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# Ichthyofaunal assessment of the Gelami and Tinggi Rivers, Pahang River System, eastern Malay Peninsula, following construction of an adjacent building complex

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**Abstract:** The fluvial fish fauna of the Gelami and Tinggi Rivers, before and after the construction of a building complex in the adjacent forest, was compared on the basis of a literature survey (covering the period: 1997–2003) and a field survey in 2010. Forty fish species, representing 14 families and 5 orders, were recorded in total, the field survey including new records for *Barbonymus gonionotus*, *Glyptothorax laosensis* and *Macrognathus maculatus*. On the other hand, twelve species, including *Osteochilus microcephalus, Luciosoma setigerum*, *Cyclocheilichthys apogon*, *Tor tambroides*, *Acantopsis choirorhynchos*, *Homaloptera orthogoniata*, *Clarias teijsmanni*, *Clarias macrocephalus*, *Pseudomystus leiacanthus*, *Mystus nigriceps*, *Parambassis siamensis* and *Trichopodus trichopterus*, that had been listed previously, were not recorded by the latter. An analysis of the results using McNemar's chi-squared test indicated that the fish fauna of the rivers has changed significantly following the construction, continuous quantitative monitoring and habitat evaluation being necessary for conservation of future biodiversity levels.

## Introduction

Freshwater ecosystems support a range of ecosystem services that are important for sustained human well-being (*e.g.*, Costanza *et al.* 1997; Secretariat of the Convention on Biological Diversity 2010). Notwithstanding, freshwater ecosystems represent one of the world's most threatened ecosystem types due to human activities, such as dam and levee construction, agricultural and urban development, and exotic species introductions (*e.g.*, Millennium Ecosystem Assessment 2005; Secretariat of the Convention on Biological Diversity 2010).

The freshwater ecosystem of Malaysia has very significant diversity, fluvial fishes alone representing more than 40% of those found in tropical South-East Asian waters (Chong *et al.* 2010). Although the former include many species of commercial (fisheries) importance, natural distribution ranges and changes in species composition with river system, which represent basic information for ongoing sustainable usage, have often been ignored (Salam and Gopinath 2006).

Othman *et al.* (2003) investigated the fish fauna of the Gelami and Tinggi Rivers, tributaries of the Pahang River, a major river system on the Malay Peninsula, from 1997 to 2003, prior to the construction of a building complex (in 2005) for the National Fisheries Research Institute in the vicinity of the rivers (Figure 1), as part of its environmental impact assessment. This was the first survey of the fish fauna of those rivers and one of the few instances of genuine environmental impact assessment in Malaysia. Thirty-seven fish species, belonging to 14 families, were recorded and classified according to the conservational and commercial views at that time (Othman *et al.* 2003). Although Kano *et al.* (2013b) recently evaluated fish mesohabitat selection in the rivers in 2010, they neither compared their results with those of past surveys, nor evaluated present conditions in terms of future fish conservation. In this study, following completion of the building construction work, the fish fauna of the Gelami and Tinggi Rivers was again investigated in 2010, in order to reassess the fish fauna.

## Materials and Methods

The Gelami and Tinggi Rivers are tributaries of the Pahang River (3°01′23″N, 102°01′28″ E; length 459 km, basin area 29,300 $m^2$), the largest and longest river on the Malay Peninsula. Both meander through mountainous and upland terrain, having stable (unchanging) pool-riffle structures (Othman *et al.* 2003; Kano *et al.* 2013b). Stream widths in the survey area ranged from 2.0 to 8.3 m (Kano *et al.* 2013b).

Fish collections were made in the Gelami and Tinggi Rivers on 6, 12, 15, 24–26, and 28 October 2010 (Figure 1), using hand nets and an electric shocking device, the sampling sites and techniques used being identical to those noted in Othman *et al.* (2003). It should be noted, however, that the sampling efforts of the two surveys were not identical, since Othman *et al.* (2003) did not indicate the length of the sampling periods or the number of replicates. The weather and stream conditions were stable throughout the 2010 survey. Voucher specimens and

photographs were deposited in the Kanagawa Prefectural Museum of Natural History, Odawara, Japan (specimens: KPM-NI; photographs: KPM-NR) and in Fishes of the Mainland Southeast Asia, an online database (Kano *et al.* 2013a; URL: http://ffish.asia/?qcode=MIYAZAKIETAL2013CL).

The systematic arrangement of families follows Nelson (2006). Fishes collected were identified to species following Rainboth (1996), Hua (2002), Othman *et al.* (2003) and Baharuddin *et al.* (2007), their scientific names following Eschmeyer and Fricke (2012).

McNemar's chi-squared test was used for comparing the fish fauna before and after the building construction work (McNemar 1947). The presence or absence of each species was categorized according to the surveys made ("before", Othman *et al.* 2003; "after", this study). The analysis was conducted using R v. 2.14.1, with significance defined as $p < 0.05$.

## Results and Discussion

A total of 40 fish species, representing 14 families in 5 orders, were recorded by the two surveys (Table 1; Figures 2–6; photographs of both fresh and live specimens are included to illustrate color differences). These included (in decreasing order of number of species) Cypriniformes (22 species, 55.0% of the total), Siluriformes (9 species, 22.5%), Perciformes (5 species, 12.5%), Synbranchiformes (3 species, 7.5%) and Beloniformes (1 species, 2.5%). Siluriformes and Perciformes, each with four families represented (28.6% of the total), included the most families, followed by Cypriniformes (3 families, 21.4%), Synbranchiformes (2 families, 14.3%) and Beloniformes (1 family, 7.1%). The family Cyprinidae had the highest number of species represented (19, 47.5% of the total), followed by Bagridae and Clariidae (each with 3 species, 7.5%), Balitoridae, Sisoridae, Mastacembelidae and Channidae (each with 2 species, 5.0%), and Cobitidae, Siluridae, Belonidae, Ambassidae, Osphronemidae, Synbranchidae and Nandidae (each with a single species, each 2.5%).

Whereas the survey undertaken in 2010 newly recorded three species: *Barbonymus gonionotus* (Bleeker, 1849), *Glyptothorax laosensis* (Fowler, 1934) and *Macrognathus maculates* (Cuvier, 1832), it failed to record the following twelve species, which had been noted in 1997–2003: *Osteochilus microcephalus* (Valenciennes, 1842), *Luciosoma setigerum* (Valenciennes, 1842), *Cyclocheilichthys apogon* (Valenciennes, 1842), *Tor tambroides* (Bleeker, 1854), *Acantopsis choirorhynchos* (Bleeker, 1854), *Homaloptera orthogoniata* Vaillant, 1902, *Clarias teijsmanni* Bleeker, 1857, *Clarias macrocephalus* Günther, 1864, *Pseudomystus leiacanthus* (Weber and de Beaufort, 1912), *Mystus nigriceps* (Valenciennes, 1840), *Parambassis siamensis* (Fowler, 1937) and *Trichopodus trichopterus* (Pallas, 1770) (Othman *et al.* 2003; Table 1). Moreover, McNemar's chi-squared test indicated a significant difference between the fish fauna recorded in the 2010 survey and that of the previous survey ($p = 0.02$; Table 1).

The results suggested that the fish fauna of the Gelami and Tinggi Rivers has changed significantly since the survey by Othman *et al.* (2003). Three "R" (rare: species usually localized within restricted geographical areas or habitats, or thinly scattered over a more extensive range) or "EN" (endangered: species facing a very high risk of extinction in the wild in the near future) species were not recorded in the most recent survey (Table 1), although several species noted by Othman *et al.* (2003) as "not common" (NC) were represented by many individuals (Kano *et al.* 2013b). It is clear that future habitat conservation and maintenance of fish diversity levels will necessitate continuous quantitative monitoring (see Kano *et al.* 2013b).

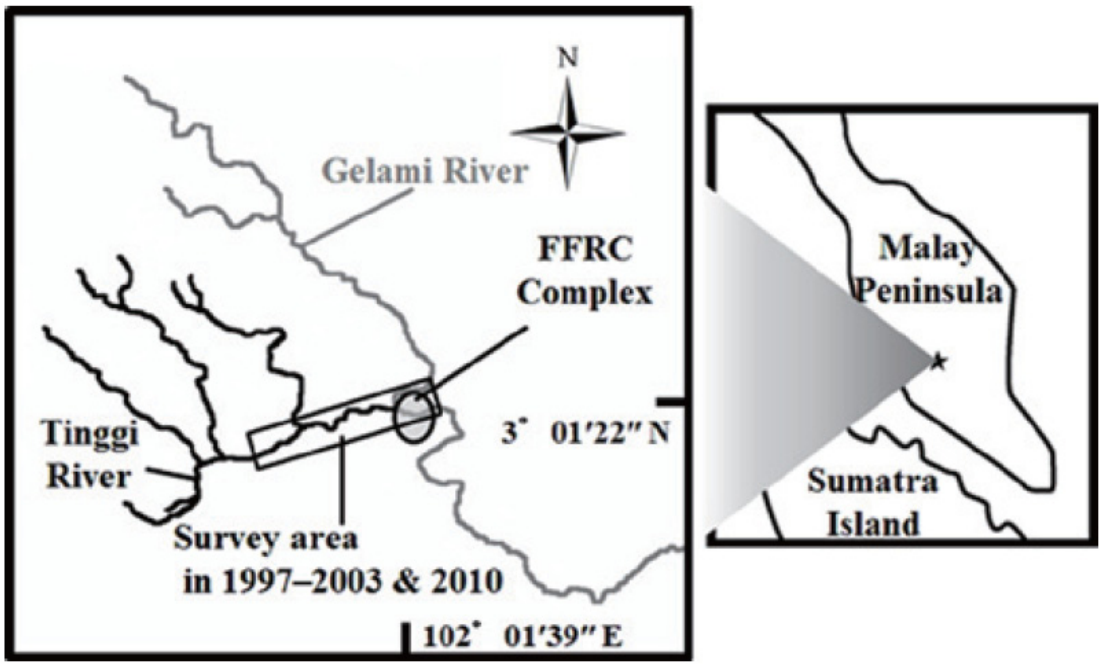


**Figure 1.** Map of the Gelami (grey line) and Tinggi (black line) Rivers, Pahang River System, eastern Malay Peninsula, Malaysia. Ellipse and rectangle indicate the Freshwater Fisheries Research Center (FFRC) and the area investigated, respectively.

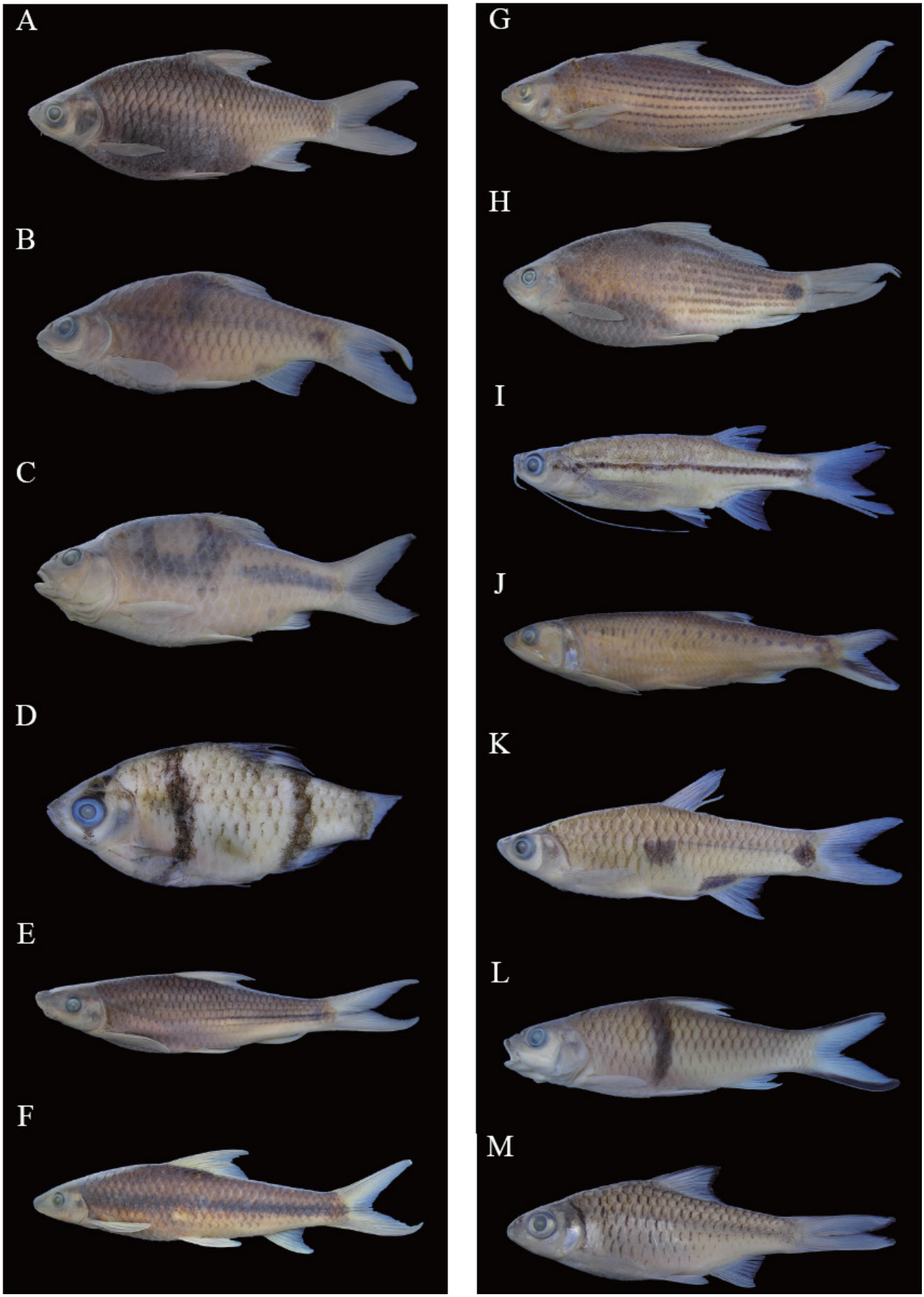


**Figure 2.** Photographs of voucher specimens. A, *Barbonymus gonionotus*, KPM-NI 27457, 163.1 mm SL; B, *Puntius rhombeus*, KPM-NI 27498, 72.4 mm SL; C, *Puntius lateristriga*, KPM-NI 27473, 104.2 mm SL; D, *Systomus partipentazona*, KPM-NI 27487, 22.8 mm SL; E, *Lobocheilos melanotaenia*, KPM-NI 27465, 110.9 mm SL; F, *Crossocheilus atrilimes*, KPM-NI 27477, 101.0 mm SL; G, *Labiobarbus leptocheilus*, KPM-NI 27459, 166.5 mm SL; H, *Osteochilus vittatus*, KPM-NI 27461, 148.3 mm SL; I, *Esomus metallicus*, KPM-NI 27481, 39.6 mm SL; J, *Raiamas guttatus*, KPM-NI 27467, 134.2 mm SL; K, *Rasbora elegans*, KPM-NI 27485, 68.6 mm SL; L, *Hampala macrolepidota*, KPM-NI 27470, 91.7 mm SL; M, *Mystacoleucus marginatus*, KPM-NI 27494, 60.7 mm SL.

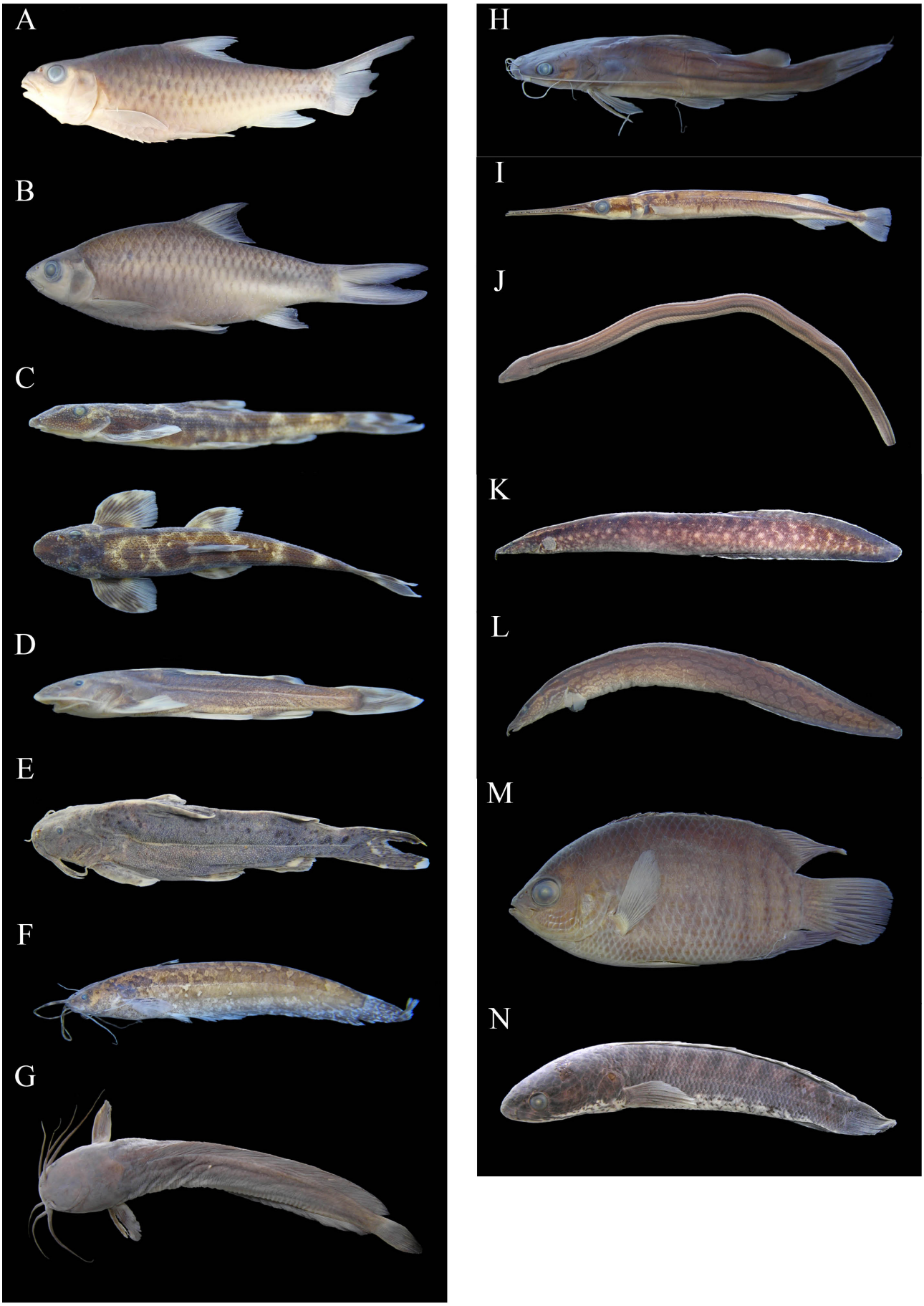


**Figure 3.** Photographs of voucher specimens. A, *Neolissochilus hexagonolepis*, KPM-NI 27489, 101.5 mm SL; B, *Poropuntius normani*, KPM-NI 27502, 120.3 mm SL; C, *Homaloptera leonardi*, KPM-NI 27519, 1 of 16 individuals, 40.0 mm SL; D, *Glyptothorax laosensis*, KPM-NI 27482, 41.9 mm SL; E, *Glyptothorax* sp. cf. *major*, KPM-NI 27520, 1 of 54 individuals, 53.3 mm SL; F, *Silurichthys hasseltii*, KPM-NI 27488, 44.5 mm SL; G, *Clarias batrachus*, KPM-NI 27460, 149.2 mm SL; H, *Hemibagrus nemurus*, KPM-NI 27468, 139.4 mm SL; I, *Xenentodon cancila*, KPM-NI 27453, 163.1 mm SL; J, *Monopterus albus*, KPM-NI 27518, 281.5 mm TL; K, *Macrognathus maculatus*, KPM-NI 27515, 234.1 mm SL; L, *Mastacembelus armatus*, KPM-NI 27506, 202.9 mm SL; M, *Pristolepis fasciata*, KPM-NI 27472, 99.4 mm SL; N, *Channa striata*, KPM-NI 27458, 187.8 mm SL.


**Figure 4.** Photographs of live specimens. A, *Barbonymus gonionotus*, KPM-NR 77844; B, *Puntius rhombeus*, KPM-NR 77936; C, *Puntius lateristriga*, KPM-NR 77944; D, *Systomus partipentazona*, KPM-NR 77955; E, *Lobocheilos melanotaenia*, KPM-NR 77859; F, *Crossocheilus atrilimes*, KPM-NR 77871; G, *Labiobarbus leptocheilus*, KPM-NR 77898; H, *Osteochilus vittatus*, KPM-NR 77924; I, *Esomus metallicus*, KPM-NR 77872; J, *Raiamas guttatus*, KPM-NR 77945; K, *Rasbora elegans*, KPM-NR 77952; L, *Hampala macrolepidota*, KPM-NR 77886.


**Figure 5.** Photographs of live specimens. A, *Mystacoleucus marginatus*, KPM-NR 77916; B, *Neolissochilus hexagonolepis*, KPM-NR 77921; C, *Poropuntius normani*, KPM-NR 77927; D, *Homaloptera leonardi*, KPM-NR 77893; E, *Glyptothorax laosensis*, KPM-NR 77874; F, *Glyptothorax* sp. cf. *major*, KPM-NR 77880; G, *Silurichthys hasseltii*, KPM-NR 77954; H, *Clarias batrachus*, KPM-NR 77864; I, *Hemibagrus nemurus*, KPM-NR 77890; J, *Xenentodon cancila*, KPM-NR 77960; K, *Monopterus albus*, KPM-NR 77911; L, *Macrognathus maculatus*, KPM-NR 77899.


**Figure 6.** Photographs of live specimens. A, *Mastacembelus armatus*, KPM-NR 77908; B, *Pristolepis fasciata*, KPM-NR 77930; C, *Channa lucius*, KPM-NR 77846; D, *Channa striata*, KPM-NR 77853.

**Table 1.** List of fishes from the Gelami and the Tinggi Rivers, eastern Malay Peninsula. CO, common; NC, not common; R, rare; EN, endangered; CT, commercially threatened; NR, not recorded (status categories follow Othman *et al.* [2003]). YES, NO; Recorded (with photographs) by Othman *et al.* (2003) and the present survey.

| TAXON | PREVIOUS SURVEY | PREVIOUS SURVEY | CONSERVATION STATUS | VOUCHER |
|---|---|---|---|---|
| | 1997–2003 | 2010 | | KPM-NI: SPECIMEN(S), KPM-NR: PHOTOGRAPH(S) |
| CYPRINIDAE | | | | |
| *Barbonymus gonionotus* (Bleeker, 1849) | NO | YES | NR | KPM-NI 27457, KPM-NR 77842–77845 |
| *Puntius lateristriga* (Valenciennes, 1842) | YES | YES | CO | KPM-NI 27473–27475, KPM-NR 77940–77944 |
| *Puntius rhombeus* Kottelat, 2000 | YES | YES | CO | KPM-NI 2749827499, KPM-NR 77933–77939 |
| *Systomus partipentazona* (Fowler, 1934) | YES | YES | CO | KPM-NI 27487, KPM-NR 77955 |
| *Lobocheilos melanotaenia* (Fowler, 1935) | YES | YES | NC | KPM-NI 27462–27465, KPM-NR 77855–77862 |
| *Crossocheilus atrilimes* Kottelat, 2000 | YES | YES | CO | KPM-NI 27476–27480, KPM-NR 77866–77871 |
| *Labiobarbus leptocheilus* (Valenciennes, 1842) | YES | YES | NC | KPM-NI 27459, KPM-NR 77895–77898 |
| *Osteochilus vittatus* (Valenciennes, 1842) | YES | YES | CO | KPM-NI 27461, KPM-NR 77923–77925 |
| *Osteochilus microcephalus* (Valenciennes, 1842) | YES | NO | CO | - |
| *Esomus metallicus* Ahl, 1923 | YES | YES | CO | KPM-NI 27481, KPM-NR 77872 |
| *Luciosoma setigerum* (Valenciennes, 1842) | YES | NO | NC | - |
| *Raiamas guttatus* (Day, 1870) | YES | YES | NC | KPM-NI 27466–27467, KPM-NR 77945–77947 |
| *Rasbora elegans* Volz, 1903) | YES | YES | CO | KPM-NI 27483–27486, KPM-NR 77948–77953 |
| *Cyclocheilichthys apogon* (Valenciennes, 1842) | YES | NO | CO | - |
| *Hampala macrolepidota* Kuhl and van Hasselt, 1823 | YES | YES | CO | KPM-NI 27470–27471, KPM-NR 77883–77886 |
| *Mystacoleucus marginatus* (Valenciennes, 1842) | YES | YES | CO | KPM-NI 27492–27497, KPM-NR 77912–77916 |
| *Neolissochilus hexagonolepis* (McClelland, 1839) | YES | YES | CO | KPM-NI 27489–27491, KPM-NR 77920–77922 |
| *Poropuntius normani* Smith, 1931 | YES | YES | CO | KPM-NI 27500–27504, KPM-NR 77926–77928 |
| *Tor tambroides* (Bleeker, 1854) | YES | NO | EN+CT | - |
| COBITIDAE | | | | |
| *Acantopsis choirorhynchos* (Bleeker, 1854) | YES | NO | NC | - |
| BALITORIDAE | | | | |
| *Homaloptera leonardi* Hora, 1941 | YES | YES | NC | KPM-NI 27519, KPM-NR 77891–77893 |
| *Homaloptera orthogoniata* Vaillant, 1902 | YES | NO | R | - |
| SISORIDAE | | | | |
| *Glyptothorax laosensis* Fowler, 1934 | NO | YES | NR | KPM-NI 27482, KPM-NR 77873–77876 |
| *Glyptothorax* sp. cf. *major* (Boulenger, 1894) | YES | YES | CO | KPM-NI 27520, KPM-NR 77877–77882 |
| SILURIDAE | | | | |
| *Silurichthys hasseltii* Bleeker, 1858 | YES | YES | CO | KPM-NI 27488, KPM-NR 77954 |
| CLARIIDAE | | | | |
| *Clarias batrachus* (Linnaeus, 1758) | YES | YES | NC | KPM-NI 27460, KPM-NR 77863–77865 |
| *Clarias macrocephalus* Günther, 1864 | YES | NO | NC | - |
| *Clarias teijsmanni* Bleeker, 1857 | YES | NO | R | - |

**Table 1.** ***Continued.***

| TAXON | PREVIOUS SURVEY 1997–2003 | PREVIOUS SURVEY 2010 | CONSERVATION STATUS | VOUCHER KPM-NI: SPECIMEN(S), KPM-NR: PHOTOGRAPH(S) |
|---|---|---|---|---|
| BAGRIDAE | | | | |
| *Hemibagrus nemurus* (Valenciennes, 1840) | YES | YES | CO | KPM-NI 27468–27469, KPM-NR 77888–77890 |
| *Pseudomystus leiacanthus* (Weber and de Beaufort, 1912) | YES | NO | CO | - |
| *Mystus nigriceps* (Valenciennes, 1840) | YES | NO | CO | - |
| BELONIDAE | | | | |
| *Xenentodon cancila* Hamilton, 1822 | YES | YES | CO | KPM-NI 27453–27456, KPM-NR 77956–77960 |
| SYNBRANCHIDAE | | | | |
| *Monopterus albus* (Zuiew, 1793) | YES | YES | NC | KPM-NI 27518, KPM-NR 77910–77911 |
| MASTACEMBELIDAE | | | | |
| *Macrognathus maculatus* (Cuvier, 1832) | NO | YES | NR | KPM-NI 27515–27517, KPM-NR 77899–77901 |
| *Mastacembelus armatus* (Lacepède, 1800) | YES | YES | CO | KPM-NI 27505–27514, KPM-NR 77904–77908 |
| AMBASSIDAE | | | | |
| *Parambassis siamensis* (Fowler, 1937) | YES | NO | CO | - |
| NANDIDAE | | | | |
| *Pristolepis fasciata* (Bleeker, 1851) | YES | YES | CO | KPM-NI 27472, KPM-NR 77929–77931 |
| OSPHRONEMIDAE | | | | |
| *Trichopodus trichopterus* (Pallas, 1770) | YES | NO | CO | - |
| CHANNIDAE | | | | |
| *Channa lucius* (Cuvier, 1831) | YES | YES | CO | KPM-NR 77846–77847 |
| *Channa striata* (Bloch, 1793) | YES | YES | CO | KPM-NI 27458, KPM-NR 77848–77854 |

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