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Fish biodiversity in Zhanjiang Mangroves National Nature Reserve, China

Juan LEI[1,2], Yongyan LIAO[1,2,*], Wei TANG[3], Dong XIE[4], Teng WANG[5], Wen XIONG[6], Peter A BOWLER[7]

[1]Guangxi Key Laboratory of Beibu Gulf Marine Biodiversity Conservation, College of Marine Sciences, Beibu Gulf University, Qinzhou, 535011, China

[2]College of Marine Sciences, Beibu Gulf University, Guangxi, China

[3]Water-Environmental Nanotechnology, Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China

[4]Co-Innovation Center for Sustainable Forestry in Southern China, Nanjing Forestry University, Nanjing 210037, China

[5]Key Laboratory of South China Sea Fishery Resources Exploitation & Utilization, Ministry of Agriculture, South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences, Guangzhou, China/Guangdong Provincial Key Laboratory of Fishery Ecology and Environment, Guangzhou, China

[6]College of Fisheries, Guangdong Ocean University, Zhanjiang 524088, China

[7]Department of Ecology and Evolutionary Biology, University of California, Irvine, California 92697-2525, USA

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Abstract: China's mangroves provide important habitat for many endangered fish species, but, there has been little research upon the diversity and the distribution of fish species within mangroves habitats. To compile an inventory of fish fauna in this field, a total of 14 ichthyological surveys were conducted in Zhanjiang Mangrove during different seasons between August 2016 and December 2019. A total of 208 fish species have identified belonging to 18 orders, 69 families and 142 genera from Zhanjiang Mangroves National Nature Reserve, the largest mangrove habitat in China. Of these 17 species are listed as threatened species in the IUCN Red List. Our research indicates that nonnative species, overfishing, and pollution from aquaculture have severely threatened the fish biodiversity of the mangrove habitat in Zhanjiang. To better protect native biodiversity and fisheries, specific measures and management strategies should be adopted and enforced. This study recommends management approaches to better protect, sustain and manage fisheries and fish biodiversity in Zhanjiang mangrove habitat.

Key words: China, conservation, fishery, invasive fish, mangrove

1. Introduction

Mangrove habitat supports a rich biodiversity and numerous endemic species in tropical environments (Sandilyan and Kathiresan, 2012) and it is considered one of the most endangered habitats in the world (Valiela et al., 2001). The current rate of decline and loss of this coastal environmental resource is higher than that of other critically endangered ecosystems, including reefs and rainforests (Duke et al., 2007; Polidoro et al., 2010). Although an extraordinary number of endemic and economically significant fish species spend part or all of their life history in mangroves (Nagelkerken et al., 2008), research regarding them has been limited. There is little data-based understanding of the status of mangrove inhabiting fishes (Faunce and Serafy, 2006).

China supports one of the greatest species richness and fish biodiversity in the world (Xing et al., 2016; He et al., 2020), yet information about fishes in China is limited and localized (Abell et al., 2008). While there has been selective research investigating fish diversity, distribution and conservation in regions such as Hainan Island and the Leizhou Peninsula (Xiong et al., 2018a, 2019), there has been relatively little study of the fishes in mangroves, the most important habitat for many endemic taxa and those of greatest economic significance.

Zhanjiang mangroves habitat comprises the largest mangrove environment in China, and is located in the Indo-Burma biodiversity hotspot (Myers et al., 2000) at the northernmost tip of the South China Sea. This is an important region for marine fisheries and mariculture (Kang et al., 2018), though there is little information regarding the fishes in the Zhanjiang mangroves ecosystem.

Zhanjiang Mangroves National Nature Reserve is located at the southernmost tip of mainland China. The Reserve is distributed in strips on the beaches along the Leizhou Peninsula in southwestern Guangdong Province.

* Correspondence: chinaxiongwen@gmail.com

It crosses Xuwen, Leizhou, Suixi, and Lianjiang, Mazhang counties, Potou, Donhai, and Xiashan, and four districts of Zhanjiang city. The geographic coordinates are 109°40′–110°35′ E and 20°14′–21°35′ N. It encompasses an area of 19,000 hectares. The Reserve was established as a Provincial Nature Reserve in 1990 with the approval of the Guangdong Provincial People's Government and it was raised to National Nature Reserve status in 1997.

Zhanjiang Mangrove National Nature Reserve is located in the transition area between the north tropical and south Asian subtropics zones. Its southern area is within the north tropical monsoon climate zone and the northern portion lies in the south Asian subtropical monsoon climate zone. The annual average temperature is 23 °C, the extreme maximum temperature is 38.8 °C, and the extreme minimum temperature is –1.4 °C. The average annual rainfall is 1534.6 mm, and the wet and dry seasons are obvious. Precipitation is concentrated from April to September, and is often accompanied with typhoon rainstorms.

The focus of this study is to compile an inventory of the fish fauna in the Zhanjiang mangroves, summarize the primary threats to fish biodiversity, and to provide recommendations for fish biodiversity conservation and management.

2. Material and methods

A total of 14 ichthyological surveys were conducted in the Zhanjiang Mangrove National Nature Reserve during different seasons between August 2016 and December 2019. Fish samples were collected using gillnets (2010 m, mesh size 0.5 cm), cage nets (200 × 10 × 15 cm, mesh size 0.5 cm), and electrofishing (CWB-2000P, 12V, 250HZ). For detailed sampling methods see Xiong et al. (2018b, 2018c). Based upon our investigations, we compiled a list of fishes in the Zhanjiang Mangrove National Nature Reserve (Supplementary file 1) (Chen and Zhang, 2016; Sun and Chen, 2013).

3. Results

A total of 208 fish species were sampled belonging to 18 orders, 69 families and 142 genera within the Zhanjiang mangrove habitat system. 17 fish species (*Hemitrygon laevigata, Anguilla japonica, Clupanodon thrissa, Sardinella lemuru, Cirrhinus molitorella, Cyprinus carpio, Hypophthalmichthys molitrix, Planiliza affinis, Scomberoides tala, Acentrogobius microps, Favonigobius reichei, Pseudupeneus prayensis, Dendrophysa russelii, Epinephelus malabaricus, Sillago asiatica, Inimicus japonicas* and *Takifugu ocellatus*) are classified as endangered species in China (Supplementary file 1).

We recorded five nonnative fish species in Zhanjiang mangroves, including the Mozambique tilapia (*Oreochromis mossambicus*), Nile tilapia (*Oreochromis niloticus*), Lacustrine goby (*Gobiopterus lacustris*),West African goatfish (*Pseudupeneus prayensis*) and mosquitofish (*Gambusia affinis*). Mosquitofish, Mozambique tilapia and Nile tilapia are the most abundant nonnative species in the mangroves (Supplementary file 1).

4. Discussion

Zhanjiang mangroves, comprising only 0.002% of the total Chinese land area, contain 200 fish species (about 4% of the total number of China), 19 of which are listed as endangered species by the IUCN. Because of this remarkable species richness, the Zhanjiang mangroves are clearly very important habitats for fish conservation in China.

4.1. Threat to fish biodiversity

Researchers have recently identified many factors that threaten China's fish biodiversity (Xiong et al., 2018a, 2019), and the primary challenges in the Zhanjiang mangroves include aquaculture pollution, nonnative species and overfishing (Xiong et al., 2019).

Zhanjiang mangroves, located in the Leizhou Peninsula of China, are the center of the most important shrimp aquaculture area in the world (Xiong et al., 2019). In the past forty years, over one third of the mangrove habitat was transformed into shrimp ponds. The production of shrimp (*Penaeus vannamei*, *P. monodon* and *Cherax quadricarinatus*) in Zhanjiang accounts for about one third of the total shrimp production in the world (Xiong et al., 2019). Most of the aquaculture industry's wastewater is discharged directly into mangrove habitat without the implementation of any mitigative measures to reduce or control its pollution or negative impacts. Nutrient overloading has led to widespread eutrophic and harmful algal blooms in a diversity of waterbodies (Liao et al., 2012) and a great number of fish die from hypoxia and toxic compounds (Xiong et al., 2019).

Recently, China has become a hotspot of nonnative aquatic species introductions (Xiong et al., 2015) and they have had significantly negative ecological and economic impacts (Xiong et al., 2015, 2017, 2018d; Wang et al., 2016). Five nonnative fish species (*Oreochromis mossambicus*, *Oreochromis niloticus*, *Gobiopterus lacustris*, *Pseudupeneus prayensis*, and *Gambusia affinis*) occur in the Zhanjiang mangroves (Xiong et al., 2018b, 2018c) and two tilapia are the most dominant nonnative aquaculture species in China (Xiong et al., 2015). The current production of tilapia in China reached 1.62 million tons, about 90 times more than that of 35 years ago (unpublished data). Tilapia has become the most widespread nonnative species in southern China and the climate of Zhanjiang is similar to that of their natural distribution (Gu et al., 2019). Tilapia has been widely used as aquaculture species in

Zhanjiang, and, unfortunately, a great number escaped and successfully established feral populations in diversified aquatic ecosystems, including mangroves (Xiong et al., 2018b, 2018c, 2019; Gu et al,. 2019). Naturalized tilapia established high density populations and have caused the decline of native fish biodiversity in mangrove habitats (Xia et al., 2019).

Lacustrine gobies were originally introduced into China as an aquarium species and the aquarium trade has become the most common current pathway of introduction for nonnative fish species in China (Xiong et al., 2015, 2017). We determined that over five hundred nonnative fish species are presently sold in stores and through the Internet market in China (Xiong et al., 2015, 2017). While our research revealed only one nonnative species introduced through the aquarium trade in mangroves, it can be anticipated that in the foreseeable future, more and more aquarium fish will become established as invasive species in Chinese mangroves.

In China, overfishing is one of the primary threats to aquatic biodiversity (Xiong et al., 2018a, 2019) and fish are the most important source of food for local residents near the Zhanjiang mangroves. A diversity of fishing techniques are used to harvest fish including traps, gill nets, drift-gill nets, hooks, and illegal methods such as electrofishing, poison, and blasting (Xiong et al., 2019). Although the precise level of fishing pressure is not clear, the population around the Zhanjiang mangroves has sharply increased because of urban development (Xiong et al., 2019). In the consultation with local fishermen, it is apparent that the number and diversity of fishes has sharply decreased.

4.2. Conservation of fish biodiversity

Although fisheries in Chinese mangroves are the most important food source for local rural residents (Xiong et al., 2019), Chinese fisheries suffer greatly from human activities (Xiong et al., 2018a, 2019). Nineteen fish species are listed as Endangered in the Red List of the IUCN (Supplementary file 1). More research and the development of protective measures are needed to conserve fish biodiversity in mangrove habitats. The establishment of natural reserves is the most effective method for conservation of fish biodiversity (Xiong et al., 2018a, 2019). Zhanjiang Mangrove National Nature Reserve was established in 1997 and is composed of dozens of small protected communities distributed on the coastline of more than 1500 km in the Leizhou Peninsula. It is highly integrated with the local communities and human activities. Nonetheless, it is challenging to manage and control human activities such as electrofishing in the protected areas within Reserve. More science-based and restrictive management measures such as protective regulations, penalties for violating them, and enforcement patrols ae needed in the Zhanjiang mangroves.

Currently, China is the most seriously threatened country by invasion of nonnative aquatic species (Xiong et al., 2015, 2017a; Wang et al., 2016, 2021). Some nonnative species were introduced into Zhanjiang for aquaculture or/and the aquarium trade. And more nonnative species are likely to be introduced in the foreseeable future. Prevention of further invasion is more effective and less costly than attempting to control the impacts of unregulated introductions of nonnative species (Leung et al., 2002). More research is needed to predict the potential distribution, life-history traits, and ecological and economic impacts of nonnative species (Xiong et al., 2015). Periodic monitoring of nonnative species is clearly needed, and should be adopted, implemented andstrengthened.

5. Conclusion

The mangrove habitats of Zhanjiang support a remarkable fish biodiversity and are located in a global biodiversity hotspot (Myers et al., 2000). According to our studies, the Zhanjiang mangroves contain the greatest fish biodiversity of all of the Chinese mangrove systems (Wang et al., 2021). Many fish species are important as fishery and aquaculture resources for the local resident. However, pollution, nonnative species and overfishing have led to severely negative impacts on fisheries. Protective measures and a viable management program should be adopted, including establishment of protected areas, control of illegal fishing, and prevention of the further invasion and establishment of nonnative species.

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Contribution of authors

JL, WX, DX, and WT collected the data and performed the fieldwork. WX led the writing of the manuscript and JL contributed to the final manuscript. JL, WX, DX, and WT collected the data and performed the fieldwork. WX and XR led the writing of the manuscript and JL contributed to the final manuscript.

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Supplement 1. List of fish species in the Zhanjiang mangroves. a: endangered species in China; b: nonnative species.

No	Order	Family	Latin name
1	Carcharhiniformes	Carcharhinidae	*Rhizoprionodon acutus* (Rüppell, 1837)
2	Myliobatiformes	Dasyatidae	*Hemitrygon laevigata* (Chu, 1960)a
3	Anguilliformes	Anguillidae	*Anguilla japonica* Temminck & Schlegel, 1846a
4	Anguilliformes	Congridae	*Uroconger lepturus* (Richardson, 1845)
5	Anguilliformes	Muraenesocidae	*Muraenesox cinereus* (Forsskål, 1775)
6	Anguilliformes	Muraenesocidae	*Muraenesox yamaguchiensis* Katayama & Takai, 1954
7	Anguilliformes	Muraenidae	*Uropterygius concolor* Rüppell, 1838
8	Anguilliformes	Ophichthidae	*Muraenichthys gymnopterus* (Bleeker, 1853)
9	Anguilliformes	Ophichthidae	*Pisodonophis boro* (Hamilton, 1822)
10	Anguilliformes	Ophichthidae	*Pisodonophis cancrivorus* (Richardson, 1848)
11	Anguilliformes	Ophichthidae	*Scolecenchelys macroptera* (Bleeker, 1857)
12	Atheriniformes	Atherinidae	*Atherinomorus lacunosus* (Forster, 1801)
13	Aulopiformes	Synodontidae	*Harpadon nehereus* (Hamilton, 1822)
14	Aulopiformes	Synodontidae	*Trachinocephalus myops* (Forster, 1801)
15	Beloniformes	Belonidae	*Strongylura leiura* (Bleeker, 1850)
16	Beloniformes	Belonidae	*Strongylura strongylura* (van Hasselt, 1823)
17	Beloniformes	Exocoetidae	*Hirundichthys rondeletii* (Valenciennes, 1847)
18	Beloniformes	Hemiramphidae	*Hyporhamphus dussumieri* (Valenciennes, 1847)
19	Beloniformes	Hemiramphidae	*Hyporhamphus intermedius* (Cantor, 1842)
20	Beloniformes	Hemiramphidae	*Hyporhamphus limbatus* (Valenciennes, 1847)
21	Beloniformes	Zenarchopteridae	*Zenarchopterus buffonis* (Valenciennes, 1847)
22	Clupeiformes	Clupeidae	*Clupanodon thrissa* (Linnaeus, 1758)a
23	Clupeiformes	Clupeidae	*Escualosa thoracata* (Valenciennes, 1847)
24	Clupeiformes	Clupeidae	*Konosirus punctatus* (Temminck & Schlegel, 1846)
25	Clupeiformes	Clupeidae	*Nematalosa nasus* (Bloch, 1795)
26	Clupeiformes	Clupeidae	*Sardinella fimbriata* (Valenciennes, 1847)
27	Clupeiformes	Clupeidae	*Sardinella hualiensis* (Chu & Tsai, 1958)a
28	Clupeiformes	Clupeidae	*Sardinella lemuru* Bleeker, 1853a
29	Clupeiformes	Clupeidae	*Sardinella melanura* (Cuvier, 1829)
30	Clupeiformes	Engraulidae	*Engraulis japonicus* Temminck & Schlegel, 1846
31	Clupeiformes	Engraulidae	*Setipinna taty* (Valenciennes, 1848)
32	Clupeiformes	Engraulidae	*Setipinna tenuifilis* (Valenciennes, 1848)
33	Clupeiformes	Engraulidae	*Stolephorus commersonnii* Lacepède, 1803
34	Clupeiformes	Engraulidae	*Thryssa hamiltonii* Gray, 1835
35	Clupeiformes	Engraulidae	*Thryssa kammalensis* (Bleeker, 1849)
36	Clupeiformes	Engraulidae	*Thryssa vitrirostris* (Gilchrist & Thompson, 1908)
37	Clupeiformes	Pristigasteridae	*Ilisha elongata* (Anonymous [Bennett], 1830)
38	Clupeiformes	Pristigasteridae	*Ilisha melastoma* (Bloch & Schneider, 1801)
39	Siluriformes	Clariidae	*Clarias batrachus* (Linnaeus, 1758)
40	Cypriniformes	Cyprinidae	*Carassius auratus* (Linnaeus, 1758)
41	Cypriniformes	Cyprinidae	*Cirrhinus molitorella* (Valenciennes, 1844)a
42	Cypriniformes	Cyprinidae	*Cyprinus carpio* Linnaeus, 1758a

Supplement 1. (Continued).

No	Order	Family	Latin name
43	Cypriniformes	Cyprinidae	*Hemibarbus maculatus* Bleeker, 1871
44	Cypriniformes	Cyprinidae	*Hemiculter leucisculus* (Basilewsky, 1855)
45	Cypriniformes	Cyprinidae	*Henicorhynchus siamensis* (Sauvage, 1881)
46	Cypriniformes	Cyprinidae	*Hypophthalmichthys molitrix* (Valenciennes, 1844)a
47	Cypriniformes	Cyprinidae	*Metzia lineata* (Pellegrin, 1907)
48	Cypriniformes	Cyprinidae	*Metzia mesembrinum* (Jordan & Evermann, 1902)
49	Cyprinodontiformes	Poeciliidae	*Gambusia affinis* (Baird & Girard, 1853)b
50	Elopiformes	Elopidae	*Elops hawaiensis* Regan, 1909
51	Elopiformes	Elopidae	*Elops machnata* (Forsskål, 1775)
52	Elopiformes	Elopidae	*Elops saurus* Linnaeus, 1766
53	Elopiformes	Megalopidae	*Megalops cyprinoides* (Broussonet, 1782)
54	Gadiformes	Bregmacerotidae	*Bregmaceros nectabanus* Whitley, 1941
55	Gadiformes	Bregmacerotidae	*Bregmaceros rarisquamosus* Munro, 1950
56	Mugiliformes	Mugilidae	*Chelon parsia* (Hamilton, 1822)
57	Mugiliformes	Mugilidae	*Crenimugil buchanani* (Bleeker, 1853)
58	Mugiliformes	Mugilidae	*Ellochelon vaigiensis* (Quoy & Gaimard, 1825)
59	Mugiliformes	Mugilidae	*Liza carinata* (Valenciennes, 1836)
60	Mugiliformes	Mugilidae	*Moolgarda engeli* (Bleeker, 1858)
61	Mugiliformes	Mugilidae	*Mugil cephalus* Linnaeus, 1758
62	Mugiliformes	Mugilidae	*Osteomugil cunnesius* (Valenciennes, 1836)
63	Mugiliformes	Mugilidae	*Planiliza affinis* (Günther, 1861)a
64	Mugiliformes	Mugilidae	*Planiliza haematocheila* (Temminck & Schlegel, 1845)
65	Mugiliformes	Mugilidae	*Planiliza macrolepis* (Smith, 1846)
66	Mugiliformes	Mugilidae	*Planiliza melinopterus* (Valenciennes, 1836)
67	Mugiliformes	Mugilidae	*Planiliza subviridis* (Valenciennes, 1836)
68	Perciformes	Ambassidae	*Ambassis gymnocephalus* (Lacepède, 1802)
69	Perciformes	Ambassidae	*Ambassis marianus* Günther, 1880
70	Perciformes	Eleotridae	*Butis koilomatodon (Bleeker, 1849)*
71	Perciformes	Gerridae	*Gerres erythrourus (Bloch, 1791)*
72	Perciformes	Gerridae	*Gerres filamentosus Cuvier, 1829*
73	Perciformes	Gerridae	*Gerres japonicus Bleeker, 1854*
74	Perciformes	Gerridae	*Gerres limbatus Cuvier, 1830*
75	Perciformes	Gerridae	*Gerres longirostris (Lacepède, 1801)*
76	Perciformes	Gerridae	*Gerres oblongus Cuvier, 1830*
77	Perciformes	Haemulidae	*Diagramma pictum (Thunberg, 1792)*
78	Perciformes	Haemulidae	*Pomadasys argenteus (Forsskål, 1775)*
79	Perciformes	Haemulidae	*Pomadasys quadrilineatus Shen & Lin, 1984*
80	Perciformes	Labridae	*Halichoeres nigrescens (Bloch & Schneider, 1801)*
81	Perciformes	Lateolabracidae	*Lateolabrax japonicus (Cuvier, 1828)*
82	Perciformes	Leiognathidae	*Equulites rivulatus (Temminck & Schlegel, 1845)*
83	Perciformes	Leiognathidae	*Leiognathus brevirostris (Valenciennes, 1835)*
84	Perciformes	Leiognathidae	*Nuchequula nuchalis (Temminck & Schlegel, 1845)*

Supplement 1. (Continued).

No	Order	Family	Latin name
85	Perciformes	Leiognathidae	*Photopectoralis bindus (Valenciennes, 1835)*
86	Perciformes	Leiognathidae	*Secutor ruconius (Hamilton, 1822)*
87	Perciformes	Lutjanidae	*Lutjanus ophuysenii (Bleeker, 1860)*
88	Perciformes	Lutjanidae	*Lutjanus russellii (Bleeker, 1849)*
89	Perciformes	Nemipteridae	*Nemipterus peronii (Valenciennes, 1830)*
90	Perciformes	Pinguipedidae	*Parapercis ommatura Jordan & Snyder, 1902*
91	Perciformes	Polynemidae	*Polydactylus sextarius (Bloch & Schneider, 1801)*
92	Perciformes	Sciaenidae	*Dendrophysa russelii (Cuvier, 1829)a*
93	Perciformes	Sciaenidae	*Johnius belangerii (Cuvier, 1830)*
94	Perciformes	Sciaenidae	*Pennahia anea (Bloch, 1793)*
95	Perciformes	Serranidae	*Epinephelus malabaricus (Bloch & Schneider, 1801)a*
96	Perciformes	Siganidae	*Siganus canaliculatus (Park, 1797)*
97	Perciformes	Siganidae	*Siganus fuscescens (Houttuyn, 1782)*
98	Perciformes	Siganidae	*Siganus guttatus (Bloch, 1787)*
99	Perciformes	Sillaginidae	*Sillago asiatica McKay, 1982a*
100	Perciformes	Sillaginidae	*Sillago sihama (Forsskål, 1775)*
101	Perciformes	Sparidae	*Acanthopagrus berda (Forsskål, 1775)*
102	Perciformes	Sparidae	*Acanthopagrus latus (Houttuyn, 1782)*
103	Perciformes	Sparidae	*Acanthopagrus schlegelii (Bleeker, 1854)*
104	Perciformes	Sparidae	*Parargyrops edita Tanaka, 1916*
105	Perciformes	Sparidae	*Rhabdosargus sarba (Forsskål, 1775)*
106	Perciformes	Sphyraenidae	*Sphyraena jello Cuvier, 1829*
107	Anabantiformes	Anabantidae	*Anabas testudineus* (Bloch, 1792)
108	Kurtiformes	Apogonidae	*Apogonichthyoides pseudotaeniatus* (Gon, 1986)
109	Kurtiformes	Apogonidae	*Ostorhinchus fasciatus* (White, 1790)
110	Callionymiformes	Callionymidae	*Repomucenus olidus* (Günther, 1873)
111	Callionymiformes	Callionymidae	*Repomucenus virgis* (Jordan & Fowler, 1903)
112	Callionymiformes	Callionymidae	*Callionymus curvicornis* Valenciennes, 1837
113	Callionymiformes	Callionymidae	*Callionymus sagitta* Pallas, 1770
114	Carangiformes	Carangidae	*Alepes djedaba* (Forsskål, 1775)
115	Carangiformes	Carangidae	*Alepes melanoptera* (Swainson, 1839)
116	Carangiformes	Carangidae	*Carangoides malabaricus* (Bloch & Schneider, 1801)
117	Carangiformes	Carangidae	*Carangoides praeustus* (Anonymous [Bennett], 1830)
118	Carangiformes	Carangidae	*Scomberoides tala* (Cuvier, 1832)a
119	Carangiformes	Carangidae	*Selaroides leptolepis* (Cuvier, 1833)
120	Carangiformes	Carangidae	*Trachinotus ovatus* (Linnaeus, 1758)
121	Cichliformes	Cichlidae	*Oreochromis mossambicus* (Peters, 1852)ab
122	Cichliformes	Cichlidae	*Oreochromis niloticus* (Linnaeus, 1758)b
123	Acanthuriformes	Drepaneidae	*Drepane punctata* (Linnaeus, 1758)
124	Gobiiformes	Eleotridae	*Bostrychus sinensis* Lacepède, 1801
125	Gobiiformes	Eleotridae	*Butis butis* (Hamilton, 1822)
126	Gobiiformes	Gobiidae	*Acentrogobius caninus* (Valenciennes, 1837)

Supplement 1. (Continued).

No	Order	Family	Latin name
127	Gobiiformes	Gobiidae	*Acentrogobius microps* (Chu & Wu, 1963)a
128	Gobiiformes	Gobiidae	*Acentrogobius pflaumii* (Bleeker, 1853)
129	Gobiiformes	Gobiidae	*Acentrogobius viridipunctatus* (Valenciennes, 1837)
130	Gobiiformes	Gobiidae	*Amblyotrypauchen arctocephalus* (Alcock, 1890)
131	Gobiiformes	Gobiidae	*Apocryptodon madurensis* (Bleeker, 1849)
132	Gobiiformes	Gobiidae	*Boleophthalmus pectinirostris* (Linnaeus, 1758)
133	Gobiiformes	Gobiidae	*Ctenogobius chusanensis* Herre, 1940
134	Gobiiformes	Gobiidae	*Exyrias puntang* (Bleeker, 1851)
135	Gobiiformes	Gobiidae	*Favonigobius gymnauchen* (Bleeker, 1860)
136	Gobiiformes	Gobiidae	*Favonigobius reichei* (Bleeker, 1854)a
137	Gobiiformes	Gobiidae	*Glossogobius aureus* Akihito & Meguro, 1975
138	Gobiiformes	Gobiidae	*Glossogobius circumspectus* (Macleay, 1883)
139	Gobiiformes	Gobiidae	*Glossogobius giuris* (Hamilton, 1822)
140	Gobiiformes	Gobiidae	*Glossogobius olivaceus* (Temminck & Schlegel, 1845)
141	Gobiiformes	Gobiidae	*Gobiopterus lacustris* (Herre, 1927)b
142	Gobiiformes	Gobiidae	*Istigobius campbelli* (Jordan & Snyder, 1901)
143	Gobiiformes	Gobiidae	*Mugilogobius abei* (Jordan & Snyder, 1901)
144	Gobiiformes	Gobiidae	*Mugilogobius chulae* (Smith, 1932)
145	Gobiiformes	Gobiidae	*Oxuderces dentatus* Eydoux & Souleyet, 1850
146	Gobiiformes	Gobiidae	*Oxyurichthys microlepis* (Bleeker, 1849)
147	Gobiiformes	Gobiidae	*Parachaeturichthys polynema* (Bleeker, 1853)
148	Gobiiformes	Gobiidae	*Parapocryptes serperaster* (Richardson, 1846)
149	Gobiiformes	Gobiidae	*Periophthalmus magnuspinnatus* Lee, Choi & Ryu, 1995
150	Gobiiformes	Gobiidae	*Periophthalmus modestus* Cantor, 1842
151	Gobiiformes	Gobiidae	*Periophthalmus novaeguineaensis* Eggert, 1935
152	Gobiiformes	Gobiidae	*Psammogobius biocellatus* (Valenciennes, 1837)
153	Gobiiformes	Gobiidae	*Pseudogobius javanicus* (Bleeker, 1856)
154	Gobiiformes	Gobiidae	*Pseudogobius masago* (Tomiyama, 1936)
155	Gobiiformes	Gobiidae	*Rhinogobius giurinus* (Rutter, 1897)
156	Gobiiformes	Gobiidae	*Sicyopterus lagocephalus* (Pallas, 1770)
157	Gobiiformes	Gobiidae	*Sicyopus zosterophorus* (Bleeker, 1856)
158	Gobiiformes	Gobiidae	*Synechogobius ommaturus* (Richardson, 1845)
159	Gobiiformes	Gobiidae	*Taenioides cirratus* (Blyth, 1860)
160	Gobiiformes	Gobiidae	*Tridentiger barbatus* (Günther, 1861)
161	Gobiiformes	Gobiidae	*Tridentiger obscurus* (Temminck & Schlegel, 1845)
162	Gobiiformes	Gobiidae	*Tridentiger trigonocephalus* (Gill, 1859)
163	Gobiiformes	Gobiidae	*Trypauchen vagina* (Bloch & Schneider, 1801)
164	Gobiiformes	Oxudercidae	*Scartelaos histophorus (Valenciennes, 1837)*
165	Mulliformes	Mullidae	*Parupeneus forsskali* (Fourmanoir & Guézé, 1976)
166	Mulliformes	Mullidae	*Pseudupeneus prayensis* (Cuvier, 1829)ab
167	Mulliformes	Mullidae	*Upeneus sulphureus* Cuvier, 1829
168	Mulliformes	Mullidae	*Upeneus tragula* Richardson, 1846

Supplement 1. (Continued).

No	Order	Family	Latin name
169	Acanthuriformes	Scatophagidae	*Scatophagus argus* (Linnaeus, 1766)
170	Acanthuriformes	Siganidae	*Siganus argenteus (Quoy & Gaimard, 1825)*
171	Scombriformes	Stromateidae	*Pampus chinensis* (Euphrasen, 1788)
172	Scombriformes	Trichiuridae	*Lepturacanthus savala (Cuvier, 1829)*
173	Scombriformes	Trichiuridae	*Trichiurus lepturus Linnaeus, 1758*
174	Centrarchiformes	Terapontidae	*Terapon jarbua* (Forsskål, 1775)
175	Centrarchiformes	Terapontidae	*Terapon theraps* Cuvier, 1829
176	Pleuronectiformes	Bothidae	*Arnoglossus tenuis* Günther, 1880
177	Pleuronectiformes	Cynoglossidae	*Cynoglossus puncticeps* (Richardson, 1846)
178	Pleuronectiformes	Cynoglossidae	*Cynoglossus robustus* Günther, 1873
179	Pleuronectiformes	Cynoglossidae	*Cynoglossus sinicus* Wu, 1932
180	Pleuronectiformes	Cynoglossidae	*Paraplagusia bilineata* (Bloch, 1787)
181	Pleuronectiformes	Paralichthyidae	*Pseudorhombus arsius* (Hamilton, 1822)
182	Pleuronectiformes	Soleidae	*Brachirus orientalis* (Bloch & Schneider, 1801)
183	Pleuronectiformes	Soleidae	*Solea ovata* Richardson, 1846
184	Pleuronectiformes	Soleidae	*Zebrias quagga* (Kaup, 1858)
185	Pleuronectiformes	Soleidae	*Zebrias zebra* (Bloch, 1787)
186	Scorpaeniformes	Platycephalidae	*Inegocia japonica* (Cuvier, 1829)
187	Scorpaeniformes	Platycephalidae	*Platycephalus indicus* (Linnaeus, 1758)
188	Scorpaeniformes	Sebastidae	*Sebastiscus marmoratus* (Cuvier, 1829)
189	Scorpaeniformes	Synanceiidae	*Inimicus japonicus* (Cuvier, 1829)a
190	Scorpaeniformes	Synanceiidae	*Minous monodactylus* (Bloch & Schneider, 1801)
191	Scorpaeniformes	Synanceiidae	*Trachicephalus uranoscopus* (Bloch & Schneider, 1801)
192	Scorpaeniformes	Tetrarogidae	*Tetraroge barbata* (Cuvier, 1829)
193	Scorpaeniformes	Tetrarogidae	*Vespicula trachinoides* (Cuvier, 1829)
194	Scorpaeniformes	Tetrarogidae	*Vespicula zollingeri* (Bleeker, 1848)
195	Siluriformes	Ariidae	*Netuma thalassina* (Rüppell, 1837)
196	Siluriformes	Bagridae	*Tachysurus sinensis* Lacepède, 1803
197	Siluriformes	Plotosidae	*Plotosus lineatus* (Thunberg, 1787)
198	Syngnathiformes	Syngnathidae	*Phoxocampus belcheri* (Kaup, 1856)
199	Tetraodontiformes	Monacanthidae	*Monacanthus chinensis* (Osbeck, 1765)
200	Tetraodontiformes	Monacanthidae	*Pseudomonacanthus peroni* (Hollard, 1854)
201	Tetraodontiformes	Tetraodontidae	*Lagocephalus lunaris* (Bloch & Schneider, 1801)
202	Tetraodontiformes	Tetraodontidae	*Lagocephalus spadiceus* (Richardson, 1845)
203	Tetraodontiformes	Tetraodontidae	*Takifugu alboplumbeus* (Richardson, 1845)
204	Tetraodontiformes	Tetraodontidae	*Takifugu niphobles* (Jordan & Snyder, 1901)
205	Tetraodontiformes	Tetraodontidae	*Takifugu oblongus* (Bloch, 1786)
206	Tetraodontiformes	Tetraodontidae	*Takifugu ocellatus* (Linnaeus, 1758)a
207	Tetraodontiformes	Tetraodontidae	*Takifugu porphyreus* (Temminck & Schlegel, 1850)
208	Tetraodontiformes	Triacanthidae	*Triacanthus nieuhofii* Bleeker, 1852