



Freshwater fishes (Actinopterygii) of Kenyir Reservoir, Peninsular Malaysia: Updated checklist, taxonomic concerns and alien species

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Abstract

Background

A total of 87 freshwater fish species from 30 families were recorded from the Kenyir Reservoir, Peninsular Malaysia, where 75 are native and 12 are introduced species. Few species still have unstable taxonomy identities which urge further studies. Most of the species were categorised as Least Concern (LC) and two were threatened species; Endangered and Critically Endangered (EN and CR). One introduced species, *Gambusia affinis* is widespread in the human-associated area, while other introduced fish species can be considered low in numbers.

New information

Twenty five fish species are recorded for the first time in the Kenyir Reservoir.

Keywords

biodiversity, conservation, impoundment, native species, Southeast Asia

Introduction

Reservoirs have generated high economic impact via inland fisheries, especially in the Asian region (Tessier et al. 2016). The number of reservoirs is also expected to increase due to economic development, climate change and human population (Zarfl et al. 2014). This has led to the fragmentation of the major rivers worldwide because of dam construction (Santos et al. 2013). The concern arises whether this fragmentation will be affecting the aquatic ecosystems at temporal and permanent spatial isolation.

Peninsular Malaysia has more than 70 reservoirs used for hydropower and agriculture purposes (Syuhada et al. 2018). One of them is Kenyir Reservoir, formed by damming the Terengganu River from 1978 until its maximum water capacity in 1985. Cramphorn (1983) had studied fish community of the Terengganu River, before the dam was wholly inundated in 1985. Since then, several researchers have conducted several studies to document the fish species recorded in this reservoir (post-inundation) (Ambak and Jalal 1998, Amirrudin et al. 2002, Kamaruddin et al. 2011). As the taxonomic revision and studies on fish advanced, many scientific names have been synonymised which need the latest update and additional information. Apart from that, some species are rarely been recorded and sometimes recorded only once or twice, for the last 40 years.

In this article, we gathered the previously-published data and our current data to review and improve the information on the fish species richness in the Kenyir Reservoir, coupled with some findings on the taxonomic ambiguity, alien invasive species (AIS) and some new records of the fish fauna. This study is essential and aligns with Malaysian Sustainable Development Goal 15 (SDG) which aims to conserve and restore the terrestrial and freshwater ecosystem, as well as to prevent invasive alien species in the water ecosystems.

Materials and methods

Study area

Kenyir is the largest freshwater reservoir in Peninsular Malaysia with approximately 260,000 hectares of catchment area (Ambak and Jalal 1998), located on the east coast of Peninsular Malaysia (5°05'20.1"N 102°43'26.5"E) in the Terengganu State (Fig. 1). There were numerous headwater streams with rocky and sandy habitats and more than ten large rivers flowing into Kenyir Reservoir (Ambak and Jalal 2006). The Reservoir comprises of 52.83% forest cover and the other 34.23% is a multitype land-use area (Kamarudin et al. 2018). It experiences northeast monsoon from November until February annually.

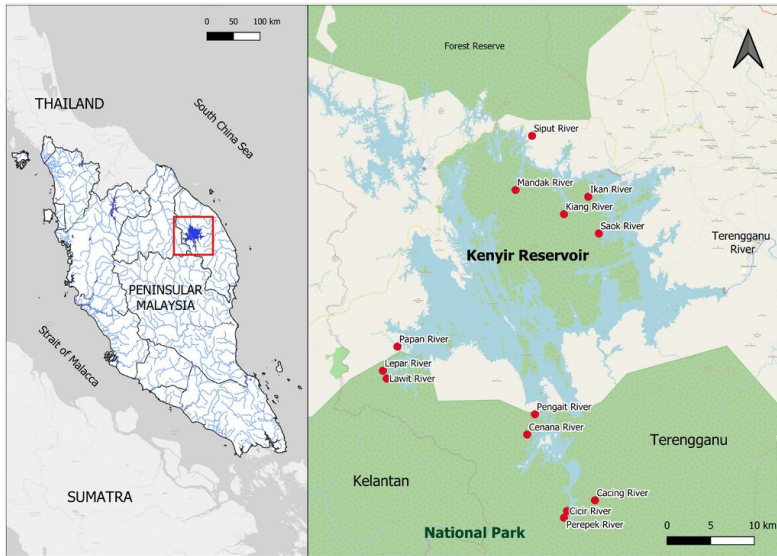


Figure 1. [doi](#)

The location of Kenyir Reservoir on the eastern part of Peninsular Malaysia within the red square (left). Streams and rivers sampled haphazardly in 2008, 2013, 2017, 2018, 2019 and 2020 are represented by the red circles (primary data).

Historical data

The previous checklists on fishes in Kenyir Reservoir were reviewed and all the synonyms and misidentifications were corrected following Zakaria-Ismail et al. (2019) and Fricke et al. (2021). The list includes information on fish reported by Cramphorn (1983), the Department of Fisheries (1994), the Department of Fisheries (1995), Yusoff et al. (1995), Zakaria et al. (1997), Ambak and Jalal (1998), Amirrudin et al. (2002), Shahid et al. (2010) and Kamaruddin et al. (2011).

Sampling

All sampling events were carried out with the permission by the Department of Fisheries, Terengganu. An electrofishing technique using backpack electro-shocker model LR-24 (Smith Roots Inc.) was used following Aqmal-Naser et al. (in press). The ethical procedure for fish collection follows guideline by Bennett et al. (2016). The data including unpublished data are owned by the corresponding author, collected in 2008, 2013, 2017, 2018, 2019 and 2020. Three units of gill nets (mesh sizes of 1.0, 2.0 and 4.0 inches; 2.5, 5.1 and 10.2 centimeters) were used to collect pelagic fish species and scoop nets were also used to collect small fish-like loaches. Interviews with the boat operators and local fishermen have also been conducted regarding the species that can be found in Kenyir Reservoir (personal communication).

Species identification

The fish were identified *in situ* when possible based on Zakaria-Ismail et al. (2019). The voucher specimens were fixed in 10% formalin and left for two weeks before rinsing and transferred into 70% alcohol for long-term storage. The preserved specimens were kept in Universiti Malaysia Terengganu Zoological Collection (UMTZC). Species validity and the spelling of the scientific names follow the California Academy of Science's Catalogue of Fishes (Fricke et al. 2021).

List of freshwater fish from Kenyir Reservoir

Scleropages formosus (Müller and Schlegel, 1840)

Material

- a. samplingProtocol: Literature; Cramphorn. J. (1983). Department of Fisheries (1994; 1995), Ambak. M.A., Jalal. K.C.A. (1998)

Native status: Native species.

Conservation status: EN

Chitala cf. lopis (Bleeker, 1851)

Material

- a. locality: Cacing River; samplingProtocol: Gill net (specimen was not taken), Literature; Cramphorn. J. (1983). Department of Fisheries (1994), Ambak. M.A., Jalal. K.C.A. (1998); year: 2017

Native status: Native species

Conservation status: NE

Notes: The distribution of *Chitala lopis* is restricted to Java, Indonesia (Kottelat and Widjanarti 2005), which raises questions about the current taxonomic identity of other identified *Chitala lopis* outside its native distribution ranges. The species is declared extinct in Java (Ng 2020) as it was not recorded for the past 100 years. The individuals resembling *Chitala borneensis* were also recorded from Peninsular Malaysia in the Endau and Terengganu River (Mohd Ilham Norhakim Lokman, pers. comm.). The identity of *Chitala* spp. from Peninsular Malaysia needs further taxonomic clarification based on morphology and molecular works (Fig. 2).



Figure 2. [doi](#)

Chitala cf. lopis from Kenyir Reservoir.

***Notopterus notopterus* (Pallas, 1769)**

Material

- a. **locality:** Cacing River, Mandak River; **samplingProtocol:** Electrofishing, Literature; Department of Fisheries (1995), Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002); **year:** 2017, 2019, 2020; **catalogNumber:** UMTZC7738

Native status: Native species.

Conservation status: LC

***Clupeichthys* sp.**

Material

- a. **locality:** Cacing River, Lepar River; **samplingProtocol:** Literature; Department of Fisheries (1994), Aqmal-Naser et al. (2021), Scoop net; **year:** 2017, 2019, 2020; **catalogNumber:** UMTZC7849

Native status: Native species

Conservation status: NE

Notes: *Clupeichthys aesarnensis* is restricted to the river systems in Cambodia, Laos, Thailand and Vietnam (Di Dario 2018). The distribution of freshwater clupeid in Peninsular Malaysia, *Clupeichthys perakensis* is restricted to the Perak River system (Ng et al. 2019). Hence, the species recorded in this study (identified as *Clupeichthys* sp.) (Fig. 3) are neither of these species and need further study on their taxonomic identities (Aqmal-Naser et al. 2021).



Figure 3. [doi](#)

Clupeichthys sp. fresh specimen (top) and preserved specimen (bottom).

***Acanthopsis dialuzona* van Hasselt, 1823**

Material

- a. locality: Cacing River, Lepar River, Lawit River, Siput River, Saok River, Ikan River, Cicir River; samplingProtocol: Electrofishing, Literature; Zakaria. M.Z., Yaacob. K.K.K., Noor. J.M. (1997), Ambak. M.A., Jalal. K.C.A. (1998); year: 2017, 2018, 2019, 2021; catalogNumber: UMTZC7633

Native status: Native species.

Conservation status: LC

***Acanthopsoides molobrion* Siebert, 1991**

Material

- a. locality: Kiang River, Mandak River, Cicir River, Perepek River; samplingProtocol: Electrofishing; year: 2017, 2019; catalogNumber: UMTZC7676

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 4).



Figure 4. [doi](#)

Acanthopsoides molobrion.

***Pangio doriae* (Perugia, 1892)**

Material

- a. locality: Perepek River; samplingProtocol: Scoop net; year: 2017, 2019, 2020; catalogNumber: UMTZC7974

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 5).



Figure 5. [doi](#)

Pangio doriae.

***Pangio filinaris* Kottelat and Lim, 1993**

Material

- a. locality: Siput River, Kiang River, Lawit River; samplingProtocol: Electrofishing, Literature; Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002); year: 2017, 2019; catalogNumber: UMTZC7011

Native status: Native species.

Conservation status: LC

***Pangio semicincta* (Fraser-Brunner, 1940)**

Material

- a. samplingProtocol: Literature; recordedBy: Ambak. M.A., Jalal. K.C.A. (1998)

Native status: Native species.

Conservation status: LC

***Balitoropsis zollingeri* (Bleeker, 1853)**

Material

- a. locality: Ikan River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019; catalogNumber: UMTZC7689

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 6).



Figure 6. [doi](#)

Balitoropsis zollingeri.

***Homaloptera ogilviei* Alfred, 1967**

Material

- a. locality: Siput River; samplingProtocol: Electrofishing; year: 2019; catalogNumber: UMTZC7641

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 7).



Figure 7. [doi](#)

Homaloptera ogilviei.

***Homalopteroides tweediei* (Herre, 1940)**

Material

- a. samplingProtocol: Literature; Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002)

Native status: Native species.

Conservation status: LC

***Pseudohomaloptera leonardi* (Hora, 1941)**

Material

- a. locality: Buluh Nipis River; samplingProtocol: Electrofishing; year: 2020; catalogNumber: UMTZC8681

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 8).



Figure 8. [doi](#)

Pseudohomaloptera leonardi.

***Nemacheilus masyae* Smith, 1933**

Material

- a. **locality:** Cacing River, Lepar River, Lawit River, Siput River, Kiang River, Cicir River, Perepek River, Cenana River; **samplingProtocol:** Electrofishing, Literature; Cramphorn. J. (1983), Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002); **year:** 2017, 2019, 2020; **catalogNumber:** UMTZC7681

Native status: Native species.

Conservation status: LC

***Barbichthys laevis* (Valenciennes, 1842)**

Material

- a. **samplingProtocol:** Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995), Zakaria. M.Z., Yaacob. K.K.K., Noor. J.M. (1997)

Native status: Native species.

Conservation status: LC

***Barbodes rhombeus* (Kottelat, 2000)**

Material

- a. **locality:** Siput River; **samplingProtocol:** Literature; Cramphorn. J. (1983), Ambak. M.A., Jalal. K.C.A. (1998); **year:** 2017; **catalogNumber:** UMTZC7646

Native status: Native species.

Conservation status: LC

***Barbodes sellifer* Kottelat and Lim, 2021**

Material

- a. locality: Siput River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019; catalogNumber: UMTZC7691

Native status: Native species.

Conservation status: LC

***Barbodes lateristriga* (Valenciennes, 1842)**

Material

- a. samplingProtocol: Literature; Cramphorn. J. (1983), Ambak. M.A., Jalal. K.C.A (1998).

Native status: Native species.

Conservation status: LC

***Barbonymus gonionotus* (Bleeker, 1849)**

Material

- a. samplingProtocol: Literature; Yusoff. F.M., Zaidi. M.Z. & Ambak. M.A. (1995)

Native status: Introduced species. The species was introduced into Kenyir Reservoir through the restocking programme in 1988-1990 by the Department of Fisheries.

***Barbonymus schwanefeldii* (Bleeker, 1854)**

Material

- a. locality: Lawit River, Perepek River, Lepar River; samplingProtocol: Electrofishing, Literature; Cramphorn. J. (1983), Ambak. M.A., Jalal. K.C.A. (1998); year: 2017, 2019, 2020; catalogNumber: UMTZC7661

Native status: Native species.

Conservation status: LC

***Crossocheilus oblongus* Kuhl and van Hasselt, 1823**

Material

- a. locality: Perepek River, Ikan River, Kiang River, Siput River, Cenana River, Pengait River; samplingProtocol: Electrofishing, Literature; Cramphorn. J. (1983) Department of Fisheries (1994), Yusoff. F.M., Zaidi. MZ., Ambak. M.A. (1995); year: 2017, 2018, 2019; catalogNumber: UMTZC7682

Native status: Native species.

Conservation status: LC

***Cyclocheilichthys apogon* (Valenciennes, 1842)**

Material

- a. locality: Kiang River, Lawit River, Mandak River, Cicir River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1994), Kamaruddin. I.S., Mustafa-Kamal. A.S., Christianus. A., Daud. A., Yu-Abit. L. (2011); year: 2017, 2019, 2020; catalogNumber: UMTZC7674

Native status: Native species.

Conservation status: LC

***Cyclocheilichthys armatus* (Valenciennes, 1842)**

Material

- a. locality: Cacing River, Cicir River; samplingProtocol: Electrofishing, Gills net; year: 2019, 2018, 2020; catalogNumber: UMTZC8678

Native status: Native species.

Conservation status: LC

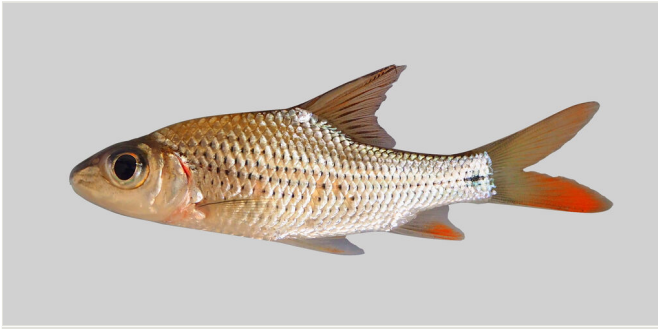
Notes: New record to Kenyir Reservoir (Fig. 9).

***Cyprinus carpio* Linnaeus, 1758**

Material

- a. samplingProtocol: Literature; Yusoff. F.M., Zaidi. M.Z. & Ambak. M.A. (1995)

Native status: Introduced species. The species was introduced into Kenyir Reservoir through the restocking programme in 1988-1990 by the Department of Fisheries.

Figure 9. [doi](#)*Cyclocheilichthys armatus*.***Ceratogarra cambodgiensis* (Tirant, 1884)****Material**

- a. locality: Saok River, Ikan River, Siput River; samplingProtocol: Electrofishing, Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7706

Native status: Native species.**Conservation status:** LC***Hampala macrolepidota* Kuhl and van Hasselt, 1823****Material**

- a. locality: Saok River, Cikir River, Siput River, Cenana River, Pengait River; samplingProtocol: Electrofishing, Literature; Cramphorn. J. (1983). Department of Fisheries (1995), Zakaria. M.Z., Yaacob. K.K.K., Noor. J.M. (1997); year: 2017, 2019, 2020; catalogNumber: UMTZC7844

Native status: Native species.**Conservation status:** LC***Labiobarbus leptocheilus* (Valenciennes, 1842)****Material**

- a. locality: Lepar River, Kiang River, Mandak River, Siput River, Lawit River, Cikir River, Perepek River; samplingProtocol: Electrofishing, Literature; Ambak. M. A., Jalal. K. C. A. (1998), Kamaruddin. I.S., Mustafa Kamal. A.S., Christianus. A., Daud. A., Yu Abit. L. (2011); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7638

Native status: Native species.

Conservation status: LC

***Lobocheilos rhabdoura* (Fowler, 1934)**

Material

- a. **locality:** Cacing River, Saok River, Perepek River; **samplingProtocol:** Electrofishing, Literature; Cramphorn. J. (1983), Yusoff. F. M., Zaidi. M. Z., Ambak. M. A. (1995); **catalogNumber:** UMTZC7766

Native status: Native species.

Conservation status: LC

***Mystacoleucus chilopterus* Fowler, 1935**

Material

- a. **samplingProtocol:** Literature; Cramphorn. J. (1983)

Native status: Native species.

Conservation status: LC

***Mystacoleucus obtusirostris* (Valenciennes, 1842)**

Material

- a. **locality:** Siput River, Kiang River, Lepar River, Saok River, Lawit River, Cicir River, Perepek River, Mandak River; **samplingProtocol:** Electrofishing, Literature; Cramphorn. J. (1983), Ambak. M.A., Jalal. K.C.A. (1998); **year:** 2017, 2018, 2019, 2020; **catalogNumber:** UMTZC7778

Native status: Native species.

Conservation status: LC

***Neolissochilus soroides* (Duncker, 1904)**

Material

- a. **locality:** Saok River, Siput River, Pengait River, Cenana River; **samplingProtocol:** Electrofishing, Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995), Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002); **year:** 2017, 2018, 2019; **catalogNumber:** UMTZC8679

Native status: Native species.

Conservation status: LC

Osteochilus scapularis Fowler, 1939

Material

- a. locality: Saok River, Ikan River, Siput River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019; catalogNumber: UMTZC8697

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 10).



Figure 10. [doi](#)

Osteochilus scapularis.

Osteochilus vittatus (Valenciennes, 1842)

Material

- a. locality: Cacing River, Lepar River, Lawit River, Siput River, Kiang River, Saok River, Cicir River, Perepek River, Mandak River; samplingProtocol: Electrofishing, Literature; Yusoff. F. M., Zaidi. M. Z., Ambak. M. A. (1995); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7650

Native status: Native species.

Conservation status: LC

Osteochilus waandersii (Bleeker, 1853)

Material

- a. locality: Lepar River, Ikan River, Siput River, Saok River, Cacing River, Lawit River, Cicir River, Perepek River, Kiang River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1994), Amirrudin. A., Siti Azizah. M.N., Yusri. Y., Norainy. M.H.,

Mohd Asnizam. A., Ali. A.B. (2002); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7663

Native status: Native species.

Conservation status: LC

***Poropuntius normani* Smith, 1931**

Material

- a. **locality:** Lepar River, Kiang River, Ikan River, Saok River, Siput River, Pengait River, Cenana River; **samplingProtocol:** Electrofishing, Literature; Zakaria. M.Z., Yaacob. K.K.K., Noor. J.M. (1997); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7607

Native status: Native species.

Conservation status: LC

***Probarbus jullieni* Sauvage, 1880**

Material

- a. **samplingProtocol:** Literature; Kamaruddin. M.K.A., Mustafa-Kamal, A.S., Christianus. A., Daud. A., Abit. L.Y. (2011); Personal communication; Syed Muhammad Fuaad (2019)

Native status: Introduced species. The species was introduced into Kenyir Reservoir by the Department of Fisheries to increase the fisheries resources.

Conservation status: CR

***Puntioplites bulu* (Bleeker, 1851)**

Material

- a. **locality:** Mandak River; **samplingProtocol:** Gill net; year: 2020; catalogNumber: UMTZC8682; **recordedBy:** Aqmal-Naser. M., Ahmad. A.B. (unpublished)

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 11).

***Tor tambra* (Valenciennes, 1842)**

Material

- a. **locality:** Kiang River, Cenana River; **samplingProtocol:** Electrofishing, Literature; Cramphorn. J. (1983); Department of Fisheries (1995); year: 2019; **recordedBy:** Ambak. M.A., Jalal. K.C.A.

Native status: Native species.

Conservation status: DD



Figure 11. [doi](#)
Puntioplites bulu.

***Esomus metallicus* Ahl, 1924**

Material

- a. locality: Kiang River; samplingProtocol: Electrofishing, Scoop net; year: 2017, 2019, 2020; catalogNumber: UMTZC7131

Native status: Introduced species.

Notes: New record to Kenyir Reservoir (Fig. 12). A common fish that thrives well in flood-plain or man-made habitats (Aqmal-Naser and Ahmad 2018a, Aqmal-Naser and Ahmad 2018b). Previously, this species is known as a native species in Peninsular Malaysia (Mohsin and Ambak 1983). However, it has been treated as an introduced species by Khan et al. (1996) and all recent studies without any justification. The identity of this species will soon be determined and the article on its status is being prepared. Hence, at the moment, we regarded this species as introduced species.

***Raiamas guttatus* (Day, 1870)**

Material

- a. samplingProtocol: Literature; Ambak. M.A., Jalal. K.C.A (1998)

Native status: Native species.

Conservation status: LC



Figure 12. [doi](#)

Esomus metallicus.

***Rasbora myersi* Brittan, 1954**

Material

- a. locality: Lepar River, Saok River, Kiang River, Lawit River, Cicir River, Perepek River, Mandak River, Siput River; samplingProtocol: Electrofishing, Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995); year: 2017, 2019, 2020; catalogNumber: UMTZC7635

Native status: Native species

Conservation status: LC

***Rasbora notura* Kottelat, 2005**

Material

- a. locality: Ikan River; samplingProtocol: Electrofishing, Literature; Amirrudin. A., Siti Azizah. M.N., Yusr.i Y., Norainy. M.H., Mohd Asnizam. A., Ali. A.B. (2002); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7675

Native status: Native species.

Conservation status: LC

***Rasbora* sp. 1**

Material

- a. locality: Ikan River, Kiang River; samplingProtocol: Electrofishing; year: 2019, 2019; catalogNumber: UMTZC7675

Native status: Native species.

Conservation status: NE

Notes: New record to Kenyir Reservoir. The *Rasbora* sp. 1 in this study has a thicker and anteriorly tapered mid-lateral stripe and the subdorsal blotch is absent, which did not fit into the description of *Rasbora notura* by Kottelat (2005) (Fig. 13).



Figure 13. [doi](#)

Rasbora notura (A) and *Rasbora* sp. 1 (B). SDB: Subdorsal blotch.

Rasbora paucisqualis* Ahl, 1935*Material**

- a. locality: Papan River; samplingProtocol: Electrofishing; year: 2020; catalogNumber: UMTZC8683

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 14).



Figure 14. [doi](#)

Rasbora paucisqualis.

***Rasbora paviana* Tirant, 1885**

Material

- a. locality: Ikan River, Saok River, Kiang River, Lawit River, Siput River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1994); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7647

Native status: Native species.

Conservation status: LC

***Rasbora* sp. 2**

Material

- a. locality: Ikan River, Papan River; samplingProtocol: Electrofishing; year: 2018, 2019, 2020; catalogNumber: UMTZC7648

Native status: Native species.

Conservation status: NE

Notes: New record to Kenyir Reservoir. There were two forms of *Rasbora* sp. collected in this study. A more common form has an incomplete mid-lateral stripe (not reaching gill opening) which is different from the real *Rasbora paviana* (Fig. 15A). It has the mid-lateral line that begins to diffuse at the mid-section of the body, known as a mid-humeral diffuse patch (MDP) (Lumbantobing 2014) (Fig. 15B). One specimen displayed a unique set of characteristics: high and pointed dorsal fin (vs. rounded), long and, when adpressed, reaching beyond the base of the anal fin (vs. only half); pectoral fin long and overlapping pelvic fin (vs. not reaching the pelvic fin); pelvic fin elongated and reaching half of the dorsal fin base (vs. not overlapping) and possessing diamond-shape caudle peduncle blotch (vs. longitudinally elongated diamond) (Fig. 15C). Due to a lack of specimens, a detailed comparison was not made at this moment.

***Leptobarbus rubripinna* (Fowler, 1937)**

Material

- a. locality: Lawit River; samplingProtocol: Gill net, Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995); year: 2019

Native status: Introduced species. The species was introduced into Kenyir Reservoir through the restocking programme in 1988-1990 by the Department of Fisheries.

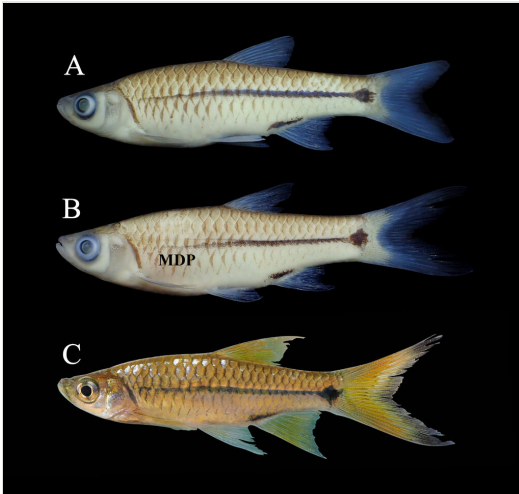


Figure 15. [doi](#)

Rasbora paviana (A) and *Rasbora* sp. 2 (B & C). Mid-humeral diffuse patch (MDP).

Hypophthalmichthys nobilis (Richardson, 1845)

Material

- a. samplingProtocol: Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995)

Native status: Introduced species. The species was introduced into Kenyir Reservoir through the restocking programme in 1988-1990 by the Department of Fisheries.

Oxygaster anomalura van Hasselt, 1823

Material

- a. locality: Cicir River; samplingProtocol: Electrofishing, Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995); year: 2019; catalogNumber: UMTZC7690

Native status: Native species.

Conservation status: LC

Piaractus brachypomus (Cuvier, 1818)

Material

- a. samplingProtocol: Literature; recordedBy: Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995)

Native status: Introduced species used for recreational cage culture in Kenyir Reservoir.

Hemibagrus capitulum* (Popta, 1906)*Material**

- a. locality: Lepar River, Ikan River, Siput River, Saok River, Cicir River, Cenana River, Pengait River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A (1998); year: 2017, 2019, 2020; catalogNumber: UMTZC7637

Native status: Native species.

Conservation status: LC

Hemibagrus gracilis* Ng and Ng, 1995*Material**

- a. locality: Siput River, Lepar River; samplingProtocol: Electrofishing, Literature; Cramphorn. J. (1983); year: 2017, 2019; catalogNumber: UMTZC7631

Native status: Native species.

Conservation status: LC

Hemibagrus wyckii* (Bleeker, 1858)*Material**

- a. samplingProtocol: Literature; Cramphorn. J. (1983); Department of Fisheries (1994)

Native status: Native species.

Conservation status: LC

Mystus castaneus* Ng, 2002*Material**

- a. locality: Budu River; samplingProtocol: Electrofishing; year: 2020; catalogNumber: UMTZC8684

Native status: Native species.

Conservation status: LC

Mystus singaringan* (Bleeker, 1846)*Material**

- a. locality: Ikan River;; samplingProtocol: Electrofishing; year: 2020; catalogNumber: UMTZC8685

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 16).



Figure 16. [doi](#)

Mystus singaringan.

***Amblyceps foratum* Ng and Kottelat, 2000**

Material

- a. locality: Kiang River, Siput River; samplingProtocol: Electrofishing; year: 2017, 2019; catalogNumber: UMTZC7711

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 17).



Figure 17. [doi](#)

Amblyceps foratum.

Glyptothorax fuscus Fowler, 1934

Material

- a. locality: Perepek River, Kiang River, Siput River; samplingProtocol: Electrofishing, Literature; Cramphorn. J. (1983); year: 2017; catalogNumber: UMTZC8687

Native status: Native species.

Conservation status: LC

Glyptothorax schmidti (Volz, 1904)

Material

- a. locality: Siput River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019; catalogNumber: UMTZC7705

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 18).



Figure 18. [doi](#)

Glyptothorax schmidti.

Pangasianodon hypophthalmus (Sauvage, 1878)

Material

- a. locality: Lawit River; samplingProtocol: Literature; Shahid. S.M., Fairuz. M.S.M., Jamil. Z.A., Radzali. M.M., Hariz. A.R.M., Fahimee. J.M., Wira. A.B., Zafrul. A.R.M., Hasliana. K. (2010) , Personal communication; Syed Muhammad Fuaad; year: 2020

Native status: Introduced species. The species was introduced through the restocking programme to increase the fisheries resources.

Pangasius nasutus* (Bleeker, 1863)*Material**

- a. samplingProtocol: Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M.A. (1995)

Native status: Introduced species used for recreational cage culture in Kenyir Reservoir.

Conservation status: LC

Ompok siluroides* Lacepède, 1803*Material**

- a. locality: Lawit River, Kiang River; samplingProtocol: Electrofishing; year: 2017, 2019; catalogNumber: UMTZC7782

Native status: Native species

Conservation status: LC

Wallagonia leerii* (Bleeker, 1851)*Material**

- a. samplingProtocol: Literature; Ambak. M.A., Jalal. K.C.A. (1998)

Native status: Native species.

Conservation status: LC

Clarias aff. batrachus* (Linnaeus, 1758)*Material**

- a. locality: Mandak River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1995); year: 2019; catalogNumber: UMTZC7792

Native status: Native species.

Conservation status: NE

Notes: The distribution of *Clarias batrachus* is restricted to Java, Indonesia (Ng and Kottelat 2008). The species is widely introduced for cultivation, but originated from an Indochinese subpopulation that may represent undescribed species (Ng and Low 2019). The previously-identified population of *C. batrachus* in north-eastern India is presently known as *Clarias magur*. Other populations were known as *Clarias aff. batrachus* 'Indochina' (from Mekong River drainage) and *Clarias aff. batrachus* 'Sundaland' (from the Malay Peninsula and Borneo) (Fig. 19).



Figure 19. [doi](#)

Clarias aff. *batrachus* from Kenyir Reservoir.

***Clarias leiacanthus* Bleeker, 1851**

Material

- a. locality: Ikan River, Kiang River, Lawit River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019; catalogNumber: UMTZC7750

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 20).



Figure 20. [doi](#)

Clarias leiacanthus.

***Oxyeleotris marmorata* (Bleeker, 1852)**

Material

- a. locality: Kiang River, Siput River, Lepar River, Cicir River, Perepek River, Mandak River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A. (1998); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7760

Native status: Native species.

Conservation status: LC

***Glossogobius giuris* (Hamilton, 1822)**

Material

- a. locality: Siput River; samplingProtocol: Electrofishing; year: 2019; catalogNumber: UMTZC7386

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 21).



Figure 21. [doi](#)

Glossogobius giuris.

***Pseudogobiopsis oligactis* (Bleeker, 1875)**

Material

- a. locality: Ikan River, Kiang River, Siput River, Lepar River, Cicir River, Perepek River, Mandak River, Cenana River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A. (1998); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7696

Native status: Native species.

Conservation status: LC

Macrognathus circumcinctus* (Hora, 1924)*Material**

- a. locality: Kiang River; samplingProtocol: Electrofishing; year: 2017, 2019; catalogNumber: UMTZC8688

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 22).



Figure 22. [doi](#)

Macrognathus circumcinctus.

Mastacembelus favus* Hora, 1923*Material**

- a. locality: Siput River, Kiang River, Mandak River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A. (1998); year: 2017, 2019; catalogNumber: UMTZC7694

Native status: Native species.

Conservation status: LC

Mastacembelus unicolor* Cuvier, 1832*Material**

- a. locality: Kiang River; samplingProtocol: Electrofishing; year: 2017; catalogNumber: UMTZC8689

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 23).



Figure 23. [doi](#)

Mastacembelus unicolor.

***Monopterus javanensis* Lacepède, 1800**

Material

- a. locality: Mandak River, Kiang River; samplingProtocol: Electrofishing; year: 2018, 2019; catalogNumber: UMTZC8690

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 24).



Figure 24. [doi](#)

Monopterus javanensis.

Betta stigmosa* Tan and Ng, 2005*Material**

- a. locality: Ikan River; samplingProtocol: Electrofishing, Scoop net; year: 2017, 2018, 2019; catalogNumber: UMTZC8691

Native status: Native species.

Conservation status: DD

Notes: New record to Kenyir Reservoir (Fig. 25).



Figure 25. [doi](#)
Betta stigmosa.

Osphronemus goramy* Lacepède, 1801*Material**

- a. locality: Saok River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1994); Ambak. M.A., Jalal. K.C.A. (1998); year: 2018, 2019; catalogNumber: UMTZC8692

Native status: Native species.

Conservation status: LC

Trichopodus trichopterus* (Pallas, 1770)*Material**

- a. locality: Siput River, Cikir River; samplingProtocol: Electrofishing; year: 2019, 2020; catalogNumber: UMTZC7636

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 26).



Figure 26. [doi](#)

Trichopodus trichopterus.

***Trichopsis vittata* (Cuvier, 1831)**

Material

- a. locality: Kiang River; samplingProtocol: Electrofishing, Scoop net; year: 2019, 2020; catalogNumber: UMTZC8693

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 27).



Figure 27. [doi](#)

Trichopsis vittata.

***Channa limbata* (Cuvier, 1831)**

Material

- a. locality: Saok River; samplingProtocol: Electrofishing, Scoop net; year: 2020; catalogNumber: UMTZC8694

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 28).



Figure 28. [doi](#)
Channa limbata.

***Channa lucius* (Cuvier, 1831)**

Material

- a. locality: Cacing River; samplingProtocol: Gill net,; year: 2014; recordedBy: Fahmi-Ahmad. M., Walton. S. (unpublished)

Native status: Native species.

Conservation status: LC

***Channa marulioides* (Bleeker, 1851)**

Material

- a. samplingProtocol: Literature; Department of Fisheries (1995)

Native status: Native species.

Conservation status: LC

Channa micropeltes* (Cuvier, 1831)*Material**

- a. locality: Cacing River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A (1998); year: 2019, 2020

Native status: Native species.

Conservation status: LC

Channa striata* (Bloch, 1793)*Material**

- a. locality: Siput River, Mandak River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A (1998); year: 2017, 2018, 2019; catalogNumber: UMTZC7654

Native status: Native species.

Conservation status: LC

Pristolepis grootii* (Bleeker, 1852)*Material**

- a. locality: Lepar River, Siput River, Kiang River, Mandak River; samplingProtocol: Electrofishing, Literature; Department of Fisheries (1994); year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7695

Native status: Native species.

Conservation status: LC

Lates calcarifer* (Bloch, 1790)*Material**

- a. samplingProtocol: Literature; Yusoff. F.M., Zaidi. M.Z., Ambak. M. (1995)

Native status: Introduced species for sports fishing in the Kenyir Reservoir.

Oreochromis niloticus* (Linnaeus, 1758)*Material**

- a. samplingProtocol: Literature; Department of Fisheries (1995)

Native status: Introduced species.

Gambusia affinis* (Baird and Girard, 1853)*Material**

- a. locality: Saok River; samplingProtocol: Electrofishing,; year: 2017, 2018, 2019; catalogNumber: UMTZC8696

Native status: Introduced species. Probably introduced via human-mediated translocation.

Xenentodon canciloides* (Bleeker, 1854)*Material**

- a. locality: Cacing River; samplingProtocol: Electrofishing, Gills net; year: 2014; catalogNumber: UMTZC7741

Native status: Native species.

Conservation status: LC

Notes: New record to Kenyir Reservoir (Fig. 29).



Figure 29. [doi](#)

Xenentodon canciloides.

Pao leiurus* (Bleeker, 1850)*Material**

- a. locality: Siput River; samplingProtocol: Electrofishing, Literature; Ambak. M.A., Jalal. K.C.A (1998); year: 2017; catalogNumber: UMTZC7716

Native status: Native species.

Conservation status: LC

***Parambassis siamensis* (Fowler, 1937)**

Material

- a. locality: Cicir River, Perepek River, Kiang River, Mandak River; samplingProtocol: Electrofishing; year: 2017, 2018, 2019, 2020; catalogNumber: UMTZC7785

Native status: Native species.

Conservation status: LC

Discussion

The species recorded contributed 25.95% of the total 289 freshwater fishes of Peninsular Malaysia (Zakaria-Ismail et al. 2019). We expect more fish species can be recorded by increasing the sampling efforts, since several families and species were already reported within the Terengganu River Basins, such as Balitoridae (*Homaloptera parclitella*), Nemacheilidae (*Nemacheilus selangoricus*), Xenocyprididae (*Parachela* spp.), Bagridae (*Leiocassis poeciloptera* and *Pseudomystus* spp.), Syngnathidae (*Doryichthys* spp.) and Akysidae (*Akysis* spp. & *Acrochordonichthys* spp.) (Aqmal-Naser et al. in press), but currently were not recorded in Kenyir Reservoir.

In his study, Cramphorn (1983) recorded the presence of *Mystacoleucus chilopterus*, but the post-inundation surveys failed to record this species. This species could have been present before, but was diminished or reduced as a result of impoundment or we did not hit the right spot to collect this species. This species is a common species found in the larger rivers, especially in the eastern part of Peninsular Malaysia (Zakaria-Ismail et al. 2019). Other species, such as *Barbichthys laevis* and *Wallagonia leerii*, were only recorded during the early post-inundation (Yusoff et al. 1995, Ambak and Jalal 1998). It was known that *Barbichthys laevis* cannot cope with the impoundment (Rainboth 1996), while *Wallagonia leerii* is a highly migratory species Riede (2004) where the impoundment could have impacted the migratory pathway for these species. Further assessments are needed to confirm the presence of these species through comprehensive field sampling. One species, *Scleropages formosus*, is now facing the threat for its highly ornamental values.

More studies also are encouraged to be done on other species especially in the Data Deficient category especially *Tor tambra* (Walton et al. 2016) and *Betta stigmosa* (Low 2019) for the updated status on their distribution and populations. We also did find any species in the ghost nets in the streams that are vulnerable to migratory fish species especially, cyprinids fish, concurrent with the finding of Aqmal-Naser and Ahmad (2020), which found dead *Tor tambra* entangled in the ghost net. Nevertheless, it is very difficult to monitor or control the fishing activities in Kenyir Reservoir due to its massive waterbody and limited enforcement.

There were three native species which were introduced for fisheries enrichment (i.e. *Pangasius nasutus* and *Probarbus jullieni*) and sports fishing (i.e. *Lates calcarifer*). Both *P.*

jullieni and *Lates calcarifer* are thriving well in the lentic ecosystem of Kenyir Reservoir and were collected by the local people for artisanal fisheries but no information regarding *Pangasius nasutus* till now. The mosquito-fish, *Gambusia affinis* is the most widespread especially in the human-associated area. It is unknown how this species ended up in Kenyir Reservoir, but probably a result of aquarium dumping, one of the major practices which lead to the alien fish species introduction (Aqmal-Naser and Ahmad 2020). However, other introduced species are rarely seen or collected, which sparks a debate on their ability to survive. For example, the juveniles of *Barbonymus gonionotus* and *Hypophthalmichthys nobilis* have been released by the Department of Fisheries (Yusoff et al. (1995), but they have never been reported or collected till the present day. The fish could be present and caught by the local fisherman, but there are no documentation and records.

All six fish species highlighted required taxonomic revision and molecular evidence to elucidate their true taxonomic lineage. The cryptic diversity amongst freshwater fishes, especially from the genus *Rasbora*, is one of the interesting subjects to begin with. We recommend more studies that integrate both morphology and the molecular aspect to resolve the taxonomic ambiguity of freshwater fishes, generally. The new fish records in Kenyir Reservoir revealed its importance as one of the conservation areas in Peninsular Malaysia. The presence of successful alien fish species like *Gambusia affinis* which can have negative impacts on the native aquatic fauna should be monitored.

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Author contributions

Aqmal-Naser, A: Data collection, Data curation, Investigation, Methodology, Writing-original draft, editing and final draft. **Ali, N. S.:** Data collection, Data curation, Investigation. **Azmi, N. U.:** Data collection, Data curation, Investigation. **Fahmi-Ahmad, M.:** Data collection, Data curation, Investigation. **Rizal, S. A.:** Data collection, Investigation, Methodology. **Ahmad, A. B.:** Conceptualisation, Funding acquisition, Project administration, Data collection, Data curation, Investigation, Methodology, Writing- original draft, editing and final draft.

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