al., 2010), the ornamental fish industry is likely to continue to offer these species for sale.

Although cichlids are currently ubiquitous in artificial freshwater and estuarine systems all over Singapore (Ng & Tan, 2010), there is little evidence to suggest that there is substantial spatial overlap with native fish diversity. However, this may be due to a paucity of studies detailing the threats of cichlids to native aquatic ecosystems and its inhabitants. Most of Singapore's native aquatic ecosystems, namely the forest streams and freshwater swamps, are connected to artificial habitats infested by cichlids, so the potential migration of these aliens into the former cannot be discounted. At least one, *Acarichthys heckelii*, has already been recorded from the Nee Soon Swamp Forest, an area of high conservation value as a refuge for endangered native fishes (Tan & Lim, 2008), but its ecological impact on the ecosystem is not known, or at least, not obvious. Based on their ecology, possible impacts include habitat modification by nest builders, predation by piscivores (such as *Cichla temensis*), general competition for resources, and spread of disease to which indigenous species are not immune. As the numbers and diversity of cichlids capable of exploiting various niches increase, the biological resistance of native species to invasive taxa better adapted to natural habitats (Yeo & Lim, 2011) may start to diminish.

Once an introduced species is established in a particular habitat, it is often difficult, if not impossible, to eradicate. While several studies have shown that eradication can be an effective measure in managing introduced species (Martin et al., 2000; Liebhold & Bascomte, 2003), others believe that the success of eradication is dependent on very specific circumstances and can often lead to unpredictable outcomes (Myers et al., 2000). Some major obstacles to the successful removal of an introduced species include lack of funds, lack of public awareness, widespread nature of the species in question, the resistance of the target species to eradication protocols, and reintroduction (Myers et al., 2000;

Genovesi, 2005). The eradication of cichlids already established in Singapore is not feasible because of their high fecundity. It does not seem possible to remove every single individual, particularly the fingerlings, from any one location.

The enhancement of regulations pertaining to the import of species via the ornamental fish industry as prevention of introductions remains the most effective measure in dealing with biological invasions (Sandlund et al., 1999). However, given Singapore's status as a major exporter of aquarium fishes (Yeo & Lim., 2011), such measures may be viewed unfavourably as a hindrance to a major source of revenue. A more practical measure would be a more rigid enforcement of regulations prohibiting the release of unwanted pets into natural habitats and reservoirs (Lye, 2011). However, said measures could be complicated given the accessibility of many natural aquatic systems to the public, and the widespread practice of mercy releases in religious ceremonies (Tan et al., 2010), as well as the wide availability of these species in the ornamental fish market. In the long run, promoting public awareness could be most effective in addressing the threats of introduced aquatic species in Singapore's waters. Additionally, comprehensive knowledge regarding the ecology of these introduced fishes is important as it enables the assessment of the risks of biological invasion. It will allow for informed management options in dealing with potential feral populations.

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LITERATURE CITED

Alfred, E. R., 1966. The fresh-water fishes of Singapore. *Zoologische Verhandelingen, Leiden*, **78**: 1–68.

Almeida-Val, V. M. F., A. L. Val, W. P. Duncan, F. C. A. Souza, M. N. Paula-Silva & S. Land, 2000. Scaling effects on hypoxia tolerance in the Amazon fish *Astronotus ocellatus* (Perciformes: Cichlidae): Contribution of tissue enzyme levels. *Comparative Biochemistry and Physiology*, **125**(Part B): 219–226.

Beeching, S. C., 1992. Visual assessment of relative body size in a cichlid fish, the oscar, *Astronotus ocellatus*. *Ethology*, **90**: 177–186.

Bergmann, G. T. & P. J. Motta, 2005. Diet and morphology through ontogeny of the nonindigenous Mayan cichlid '*Cichlasoma* (*Nandopsis*)' *uropthalmus* (Gunther, 1862) in Southern Florida. *Environmental Biology of Fishes*, **72**: 205–211.

Chen, C. C., 1998. Head-hole disease and relative syndromes in the aquarium cultural Cichlid fishes. *Aquatic Magazine*, **118**: 117–121.

Chen, C. C. & S. N. Chen, 2011. Water quality management with *Bacillus* spp. in the high-density culture of red-parrot fish *Cichlasoma citrinellum* × *C. synspilum*. *North American Journal of Aquaculture*, **63**: 66–73.

Concheiro Pérez, G. A., O. Rícan, G. Orti, E. Bermingham, I. Doadrio & R. Zardoya, 2007. Phylogeny and biogeography of 91 species of heroine cichlids (Teleostei: Cichlidae) based on sequences of the cytochrome *b* gene. *Molecular Phylogenetic and Evolution*, **43**: 91–110.

Fryer, G. & T. D. Iles, 1972. *The Cichlid Fishes of the Great Lakes of Africa.* Oliver & Boyd, Edinburgh. 641 pp.

Genovesi, P., 2005. Eradications of invasive alien species in Europe: A review. *Biological Invasions*, **7**: 127–133.

Harrington, B., 2011. *Metriaclima estherae*. In: *Cichlid forum*. http://www.cichlid-forum.com/articles/met_estherae.php. (Accessed 8 Mar.2012).

Jepsen, D. B., K. O. Winemiller, D. C. Taphorn & D. R. Olarte, 1999. Age structure and growth of peacock cichlids from rivers and reservoirs of Venezuela. *Journal of Fish Biology*, **55**: 433–450.

Konings, A. D., 1995. Description of *Pseudotropheus estherae* sp. nov., the well known red zebra from Lake Malawi. *Tropical fish hobbyist*, **9**: 206–212.

Kullander, S. O., 2003. Family Cichlidae (Cichlids). In: Reis, R. E., S. O. Kullander & S. J. Feraris (eds.), *Check List of the Freshwater Fishes of South and Central America*. EDIPUCR, Brazil. Pp. 605–654.

Liebhold, A. & J. Bascomte, 2003. The allee effect, stochastic dynamics and the eradication of alien species. *Ecology Letters*, **6**: 133–140.

Lim, K. K. P. & P. K. L. Ng (eds.), 1990. *A Guide to the Freshwater Fishes of Singapore*. Singapore Science Centre, Singapore. 160 pp.

Linde, A. R., J. I. Izquierdo, J. C. Moreira & E. Garcia-Vasquez, 2008. Invasive tilapia juveniles are associated with degraded river habitats. *Aquatic Conservation: Marine and Freshwater Ecosystems*, **18**: 891–895.

Lye, L. H., 2011. Legal protection for nature in Singapore. In: Ng, P. K. L., R. T. Corlett & H. T. W. Tan (eds.), *Singapore Biodiversity: An Encyclopedia of the Natural Environment and Sustainable Development*. Didier Millet, Singapore. Pp. 202–206.

Martin, J. L., J. C. Thibault & V. Bretagnolle, 2000. Black rats, island characteristics and colonial nesting birds in the mediterranean: Consequences of an ancient introduction. *Conservation Biology*, **14**: 1452–1466.

Myers, J. H., D. Simberloff, A. M. Kuris & J. R. Carey, 2000. Eradication revisited: Dealing with exotic species. *Trends in Ecology and Evolution*, **15**: 316–320.

Ng, H. H. & H. H. Tan, 2010. An annotated checklist of the non-native freshwater fish species. *COSMOS*, **6**: 95–116.

Ng, P. K. L. & K. K. P. Lim, 1996. The freshwater fishes of Singapore. *Journal of the Singapore National Academy of Science*, **22–24**: 109–124.

Ng, P. K. L. & K. K. P. Lim, 1997. The diversity and conservation status of fishes in the nature reserves of Singapore. *The Gardens' Bulletin, Singapore*, **49**: 245–265.

Oc, D. (ed.), 2011. *Cichlid Care Secrets: For Keeping Healthy Happy Fish*. David Oc. 109 pp.

Padilla, D. K. & S. L. Williams, 2004. Beyond ballast water: Aquarium and ornamental trades as sources of invasive species in aquatic ecosystems. *Frontiers in Ecology and the Environment*, **2**: 131–138.

Planquette, P., P. Keith & P. Y. Le Bail (eds.), 2000. *Atlas des Poisson d'Eau Douce de Guyane, Tome 2.* Museum National d'Histoire Naturelle, Paris. 593 pp.

Pullin, R. S. V., 1991. Cichlids in aquaculture. In: Keenleyside, M. H. A. (ed.), *Cichlid Fishes: Behaviour, Ecology and Evolution*. Chapman & Hall, London. Pp. 280–300.

Rebeiro, F., R. L. Orjuela, M. F. Magalhaes & M. J. Collares-Pereira, 2007. Variability in feeding ecology of a South American cichlid: A reason for successful invasion in Mediterranean-type rivers? *Ecology of Freshwater Fish*, **16**: 559–569.

Reiss, P., K. W. Able, M. S. Nunes & T. Hrbek, 2012. Color pattern variation in *Cichla temensis* (Perciformes: Cichlidae): Resolution based on morphological, molecular and reproductive data. *Neotropical Ichthyology*, **10**: 59–70.

Sandlund, O. T., P. J. Schei & A. Vilken (eds.), 1999. *Invasive Species and Biodiversity Management*. Kluwer, Dordrecht. 435 pp.

Stiassny, M .L. J., 1991. Phylogenetic intrarelationships of the family Cichlidae: An overview. In: Keenleyside, M. H. A. (ed.), *Cichlid Fishes: Behaviour, Ecology and Evolution*. Chapman & Hall, London. Pp. 1–31.

Tan, H. H. & K. K. P. Lim, 2008. *Acarichthys heckelii* (Muller & Troschel), an introduced cichlid fish in Singapore. *Nature in Singapore*, **1**: 129–133.

Tan, H. T. W., L. M. Chou, D. C. J. Yeo & P. K. L. Ng, 2010. *The Natural Heritage of Singapore*. *3rd Edition*. Pearson, Singapore. 323 pp.

Williams J. D., K. O. Winemiller, D. C. Taphorn & L. Balbas, 1998. Ecology and status of piscivores in Guri, an oligotrophic tropical reservoir. *North American Journal of Fisheries and Management*, **18**: 271–285.

Yeo, D. C. J. & K. K. P. Lim, 2011. Freshwater ecosystems. In: Ng, P. K. L., R. T. Corlett & H. T. W. Tan (eds.), *Singapore Biodiversity: An Encyclopedia of the Natural Environment and Sustainable Development*. Didier Millet, Singapore. Pp. 52–64.

Yeo, D. C. J. & C. S. W. Chia, 2010. Introduced species in Singapore: An overview. *COSMOS*, **6**: 23–37.