

An annotated checklist of fish fauna of Bukit Merah Reservoir and its catchment area, Perak, Malaysia

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ABSTRACT: The fish fauna was surveyed at Bukit Merah Reservoir of Perak (one of the oldest reservoir in Peninsular Malaysia) and its catchment areas. A total of 47 species from 19 families were recorded: 38 fish species were recorded from eight sampling stations located in selected tributaries (lotic zone), while another 25 fish species were recorded in the reservoir itself (lentic zone). Based on a combination of previously published checklists and the present survey, a total of 76 fish species were recorded at Bukit Merah Reservoir. Out of these species, 25 fish species from this survey were new records. Most of the new records were found in the catchment area of the river basin. The presence of two alien species, *Oreochromis niloticus* and *Clarias gariepinus*, should be noted as these species could affect the population of native species.

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INTRODUCTION

The freshwater ecosystems of Peninsular Malaysia can be divided into lentic and lotic water bodies (Mohsin and Ambak 1983). Bukit Merah Reservoir (BMR), which was built in 1902 and operated in 1906 is one of the oldest man-made reservoirs in Peninsular Malaysia, and its water catchment is an example where these two types of water bodies can be found. Located in the district of Kerian, these lentic and lotic water bodies form contiguous irrigation and drainage canals in the northwestern part of Perak State. There are two main catchment areas that are located upstream of the reservoir, namely the Kurau and Merah rivers (Figure 1). The catchment areas that are located in the eastern part of the reservoir provide more than 80% of stream networks and watershed land areas (Wipfli *et al.* 2007). Water from the reservoir is channeled out through two outlet canals, i.e. Besar and Selinsing canals (Ismail and Najib 2011; DID 2012). According to Department of Irrigation and Drainage of Kerian (DID 2012), the main function of BMR is to provide irrigation water for double cropping to 24,000 Ha of paddy fields under the Kerian–Manik River Project. The reservoir is also recognized as a sanctuary for a commercially valuable fish, the Asian Arowana, *Scleropages formosus*.

There have been inventories of the fishes from the reservoir since 1930s. Most of the available literature focuses on fish inventories from Kurau River basin to the BMR but there is lack information about fish inventories in tributaries within the catchment area. As reported by Wipfli *et al.* (2007), the upper and lower streams are the most important freshwater resources that support the biological productivity and species richness of the reservoir. Thus, this study provides an extensive fish species checklist together in the present study and later will be compared to earlier surveys by de Beaufort (1933),

Tweedie (1936), Herre and Myers (1937), Yap (1982), DoF (1993) and Arai *et al.* (2012) with the intention of providing updated information on the fish biodiversity of Bukit Merah Reservoir (BMR).

MATERIALS AND METHODS

Study site

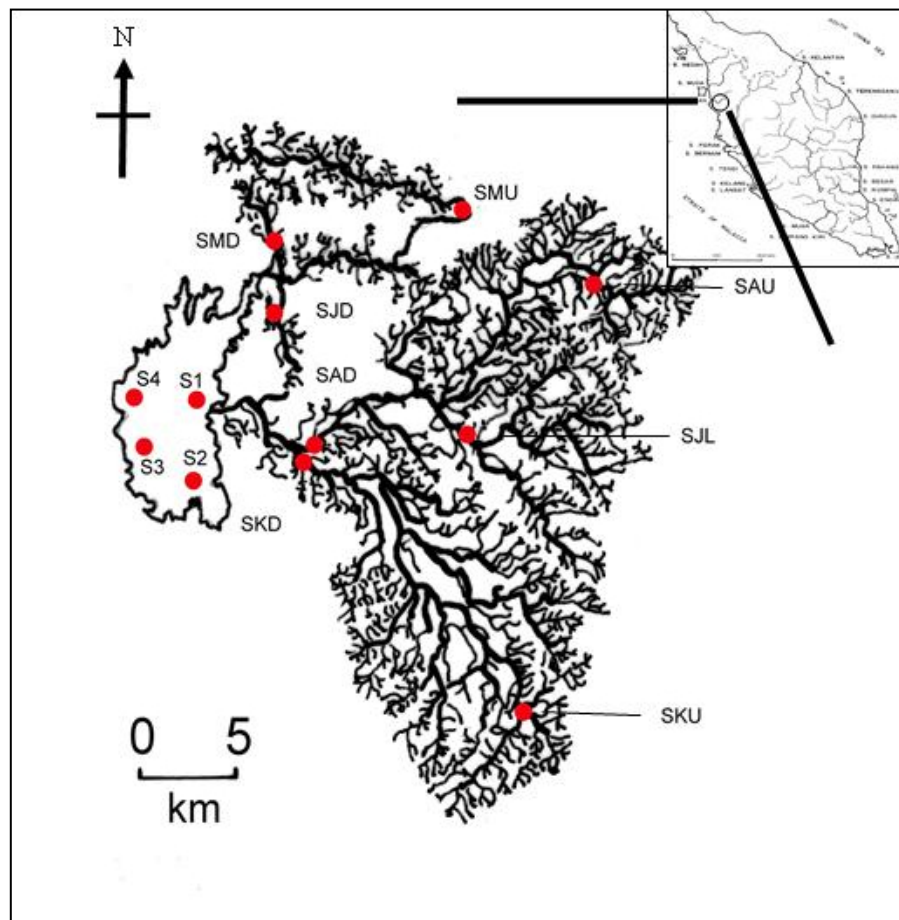
The Bukit Merah Reservoir is located in 05°01'35.42" N, 100°39'42.92" E, and it is formed by the construction of a dam in the middle Kurau River. Its surface area is about 40 km². There are two main rivers, namely the Kurau and Merah rivers that supply water to the reservoir. Four sampling stations (S1, S2, S3 and S4) were established within the reservoir area (lentic zone) while eight sampling stations were selected in the catchment area (lotic zone) in the upper reaches of the Merah (SMU), Ara (SAU), and Kurau (SKU) rivers, and in the lower reaches of the Merah (SMD), Ara (SAD), Kurau (SKD), Jelutong (SJD), and Jelai (SJL) rivers (Figure 1). All the descriptions and locations are described in Table 1.

Data collection

Intensive fish sampling was carried out twice a month at week two and week four from December 2012 to December 2013. Fish in the reservoir were caught by multiple panel gill nets and their mesh sizes were ranging from 2.5 cm to 13 cm, while in the rivers and streams, a backpack electrofishing gear (Smith-Root POW Electroshocker Model 12-B) and a cast net of 2 cm stretched-mesh, 2.5 m long with 2.5 m radius were used. All fish caught were counted and identified to the species level by using standard taxonomic keys of Kottelat *et al.* (1993). Representative specimens were euthanized on an ice slurry following the fieldwork standard procedure by IACUC, fixed in 10% formalin, preserved in 70% denatured

TABLE 1. General characteristics of sampling stations with coordinates in Bukit Merah Reservoir.

STATION	APPROXIMATE SAMPLING LOCATION	DESCRIPTION OF SITE
SMU	5°7'16" N 100°48'10.70" E	Steep river banks, relatively fast flowing water, partially shaded by fruit and bamboo trees. The main substrates for this river are sand and gravel.
SAU	5°5'25.5" N 100°51'10.70" E	A river with low gradient river banks. A clear, shallow to moderate river depth, fast flowing water and partially shaded by the riparian vegetation. The river is surrounded by rural areas. The main substrates for this river are sand, gravel and cobble.
SKU	4°54'17.4" N 100°49'59.9" E	A moderate size hillstream river with low gradient river banks. It is located in hilly areas with fruit orchards nearby. This river is relatively fast flowing with the main substrates are boulder and cobble. This river is partially shaded by riparian vegetations such as <i>Koompassia malaccensis</i> .
SJL	5°0'49.8" N 100°48'37.4" E	A large hillstream river with moderate gradient river banks. It has very fast flowing water with substrate dominated by sand. The grass is the main vegetation.
SMD	5°5'53.4" N 100°43'13.20" E	This is a small river located within the Pondok Tanjung Forest Reserve. The river is moderate in water depth with sand as a substrate.
SAD	5°0'38.5" N 100°43'51.60" E	The river has been altered to become steep of river banks, deep and fast flowing water This water surface is exposed directly to sunlight. The main substrate is sand and only grass is found to be the main vegetation.
SKD	5°0'42.6" N 100°43'56.40" E	The river has been altered to become wide, moderate flowing water and near to SAD. Moderate river banks and the main substrates are sand and gravel. The SAD and SKD are adjacent to the railway.
SJD	5°4'17.2" N 100°43'11.70" E	Similar to SMD.
S1	5°1'56.40" N 100°40'4.3" E	This station is located at the inlet of Kurau River Basin.
S2	4°59'48.00" N 100°41'14.5" E	This station is located near the Orang Utan Island. There are many submerged vegetation such as <i>Cabomba</i> sp.
S3	5°1'4.20" N 100°39'20.30" E	This station is near the intake of the reservoir.
S4	5°1'52.1" N 100°39'12.30" E	This station is located near the spillway of the reservoir.

**FIGURE 1.** Locations of sampling stations in Bukit Merah Reservoir and its catchment areas, Perak, Malaysia.

ethanol for long-term storage, given a catalogue number and housed in the Museum of Zoology of the School of Biological Sciences, Universiti Sains Malaysia.

The checklist is arranged in systematic order following Nelson (2006). Under the material examined, the following data were presented: Universiti Sains Malaysia Fish Collection acronym (USMFC) with its catalogue number, number of specimens examined, and standard length (SL) in millimeters (mm) or range of standard length, locality and collector. The fish data from the current studies were compared to and combined with studies from de Beaufort (1933), Tweedie (1936), Herre and Myers (1937), Yap (1982), DoF (1993) and Arai *et al.* (2012) to provide a more comprehensive view of the fish species diversity of the studied locality.

RESULTS

A total of 47 species from 19 families were recorded during the study period. Thirty-eight species were recorded in the rivers and streams of the catchment area (lotic zone) while 25 species were collected in the reservoir (lentic zone). The spatial fish diversity shows an ascending trend from upstream to downstream in the rivers, especially in the Kurau and Merah rivers, where the number of species increased from six and 11 to 17 and 12, respectively. However, the trend was not occurred in the Ara River where the number of species at the upstream of the river was higher than the downstream (15 to 9). Of the 47 species, only 22 were recorded in the lotic zone: *Akysis hendricksoni* (Akysidae), *Leiocassis micropogon*, *Mystus castaneus*, *M. singaringan* (Bagridae), *Channa gachua*, *C. marulioides* (Channidae), *Clarias batrachus* (Clariidae), *Acantopsis dialuzona* (Cobitidae), *Crossocheilus oblongus*, *Devario regina*, *Mystacoleucus marginatus*, *Neolissochilus soroides*, *Osteochilus waandersii*, *Systomus binotatus*, *Rasbora vulgaris* (Cyprinidae), *Macrognathus maculatus*, *Mastacembelus notophthalmus*, *Mastacembelus tinwini* (Mastacembelidae), *Silurichthys hasseltii* (Siluridae), *Glyptothorax siamensis* (Sisoridae), *Monopterus javanensis* (Synbranchidae) and *Doryichthys martensii* (Synnathidae), while nine species were recorded in the lentic zone: *Anabas testudineus* (Anabantidae), *Channa micropeltes*, *C. striata* (Channidae), *Oreochromis niloticus* (Cichlidae), *Clarias gariepinus* (Clariidae), *Oxyeleotris marmorata* (Eleotridae), *Helostoma temminckii* (Helostomatidae), *Osphronemus goramy*, *Trichopodus pectoralis* and *T. trichopterus* (Osphronemidae) (Table 2). The other 16 species (*Hemibagrus capitulum* (Bagridae), *Parambassis siamensis* (Ambassidae), *Channa lucius* (Channidae), *Cyclocheilichthys apogon*, *Barbonymus gonionotus*, *B. schwanenfeldii*, *Hampala macrolepidota*, *Labiobarbus leptocheilus*, *Osteochilus vittatus*, *Oxygaster anomalura*, *Systomus orphoides*, *Thynnichthys tynnoides* (Cyprinidae), *Pristolepis fasciata* (Pristolepididae), *Notopterus notopterus* (Notopteridae) and *Ompok siluroides* (Siluridae)) can be found in both lotic and lentic areas of BMR (Table 2). Based on the surveys conducted by de Beaufort (1933), Tweedie (1936), Herre and Myers (1937), Yap (1982), DoF (1993), Arai *et al.* (2012) and the present study, the total number of fish species and family recorded in this area were 76 and 25, respectively. Our survey added 25 fish species this list.

DISCUSSION

The total number of fish species from the present study had higher than the previous studies (47 fish species) but lower than the total number of species recorded in the State of Perak (128 fish species) (Yusoff *et al.* 2006; Chong *et al.* 2010). Among all fish species, cyprinid fishes are the most dominant family in both lentic and lotic areas. Many species belonging to this family are naturally found throughout tropical and subtropical of southern and southeastern Asia (Zakaria-Ismail 1994; Nguyen and De Silva 2006; Chong *et al.* 2010). Twenty-two fish species recorded from previous surveys were frequently encountered in our surveys, but we did not encounter 29 of the previously reported species in our surveys, including the type locality of two species from this reservoir, *Lepidocephalichthys furcatus* and *Macrognathus perakensis* (de Beaufort 1933; Herre and Myers 1937).

In Ara River, the heterogeneous habitat in the upper reaches of this river (SAU) contributes to the species richness instead of homogeneous habitat in the SAD. Generally, species richness in Malaysian rivers is correlated with water depth and velocity (Mendelson 1975; Schlosser 1985; Meffe and Sheldon 1988), substrate type, aquatic vegetation and bank cover (Gorman and Karr 1978; Schlosser 1982). In the SAU, the habitat that contains pools, riffles and riparian vegetation including grass provides variable food sources, shelter and diversity of fishes. However, the SAD had been altered from shallow, slow moving water into steep river banks, deep and fast flowing river hence reducing the efficiency of using current sampling gears to collect fishes. The ecotone of the river and reservoir, known as the transitional zone, contributes to the increase in fish diversity due to high abundance of submerged and floating macrophytes that increase spatial heterogeneity and feeding resource availability (Lowe-McConnell 1991; Aliko *et al.* 2010; Terra *et al.* 2010). Thus, lotic and lentic species that co-exist and inhabit this zone temporally contributed to the increasing of species richness (Oliveira *et al.* 2003), and it is assumed that this might have been the case in SKD, SMD and SJD.

There are several factors that influence the discrepancy in the number of species between previous studies and our survey. One such factor is the increase in the area sampled. The previous studies only covered the area between the influxes of the Kurau River into the BMR to the reservoir outlet at the dam, whereas the present study included tributaries within the catchment area, with these new sampling sites significantly contributing to the species richness of the samples. Maximizing sampling efforts by using different sampling gear also helped to increase the catch potential of fish in different habitats. These are the reasons for most of the newly-recorded species being from the catchment area of the reservoir. Among these new records, species such as *Devario regina*, *Glyptothorax siamensis* and *Channa gachua* are known to be restricted to the upper parts of river systems (Johnson 1967); this may explain their absence in previous surveys.

In our study, two alien species were newly recorded from the BMR: *Oreochromis niloticus* (Nile Tilapia) and *Clarias gariepinus* (African catfish); *Cyprinus carpio* (common carp) has also been previously recorded here, but we did not encounter this species. Many alien fish species had been

introduced in Malaysia, mainly for aquaculture purposes (Yusoff et al. 2006); these include *Barbonymus gonionotus* (Indonesian carp), *O. niloticus*, and *C. carpio*. In other cases, many local recreational anglers used non-native species such as *C. gariepinus* as a bait to catch *Channa micropeltes* for sport. This situation has led to the introduction of alien invasive (Ng and Tan 2010; Ng et al. 2014). The presence of *O. niloticus* in this reservoir was unknown, although there was a report that it had escaped into the lake from cages in which they were cultured (DoF 1993). Some of the non-native species such as *B. gonionotus* and *T. pectoralis* are well established in local freshwater ecosystems. However, the impacts of *O. niloticus* and *C. gariepinus* on local species and their habitats have yet to be established, but their

presence should be of concern, because these species have been shown to adversely affect native fish species as alien invasives (Cowx 1997; Nguyen and De Silva 2006; Diana 2009; Ng et al. 2014). The introduced species can deconstruct native freshwater ecologies by disrupting the food chain, outcompeting native species for food, habitat and water quality alterations and the importation of parasites and diseases (Arthington 1991; Diana 2009; Ng et al. 2014). The list of fish species in Bukit Merah Reservoir and its catchment area indicates that limitations in the present sampling techniques may fail to capture some species and there has still some improvements can be made with the use of the appropriate fishing gear that addresses the deficiencies.

TABLE 1. Fish checklist of Bukit Merah Reservoir (BMR) and its catchment area based on presence (+) and absence (-) data by site, and data from (a) de Beaufort (1933), (b) Tweedie (1936), (c) Herre and Myers (1937), (d) Yap (1982), (e) DoF (1993) and (f) Arai et al. (2012). Abbreviations for lotic sites are SAU = Upstream of Ara River, SKU = Upstream of Kurau River, SMU = Upstream of Merah River, SJL = Jelai River, SAD = Downstream of Ara River, SKD = Downstream of Kurau River, SMD = Downstream of Merah River, and SJD = Downstream of Jelutong River, RES = Reservoir data includes S1 – S4 (lentic sites). Material examined under the abbreviation USMFC is provided under the species name. (*) = Fish species that are newly recorded. (**) = Type locality of BMR.

SPECIES (Catalogue number)	CURRENT STUDY									(a)	(b)	(c)	(d)	(e)	(f)	
	SAU	SKU	SMU	SJL	SAD	SKD	SMD	SJD	RES							
ANGUILLIFORMES																
ANGUILLIDAE																
<i>Anguilla bicolor bicolor</i> McClelland, 1844	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
OSTEOGLOSSIFORMES																
OSTEOGLOSSIDAE																
<i>Scleropages formosus</i> (Müller & Schlegel, 1844)	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	
NOTOPTERIDAE																
<i>Chitala ornata</i> (Gray, 1831)	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	
* <i>Notopterus notopterus</i> (Pallas, 1769) (USMFC 1087, 1 ex. 156 mm SL, Reservoir, Mohd. Shafiq)	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	
ELOPIFORMES																
MEGALOPIDAE																
<i>Megalops cyprinoides</i> (Broussonet, 1782)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
CYPRINIFORMES																
CYPRINIDAE																
<i>Barbonymus gonionotus</i> (Bleeker, 1849) (USMFC 1068, 1 ex., 126 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	+	+	-	-	+	-	-	-	+	+	-	
<i>Barbonymus schwanenfeldii</i> (Bleeker, 1854) (USMFC 1086, 1 ex., 140 mm SL, Reservoir, Mohd Shafiq)	-	-	+	+	+	+	+	+	+	-	-	-	+	+	-	
* <i>Crossocheilus oblongus</i> (Kuhl & van Hasselt, 1823) (USMFC 1046, 1 ex., 106 mm SL, Sungai Jelai, Syaiful)	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	
<i>Cyclocheilichthys apogon</i> (Valenciennes, 1842) (USMFC 1034, 1 ex., 95 mm SL, Sungai Jelutong, Syaiful)	-	-	+	+	-	+	+	+	+	-	+	+	+	-	-	
<i>Cyclocheilichthys armatus</i> (Valenciennes, 1842)	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	
<i>Cyprinus carpio</i> Linnaeus, 1758	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
* <i>Devario regina</i> (Fowler, 1934) (USMFC 1132, 1 ex., 68 mm SL, Sungai Ara, Syaiful)	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Hampala macrolepidota</i> (Kuhl & van Hasselt, 1823) (USMFC 1085, 1 ex., 129 mm SL, Reservoir, Mohd Shafiq)	+	-	-	+	-	+	-	+	+	-	+	-	+	+	-	
<i>Labiobarbus fasciatus</i> (Bleeker, 1853)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>Labiobarbus festivus</i> (Heckel, 1843)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>Labiobarbus leptocheilus</i> (Valenciennes, 1842) (USMFC 1118, 1 ex., 170 mm SL, Reservoir, Mohd Shafiq)	-	-	+	-	-	+	+	+	+	-	+	+	-	+	-	
* <i>Mystacoleucus marginatus</i> (Valenciennes, 1842) (USMFC 1078, 1 ex., 88 mm SL, Sungai Ara, Syaiful)	+	-	+	+	+	+	-	+	-	-	-	-	-	-	-	
* <i>Neolissochilus soroides</i> (Dunker, 1904) (USMFC 1083, 1 ex., 62 mm SL, Sungai Kurau, Syaiful)	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	
<i>Osteochilus vittatus</i> (Valenciennes, 1842) (USMFC 1022, 1 ex., 89 mm SL, Sungai Jelutong, Syaiful)	-	-	-	+	+	+	+	+	+	-	+	-	+	+	-	
* <i>Osteochilus waandersii</i> (Bleeker, 1853) (USMFC 1107, 1 ex. 63 mm SL, Sungai Merah, Syaiful)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Oxygaster anomalura</i> (van Hasselt, 1823) (USMFC 1069, 1 ex., 121 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	+	-	+	+	-	+	-	-	-	-	
<i>Parachela oxygastroides</i> (Bleeker, 1852)	-	-	-	-	-	-	-	-	-	-	+	-	+	-	-	
<i>Rasbora borapetensis</i> (Smith, 1934)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>Rasbora einthovenii</i> (Bleeker, 1851)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>Rasbora trilineata</i> Steindachner, 1870	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	

TABLE 1. Continued.

SPECIES (Catalogue number)	CURRENT STUDY									(a)	(b)	(c)	(d)	(e)	(f)	
	SAU	SKU	SMU	SJL	SAD	SKD	SMD	SJD	RES							
<i>*Rasbora vulgaris</i> Duncker, 1904 (USMFC 1031, 1 ex., 76 mm SL, Sungai Merah, Syaiful)	+	-	+	+	+	+	+	+	-	-	-	-	-	-	-	
<i>Barbodes binotatus</i> (Valenciennes, 1842) (USMFC1021, 1 ex., 90 mm SL, Sungai Ara, Syaiful)	+	-	+	-	+	+	-	+	-	-	-	+	-	-	-	
<i>*Systomus orphoides</i> (Valenciennes, 1842) (USMFC 1020, 1 ex., 120 mm SL, Reservoir, Amir Shah)	-	-	-	-	-	-	+	-	+	-	-	-	-	-	-	
<i>*Thynnichthys thynnoides</i> (Bleeker, 1852) (USMFC 1084, 1 ex., 211 mm SL, Reservoir, Mohd Shafiq)	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	
<i>Trigonopoma pauciperforatum</i> (Weber & de Beaufort, 1916)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	
<i>Trigonostigma heteromorpha</i> (Duncker, 1904)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
COBITIDAE																
<i>*Acantopsis dialuzona</i> (van Hasselt, 1823) (USMFC 1075, 1 ex., 156 mm SL, Sungai Ara, Syaiful)	-	-	+	+	+	+	+	+	-	-	-	-	-	-	-	
<i>**Lepidocephalichthys furcatus</i> (de Beaufort, 1933)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	
SILURIFORMES																
AKYSIDAE																
<i>*Akysis hendricksoni</i> Alfred, 1966 (USMFC 1110, 1 ex., 77 mm SL, Sungai Merah, Mohd Shafiq)	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	
CHACIDAE																
<i>Chaca bankanensis</i> Bleeker, 1852	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
PANGASIIDAE																
<i>Pseudolais micronemus</i> (Bleeker, 1846)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
SISORIDAE																
<i>*Glyptothorax siamensis</i> (Hora, 1923) (USMFC 1054, 1 ex., 55 mm SL, Sungai Kurau, Syaiful)	+	+	-	+	-	-	-	-	-	-	-	-	-	-	-	
SILURIDAE																
<i>Kryptopterus macrocephalus</i> (Bleeker, 1858)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>*Ompok siluroides</i> Lacepède, 1803 (USMFC 1095, 1 ex. 49 mm SL, Sungai Kurau, Syaiful)	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	
<i>*Silurichthys hasseltii</i> Bleeker, 1858 (USMFC 1116, 1 ex. 108 mm SL, Sungai Kurau, Mohd Shafiq)	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	
<i>Wallagonia leerii</i> (Bleeker, 1851)	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	
CLARIIDAE																
<i>Clarias batrachus</i> (Linnaeus, 1758) (USMFC 1099, 1 ex. 174 mm, Sungai Ara, Syaiful)	+	-	-	-	-	-	-	-	-	-	-	-	-	+	+	
<i>Clarias macrocephalus</i> (Günther, 1864)	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
<i>Clarias leiacanthus</i> Bleeker, 1851	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
<i>*Clarias gariiepinus</i> (Burchell, 1822) (USMFC 1044, 1 ex., 260 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	
BAGRIDAE																
<i>Hemibagrus capitulum</i> (Popta, 1906) (USMFC 1028, 1 ex., 103 mm SL, Sungai Merah, Syaiful)	-	-	-	-	-	-	+	+	+	-	+	+	+	+	-	
<i>Hemibagrus divaricatus</i> Ng & Kottelat, 2013	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	
<i>Leiocassis micropogon</i> (Bleeker, 1852) (USMFC 1117, 1 ex., 79 mm SL, Sungai Jelutong, Mohd Shafiq)	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	
<i>Mystus castaneus</i> Ng, 2002 (USMFC 1025, 1 ex., 104 mm SL, Sungai Merah, Syaiful)	-	-	-	-	-	+	+	-	-	-	+	-	-	-	-	
<i>*Mystus singaringan</i> (Bleeker, 1846) (USMFC 1027, 1 ex., 95 mm SL, Sungai Merah, Syaiful)	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	
SYNGNATHIFORMES																
SYNGNATHIDAE																
<i>*Doryichthys martensii</i> (Peters, 1868) (USMFC 1058, 1ex., 122mm SL, Sungai Ara, Syaiful)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SYNBRANCHIFORMES																
SYNBRANCHIDAE																
<i>Monopterus javanensis</i> (Lacepède, 1800) (USMFC 1094, 1 ex. 300 mm, Sungai Kurau, Syaiful)	+	-	-	+	-	+	+	-	-	-	-	-	-	+	-	
MASTACEMBELIDAE																
<i>*Macrogathus maculatus</i> (Cuvier, 1832) (USMFC 1105, 1 ex., 156 mm SL, Sungai Ara, Syaiful)	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>*Mastacembelus notophthalmus</i> (Roberts, 1989) (USMFC 1106, 1 ex., 247 mm SL, Sungai Kurau, Syaiful)	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>**Macrogathus perakensis</i> (Myers, 1937)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	
<i>*Mastacembelus tinwini</i> (Britz, 2007) (USMFC 1113, 1 ex., 166 mm SL, Sungai Jelai, Mohd. Shafiq)	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	
<i>Macrogathus tapirus</i> Kottelat & Widjanarti 2005	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	

TABLE 1. Continued.

SPECIES (Catalogue number)	CURRENT STUDY									(a)	(b)	(c)	(d)	(e)	(f)
	SAU	SKU	SMU	SJL	SAD	SKD	SMD	SJD	RES						
PERCIFORMES															
AMBASSIDAE															
* <i>Parambassis siamensis</i> (Fowler, 1937) (USMFC 1075, 1 ex., 35 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	+	+	-	-	+	-	-	-	-	-	-
PRISTOLEPIDIDAE (= NANDIDAE)															
<i>Pristolepis fasciata</i> (Bleeker, 1851) (USMFC 1024, 1 ex., 63 mm SL, Sungai Merah, Syaiful)	-	-	-	-	-	-	+	-	+	-	+	+	+	-	-
<i>Nandus nebulosus</i> (Gray, 1835)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
CICHLIDAE															
* <i>Oreochromis niloticus</i> (Linnaeus, 1758) (USMFC 1074, 1 ex., 175 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
ELEOTRIDAE															
<i>Oxyeleotris marmorata</i> (Bleeker, 1852) (USMFC 1039, 1 ex., 180 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-
HELOSTOMATIDAE															
<i>Helostoma temminckii</i> (Cuvier, 1829) (USMFC 1045, 1 ex., 135 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-
OSPHRONEMIDAE															
<i>Betta pugnax</i> (Cantor, 1849)	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
<i>Belontia hasselti</i> (Cuvier, 1831)	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-
<i>Osphronemus goramy</i> (Lacepède, 1801) (USMFC 1083, 1 ex., 146 mm SL, Reservoir, Mohd. Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-
<i>Trichopodus pectoralis</i> (Regan, 1910) (USMFC 1082, 1 ex., 124 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	+	+	-
* <i>Trichopodus trichopterus</i> (Pallas, 1770) (USMFC 1092, 1 ex., 52 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
ANABANTIDAE															
<i>Anabas testudineus</i> (Bloch, 1792)	-	-	-	-	-	-	-	-	+	-	-	+	+	+	-
CHANNIDAE															
* <i>Channa gachua</i> (Hamilton, 1822) (USMFC 1121, 1 ex., 97 mm SL, Sungai Kurau, Syaiful)	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Channa lucius</i> (Cuvier, 1831) (USMFC 1042, 1 ex., 320 mm SL, Reservoir, Mohd Shafiq)	+	-	-	-	-	-	-	-	+	-	+	+	+	+	-
* <i>Channa maruloides</i> (Bleeker, 1851) (USMFC 1074, 1 ex., 113 mm SL, Sungai Jelutong, Syaiful)	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
<i>Channa melasoma</i> (Bleeker, 1851)	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-
<i>Channa micropeltes</i> (Cuvier, 1831) (USMFC 1073, 1 ex., 165 mm SL, Reservoir, Mohd Shafiq)	-	-	-	-	-	-	-	-	+	-	+	-	+	+	-
<i>Channa striata</i> (Bloch, 1793) (USMFC 1038, 1 ex., 245 mm SL, Reservoir, Mohd Shafiq)	+	-	-	-	-	-	-	-	+	-	+	+	+	+	-
TETRAODONTIFORMES															
TETRAODONTIDAE															
<i>Tetraodon kretamensis</i> Inger, 1953	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Total species	15	6	11	11	9	17	12	14	25	1	19	14	33	17	1

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