Ornamental Fisheries in Hindu Kush Himalayan Region

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Abstract

Cold-water fisheries in the Hindu Kush Himalayan region mainly span the highland and midland streams and rivers of eight countries: Afghanistan, Pakistan, Nepal, Bhutan, China, Myanmar, Bangladesh, and India. This paper summarizes the existing information on cold-water ornamental fisheries resources and prevalent hazards in all Hindu Kush Himalayan nations. In addition, the Indian resources and valuable indigenous group of ornamental fishes are described in-depth. The fisheries in the majority of the Himalayan nations are little studied and at significant risk due to several natural and anthropogenic hazards. Construction of hydroelectric power plants in the streams and rivers is recognized as the primary cause for declining fish population. In India, overfishing of ornamental fishes is also becoming a significant issue for the sustainable management of ornamental fisheries.

Keywords

Ornamental fisheries · Himalayan countries · Hill stream fish

10.1 Introduction

The Hindu Kush Himalaya is one of the world's largest mountain systems, spanning 4.2 million km^2 area (Bajracharya et al. 2015) over eight nations from Afghanistan in the west to Myanmar in the east and traversing Pakistan, India, Nepal, Bhutan,

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China, and Bangladesh. The Hindu Kush Himalayan region is source of ten Asia's major river basins including the Ganges, Indus, Brahmaputra, Yellow, Yangtze, Irrawaddy, Salween, Mekong, Amu Darya, and Tarim, and it contains large volume of ice and snow. The Indian Himalayan region contributes the largest share of Himalayan range spreading over 500,000 km^2 (16.2% of the nation's total geographical area) and marks the northern border of the country. The Himalaya is home to diverse flora, and fauna, including a number of different fish species. The rivers and streams in the Himalayan mountains predominantly sustain the recreational or sport fishes such as mahseer, snow trout, etc. and small-sized fishes such as barbs, loaches, catfish, suckers, and minnows with ornamental and food value. Water current is high, and biological productivity is low in the Himalayan hill steams, for which most fishes in this region (except mahseer and trout) are small in size with adhesive organs to protect themselves from being swept away. The fisheries are underdeveloped, owing to severe terrain and inaccessibility in the mountains. Commercial fisheries are mostly carried out in some lakes and reservoirs in some countries. The Hindu Kush Himalayan region is facing several sustainable developmental challenges which include climate change, overexploitation of natural resources, difficulty in implementing infrastructure development plans, and unplanned societal growth. Furthermore, construction of hydropower projects, damming, and the associated habitat degradation are harming the Himalayan fisheries.

10.2 Geography, Ornamental Fish Diversity, and Challenges

The geography, ornamental fish diversity, and their challenges in different regions of the Hindu Kush Himalaya are discussed in the following:

10.2.1 Nepal

Nepal stretches about 800 km along the southern slopes of the Himalayas, dividing the parched Tibetan Plateau to the north and the lush Gangetic Plain to the south. Rugged hills and mountains cover more than 80% of the geographical area. Trans-Himalaya, highlands, subtropical midlands, and tropical lowlands or terai are the primary ecological regions. The major rivers, Koshi, Gandaki, Karnali (originating from the northern slopes of the greater Himalayas), and Mahakali (originating from the high mountains of Nepal), are of primary interest for the cold-water ornamental fish diversity. The ornamental fish fauna of the river Koshi consists of *Barilius* spp., *Garra* spp., *Nemacheilus* spp., *Glyptothorax* spp., *Danio* spp., *Schistura* spp., *Botia almorhae*, *Balitora brucei*, *Olyra longicaudata*, *Puntius conchonius*, *P. phutunio* (pigmy barb), *Channa stewartii*, etc. In the river Gandaki, the important ornamental fish species are *Garra annandalei*, *G. gotyla*, *Devario aequipinnatus*, *Danio dangila*, *D. rerio*, *Chela labuca*, *Glyptothorax pectinopterus*, *Botia almorhae*, and *Channa gachua*. Several species under the genera *Garra*, *Glyptothorax*, *Barilius*, and *Nemacheilus* are also found in Karnali and Mahakali rivers.

Nepal has a wide diversity of indigenous ornamental fishes, but the exotic species such as goldfish, koi carp, and live bearers dominate the aquarium market with a significant share of imports from India (85%) and the remaining (15%) from other countries. Several indigenous fish species, i.e., *Barilius barna*, *B. vagra*, *B. bendelisis*, *Puntius sophore*, *P. conchonius*, *P. ticto*, *Danio devario*, *D. rerio*, *Mastacembelus armatus*, *Xenentodon cancila*, *Mystus bleekeri*, *Channa gachua*, and *C. punctatus*, have been recognized for their ornamental fisheries potential (Husen et al. 2021). However, the breeding techniques of these indigenous fishes need to be standardized to enhance their production and bring them into the international market.

The rising number of hydropower projects in Nepal is causing challenges for cold-water fisheries. Besides the hydropower projects, overfishing, dangerous fishing tactics, and pollution have all contributed to the decline of indigenous fish population. River damming, for example, has a significant influence on river ecology and aquatic flora and fauna, including fish. The lack of technical knowledge among the local farmers and stakeholders is the primary reason behind Nepal's low success in indigenous fish breeding and culture. Considering the ornamental fisheries resources and their positive potential, there is an urgent need to enhance the scientific studies related to breeding, nutrition, and health management.

10.2.2 Bhutan

The Himalayan range of Bhutan is divided into three zones: the southern foothills and plains (altitudes less than 2000 m), the Inner Himalayas (2000–3000 m), and the Great Himalayas (3000–7500 m). Manas, Sankosh, Amo, Wang, and Tongsa are the major cold-water rivers of Bhutan. A few studies have been carried out in Bhutan regarding the ornamental fisheries resources. Important indigenous ornamental fishes, reported from various rivers and streams of Bhutan, are *Barilius barna*, *Danio aequipinnatus*, *D. dangila*, *Bagarius bagarius*, *Nangra punctata*, and *Badis badis* from Manas; *Puntius macropogon*, *P. sophore*, *P. ticto*, *Garra annandalei*, *Rasbora daniconius*, *B. bendelisis*, *Batasio batasio*, *Mystus bleekeri*, *M. vittatus*, and *Nandus nandus* from the Gaylegphug; *B. barna*, *B. bola*, *G. annandalei*, *G. gotyla*, *Semiplotussemiplotus*, *Xenentodon cancila*, and *Channa gachua* from the Phepsu; *B. barna*, *B. bendelisis*, *P. ticto*, *G. annandalei*, *G. gotyla*, *D. aequipinnatus*, *D. dangila*, *Brachydanio rerio*, *Noemacheilus botia*, and *Mastacembelus armatus* from the Sarbhang Khola; and *P. titius* and *G. gotyla* from the Sankosh and Magdi (Petr and Swar 2002).

The indigenous aquatic resources and their potential are recognized in Bhutan, but due to the lack of studies on fish diversity, conservation, culture practices, and poorly developed aquaculture support services, growth of ornamental industry is dormant. Furthermore, the mega hydropower projects on the major rivers possess severe threat to the fish diversity.

10.2.3 China

In 2020, China ranked second in the world for ornamental fish imports ($ 23 million, 8.13% of world imports) after the United States ($ 67 million, 23%). The country's ornamental fish exports account for 1.4% of the global exports worth $ 4 million. Ornamental fish fauna in the temperate regions of China largely covers the Yangtze, Yellow, and Yarlung Zangbo (Brahmaputra) rivers originating from Qinghai-Tibetan Plateau Region and Heilongjiang (Amur) river originating from Siberian-Mongolian border. The Upper Yangtze region consists of the fishes from genera *Leptobotia*, *Pseudobagrus*, *Rhinogobio*, *Beaufortia*, *Anabarilius*, and *Triplophysa*, and the middle-lower Yangtze region consists of fishes such as *Myxocyprinus* (Chinese sucker) and *Nemacheilus* from Catostomidae and Balitoridae and fish from Cyprinidae families. *Triplophysa*, *Leptobotia*, and *Pseudorasbora* are the dominant fish species found in the Yellow river. The ornamental fish fauna in Heilongjiang region contains a large number of species from the minnow, goby, and spiny loach group in the genera *Rhynchocypris*, *Rhinogobio*, and *Cobitis*. Moltrecht's minnow (*Pararasbora moltrechti*, Cyprinidae) and white cloud mountain minnow (*Tanichthys albonubes*, Cyprinidae), the two popular native ornamental fishes of China, are distributed in the Hainan and Taiwan in the south region (Kang et al. 2014; Li et al. 2022). China has suffered population collapse of several freshwater fishes in the Yangtze and Yellow rivers due to climate change, change in river discharge pattern, and construction of dams for hydropower projects (Fu et al. 2003; Xing et al. 2016).

10.2.4 Afghanistan

Afghanistan covers high mountain ranges of the Western range of Hindu Kush, plains, valleys, and highlands with numerous rivers, streams, and lakes. Nearly 75% of the area is covered with mountains. The species diversity of Afghanistan is dominated by Cyprinidae (56.9%), Cobitidae (24.5%), and, to a lesser extent, Siluridae (11.8%). Cold-water fisheries resources are mainly surveyed in the Kabul river and Helmand river originating from the Hindu Kush. Kabul river is dominated by several indigenous ornamental fishes which are popular in the aquarium trade such as *Danio devario*, *Barilius vagra*, *Puntius conchonicus*, *P. sophore*, *Esomus dandricus*, *Nemacheilus* spp., *Channa gachua*, and *C. punctatus* (Petr and Swar 2002). On the contrary, the Helmand river has the least diverse ichthyofauna. *Noemacheilus* spp. are found in all the major drainages of Helmand river (Coad 1981).

The prime reason behind the poor development of cold-water fisheries in Afghanistan is the lack of proper studies. The fish fauna of the Kabul river downstream faces numerous threats from increasing anthropogenic activities such as pollution, overfishing, and societal development (Kelzang et al. 2021).

10.2.5 Pakistan

Pakistan shares <0.5% in world exports and imports of ornamental fish ($ 0.38 million export and $ 0.07 million import). Cold-water rivers and streams of Pakistan are restricted to the higher latitudes of Northern Pakistan, where the Hindu Kush, Karakoram, and Himalayas stretch from west to east. The major rivers such as Indus and Jhelum flowing in the northern part of Pakistan inhabit several indigenous fishes of the group *Triplophasia*, *Nemacheilus*, *Schistura*, *Garra*, *Glyptothorax*, *Puntius*, *Barilius*, *Aphanius*, *Aplocheilus*, *Chela*, etc. (Petr and Swar 2002). The majority of Pakistan's indigenous fish fauna is limited to hilly and submountainous environments. The region is the primary site of damming and stream obstruction which may eventually lead to the extinction of freshwater biodiversity (Zai 2018).

10.2.6 Bangladesh

Bangladesh is situated at the foot of the Himalayas, with most of its parts being floodplains formed by the Himalayan rivers. Hills are confined to the northeast and the southeast regions bordering India and Myanmar. Feni, Karnaphuli, Kangsho, Shangu, Somesswari, Matamuhori, Piyang, and Sari are the cold-water rivers of Bangladesh, and Kaptai lake is the large cold water reservoir, located in one of the hill districts (Petr and Swar 2002).

The ornamental fisheries sector of Bangladesh has not developed much, although the resource potential is well recognized (Mostafizur et al. 2009). Fish keeping as a hobby is becoming popular with the operating system's ease and lower operating costs (Mostafizur et al. 2009); still most of the enterprises are centered in the major cities like Dhaka, Rajshahi, Khulna, etc. Although the country has a long history of introducing ornamental fishes, documentation and quarantine methods have not been standardized and given importance. So far, a few native species have gained importance as ornamental fish, and exotic species are contributing the majority.

The potential of indigenous ornamental fish and gastropod species has been recognized for *Acanthocobitis botia*, *Amblypharyngodon microlepis*, *A. mola*, *Badis badis*, *Botia dario*, *Chanda nama*, *Channa punctata*, *Chela laubuca*, *Macrognathus aculeatus*, *M. pancalus*, *Mystus tengara*, *Parambassis ranga*, *Puntius chola*, *P. conchonius*, *P. gelius*, *P. guganio*, *P. puntio*, *Gagata cenia*, and *Lymnaea stagnalis*.

Various problems have been recognized for the slow growth of the ornamental fisheries sector of Bangladesh, such as lack of information about the import and export data; lack of market channels; lack of knowledge about the breeding, culture, and health management of important indigenous fish species; etc., that need to be addressed at the earliest.

10.2.7 Myanmar

Cold-water fisheries in Myanmar prevail in the northern region, bordered by Tibet and Yunnan in the north and east and Indian hills on the west. Only four northern states of Myanmar, i.e., Kachin, Kayah, Chin, and Shan, are reported to be under the cold-water zone (Moo 2002). The largest river in Myanmar, Irrawaddy, originates in the Kachin state due to the confluence of the N'mai (Nam Gio) and Mali rivers. The Himalayan glaciers of upper Myanmar serve as the source of both the N'mai and Mali rivers. The cold-water fisheries are poorly developed, with least or no studies so far. The ornamental fish industry has shown decreasing trend in Myanmar during the past few years, and export values recorded for the years 2016, 2017, 2018, and 2019 were US$ 32,056, US$ 30,533, US$ 12,405, and US$ 6748. Cold-water ornamental fishes, reported from Myanmar, are *Aborichthys kempi*, *Acanthopthalmus pangia*, *Akysis prashadi*, *Amblyceps murray stuarti*, *Badis badis*, *Botia berdmorei*, *B. dario*, *Bagarius bagarius*, *Balitora brucei*, *B. maculate*, *Barbodes hexagonolepis*, *Barilius bendelisis*, *B. barna*, *B. grandis*, *Brachydanio choprai*, *B. rerio*, *Danio aequipinnatus*, *D. daniconius*, *Chanda ranga*, *Channa burmanica*, *C. gachua*, *C. striatus*, *Chela laubuca*, *Epalzeorhynchus siamensis*, *Gagata cenia*, *Garra gotyla*, *G. gravelyi*, *G. kempi*, *G. lamta*, *Hara filamentosa*, *Indostomus paradoxus*, *Inlecypris auropurpureus*, *Lepidocephalichthys berdmorei*, *L. guntea*, *Macrognathus caudiocellatus*, *Mastacembelus armatus*, *M. dayi*, *M. oatesii*, *Microrasbora erythromicron*, *M. rubescens*, *Monopterus albus*, *M. cuchia*, *Mystus bleekeri*, *Nemacheilus* spp., *Notopterus chitala*, *N. notopterus*, *Ompok bimaculatus*, *O. pabda*, *Oreinus plagiostomus*, *Parasphaerichthys ocellitus*, *Psilorhynchus balitora*, *Puntius* spp., *Rasbora daniconius*, *R. rasbora*, *Schistura malaise*, *S. sikmaiensis*, *Tetraodon cutcutia*, *Trichogaster fasciatus*, *Xenentodon cancila*, *Yunnanilus brevis*, etc. (Moo 2002). The major challenges in assessing the cold-water fisheries resources of Myanmar are the remoteness and difficulty of accessing them. The potential for the development of cold-water aquaculture needs to be studied for combating food shortage and crisis in remote areas.

10.2.8 India

India contributes relatively a small proportion (<1%) to the global ornamental fish trade. Export value for the Indian ornamental fish industry in 2020 was US$ 1.7 million, contributing to 0.3% of the total export. The Indian Himalayan region is spreading across 13 Indian states, i.e., Ladakh, Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Meghalaya, Nagaland, Arunachal Pradesh, Manipur, Mizoram, Tripura, Sikkim, and hill regions of two states Assam and West Bengal, and inhabits numerous ornamental fish species (Table 10.1). The main markets for Indian ornamental fishes are China, the United States, Bangladesh, and Thailand. Indian ornamental fish export basket constitutes around 287 native fish species, 92 exotic fish species, and 45 shrimps. Out of 287 indigenous fishes, 239 are freshwater and 48 were marine fish species. Among the indigenous freshwater

Table 10.1 Diversity of indigenous hill stream ornamental fishes in the Indian Himalayan region

Species name	Common name	IUCN status, 2010
Himachal Pradesh		
Family: Cyprinidae		
Pethia ticto	Ticto barb	LC
Pethia conchonius	Rosy barb	LC
Puntius sophore	Spotfin swamp barb	LC
Puntius chola	Chola barb	NE
Systomus sarana	Olive barb	LC
Osteobrama cotio	Cotio	LC
Salmostoma bacaila	Large minnow	LC
Barilius bendelisis	Hamilton's barila	LC
Barilius barila	Barred baril	LC
Barilius vagra	Vagra baril	LC
Barilius barna	Barna baril	LC
Barilius shacra	Shacra baril	LC
Danio rerio	Zebra fish	LC
Devario devario	Devario danio	LC
Esomus danrica	Flying barb	LC
Rasbora daniconius	Blackline rasbora	LC
Crossocheilus latius	Gangetic latia	LC
Garra gotyla	Sucker head	LC
Garra lamta	Lamta garra	LC
Nemacheilidae		
Schistura denisoni	Mura	LC
Schistura rupecula	Hill loach/stone loach	LC
Schistura horai	Horai loach	NE
Schistura himachalensis	–	NE
Triplophysa stoliczkae	Stoliczka triplophysa loach	LC
Lepidocephalichthys guntea	Guntea loach	LC
Botia dario	Queen loach	LC
Botia birdi	Birdi loach	NE
Amblyceps mangois	India torrent catfish	LC
Glyptothorax brevipinnis	Mountain catfish	DD
Glyptothorax conirostris	–	DD
Glyptothorax pectinopterus	River cat/Nayid	LC
Glyptothorax stoliczkae	–	LC
Parambassis baculis	Himalayan glassy perchlet	LC
Badis badis	Dwarf chameleon fish	LC
Glossogobius giuris	Tank goby	LC
Jammu and Kashmir		
Puntius conchonius	Rosy barb	LC
Puntius sophore	Pool barb	LC
Puntius ticto	Ticto barb	LC

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Barilius bendelisis	Hamilton's barila	LC
Barilius vagra	Vagra baril	LC
Garra gotyla	Sucker head	LC
Crossocheilus latius	Gangetic latia	LC
Glyptothorax pectinopterus	Nayid/River cat	LC
Uttarakhand		
Barilius bendelisis	Hamilton's barila	LC
Barilius vagra	Vagra baril	LC
Barilius barna	Barna baril	LC
Garra gotyla gotyla	Gotyla garra/sucker head	LC
Garra lamta	Lamta garra	LC
Puntius sophore	Spotfin swamp barb	LC
Puntius ticto	Ticto barb	LC
Crossocheilus latius latius	Gangetic latia or stone roller	LC
Nemacheilus denisoni	Stone loach	LC
Schistura multifasciata	Stone loach	LC
Schistura obliquofascia	–	NE
Acanthocobitis botia	Mottled *loach*	LC
Botia almorae	Yo Yo loach or chitli	LC
Botia rostrata	Gangetic loach, ladder loach, or twin-banded loach	VU
Lepidocephalus guntea	Guntea loach	LC
Glyptothorax saisii	Pathar-chatti	VU
Glyptothorax telchitta	Sipliya	LC
Glyptothorax pectinopterus	River cat/Nayid/Pathar-chatti	LC
Macrognathus pancalus	Baam	LC
Channa gachua	Dwarf snakehead, sowan, dawla	LC
Northeastern states of India		
Clupeidae		
Nematalosa nasus	Bloch's gizzard shad	LC
Engraulidae		
Setipinna phasa	Gangetic hairfin anchovy	LC
Cyprinidae		
Amblypharyngodon mola	Mola carplet	LC
Aspidoparia jaya	Jaya	LC
Aspidoparia morar	Morar	LC
Barilius barila	Barred baril	LC
Barilius barna	Barna baril	LC
Barilius bakeri	Malabar baril	LC
Barilius bendelisis	Hamilton's barila	LC
Barilius chatricensis	Chatrickongi bariil	VU
Barilius dogarsinghi	Manipur baril	VU

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Barilius ngawa	Sherou bariil	VU
Barilius radiolatus	Gunther's baril	DD
Barilius shacra	Shacra baril	LC
Barilius tileo	Tileo baril	LC
Barilius vagra	Vagra baril	LC
Brachydanio albolineatus	Pearl danio	LC
Danio nigrofasciatus	Dwarf spotted danio	DD
Danio choprai	Glowlight danio	LC
Devario shanensis	Hora danio	DD
Devario sondhii	Sondhi devario	DD
Chela cachius	Silver hatchet chela	LC
Laubuka laubuca	Indian glass barb	LC
Laubuka fasciata	Malabar hatchet chela	VU
Crossocheilus burmanicus	Burmese latia	LC
Tariqilabeo latius	Gangetic latia	LC
Cyprinion semiplotum	Assamese kingfish	VU
Danio dangila	Dangila danio	LC
Danio rerio	Zebra danio	LC
Devario annandalei	–	DD
Devario acuticephala	Manipur danio	VU
Devario aequipinnatus	Giant danio	LC
Devario assamensis	Assami devaario	VU
Devario anomalus	Chittagongi devaario	VU
Devario devario	Bengal Dario	LC
Devario horai	Hora devario	EN
Devario naganensis	Naga devario	VU
Devario regina	Fowler's danio	VU
Devario yuensis	Yu devaario	VU
Esomus danricus	Flying barb	LC
Garra abhoyai	–	NE
Garra rupecula	Mishmi garra	NT
Garra annandalei	Annandale garra	LC
Garra compressus	–	VU
Garra flavatra	–	VU
Garra gotyla	Gotyla	LC
Garra gravely	Burmese garra	NT
Garra kempi	Kemp garra	LC
Garra kalpangi	–	
Garra lamta	Lamta garra	LC
Garra mcclellandi	Cauvery garra	LC
Garra notata	Tenasserim garra	LC
Garra lissorhynchus	Khasi garra	LC

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Garra litanensis	–	VU
Garra manipurensis	–	VU
Garra naganensis	Naga garra	LC
Garra nambulica	–	VU
Garra nasuta	Khasi garra	LC
Garra paralissorhynchus	–	VU
Oreichthys cosuatis	Khavli	LC
Pethia atra	-	VU
Pethia meingangbii	–	LC
Naziritor chelynoides	Dark mahseer	VU
Puntius chola	Chola barb	LC
Pethia conchonius	Rosy barb	LC
Dawkinsia filamentosa	Filament barb	LC
Puntius fraseri	Dharna barb	EN
Pethia gelius	Golden barb	LC
Puntius guganio	Glass barb	LC
Pethia khugae	Khuga pethia	LC
Pethia manipurensis	Manipuri pethia	EN
Pethia meingangbii	**Ngakha- meingangbi**	LC
Pethia ornata	–	VU
Pethia phutunio	Spotted sail barb	LC
Pethia punctata	Dotted sawfin barb	LC
Pethia shalynius	Shalyni barb	VU
Pethia stoliczkana	–	LC
Puntius sophore	Spotfin swamp barb	LC
Puntius terio	One spot barb	LC
Puntius ticto	Ticto barb	LC
Systomus clavatus	Stedman barb	NT
Raiamas bola	Indian trout	LC
Raiamas guttatus	Burmese trout	LC
Rasbora daniconius	Slender rasbora	LC
Rasbora ornata	–	VU
Rasbora rasbora	Gangetic scissortail rasbora	LC
Salmophasia bacaila	Large razorbelly minnow	LC
Salmostoma phulo	Finescale razorbelly minnow	LC
Securicula gora	Gora-chela	LC
Psilorhynchidae		
Psilorhynchoides arunachalensis		DD
Psilorhynchus balitora	Balitora minnow	LC
Psilorhynchus sucatio	River stone carp	LC
Balitoridae		
Aborichthys garoensis	–	VU

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Aborichthys elongatus	Red tailed loach	LC
Aborichthys kempi	–	NT
Aborichthys tikaderi	–	VU
Acanthocobitis botia	Zipper loach or mottled loach	LC
Acanthocobitis pavonacea	–	VU
Paracanthocobitis zonalternans	–	LC
Balitora brucei	Gray's stone loach	NT
Balitora burmanica	Burmese stone loach	LC
Homaloptera modesta	–	DD
Homaloptera rupicola	–	LC
Nemacheilidae		
Schistura reticulofasciata	–	VU
Neonoemacheilus assamensis	–	NT
Neonoemacheilus labeosus	–	LC
Neonoemacheilus morehensis	–	DD
Neonoemacheilus peguensis	–	DD
Schistura carletoni	–	NE
Schistura rupecula	Puinya	LC
Physoschistura elongata	–	VU
Schistura beavani	Creek loach	LC
Schistura cincticauda	–	DD
Nemacheiluscorica	Korica	LC
Schistura devdevi	–	NT
Schistura khugae	–	VU
Schistura manipurensis	–	NT
Schistura minutus	–	EN
Paraschistura montana	Chitai, Gadera	NE
Schistura multifasciata	–	LC
Schistura nagaensis	–	VU
Schistura papulifera	–	CE
Schistura prashadi	–	VU
Schistura reticulata	–	EN
Schistura savona	–	LC
Schistura scaturigina	–	LC
Schistura sikmaiensis	–	LC
Nemacheilus singhi	–	VU
Schistura sijuensis	–	EN
Schistura tigrina	–	EN
Schistura tirapensis	–	LC
Nemacheilus inglisi	–	VU
Schistura reticulofasciata	–	VU
Schistura vinciguerrae	–	LC

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Triplophysa gracilis	–	NE
Cobitidae		
Acantopsis multistigmatus	–	NT
Acantopsis dialuzona	–	LC
Botiidae		
Botia almorhae	Almorha loach or Yo Yo loach	LC
Botia dario	Bengal loach	LC
Botia histrionica	Burmese loach	LC
Botia lohachata	Reticulate loach	NE
Botia rostrata	Gangetic loach	VU
Lepidocephalichthys arunachalensis	–	EN
Lepidocephalichthys berdmorei	Burmese loach	LC
Lepidocephalichthys guntea	Guntea loach	LC
Lepidocephalichthys irrorata	Puiya/loktak loach	LC
Lepidocephalichthys manipurensis	Yu loach	LC
Lepidocephalichthys annandalei	Gutum/Annandale loach/tilak loach/ pillai loach	LC
Lepidocephalichthys menoni	Gutum/Annandale loach/tilak loach/ pillai loach	DD
Neoeucirrhichthys maydelli	Goalpara loach	LC
Syncrossus berdmorei	Tiger botia	NT
Canthophrys gongota	Gongota loach	LC
Batasio batasio	Bojori/tista batasio	LC
Batasio fasciolatus	–	LC
Batasio niger	–	DD
Batasio spilurus	–	DD
Batasio tengana	Batasio/*Assamese batasio*	LC
Chandramara chandramara	Asian cory	LC
Bagridae		
Mystus bleekeri	Ngacep/singarah/singorah/tengra	LC
Mystus cavasius	Barsingarah/singarah/gulia/kabashi-tengra	LC
Mystus falcarius	–	LC
Mystus horai	Indus catfish	NE
Mystus montanus	Gagol/girlu/wynaad mystus	LC
Mystus pulcher	Pulcher mystus	LC
Mystus rufescens	Meetan mystus	LC
Mystus tengara	Singorah/Bajari-tengra/stripped dwarf catfish	LC
Mystus vittatus	Lal tingara/singorah/kuggur/palwa/ chittu	LC
Olyra kempi	–	LC
Olyra longicaudata		LC

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
	Botsingi/Himalayan olyra/longtail catfish	
Olyra horae	Hora olyra	DD
Amblycipitidae		
Amblyceps apangi	–	LC
Amblyceps arunachalensis	–	EN
Amblyceps laticeps	–	LC
Amblyceps cerinum	–	
Amblyceps mangois	Indian torrent catfish/chikka	LC
Amblyceps torrentis	–	DD
Amblyceps tuberculatum	–	DD
Akysis manipurensis	–	DD
Akysis prashadi	–	DD
Nandidae		
Badis assamensis	Assamese chameleon fish	DD
Badis badis	Blue perch/blue badis	LC
Badis blosyrus	–	LC
Badis chittagongis	–	DD
Badis ferrarisi	–	LC
Badis kanabos	–	DD
Badis tuivaiei	–	EN
Nandus nandus	Gangetic leaf fish	LC
Chandidae		
Chanda nama	Asiatic glassfish/chanda	LC
Parambassis baculis	Chanda/phopa chanda	LC
Parambassis lala	Highfin glassy perchlet/choto chanda/ Lille glasfish	NT
Parambassis ranga	Indian glassy fish/Indian glassy perch/Indian X-ray fish	LC
Parambassis tenasserimensis		DD
Synbranchidae		
Macrognathus morehensis	Baim/Guchi/Indian spiny eel	LC
Macrognathus pancalus	Tire track eel/bami/baam	VU
Mastacembelidae		
Mastacembelus armatus	Tire track eel/bami/baam	VU
Pillaia indica	Hillstream spineless eel	LC
Garo khajuriai	Garo spineless eel	LC
Syngnathidae		
Microphis deocata	Deocata pipefish/kumirer khil	NT
Aplocheilidae		
Aplocheilus panchax	Blue panchax	LC
Belonidae		

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Xenentodon cancila	Gars/needlefish/garpike/kokila	LC
Strongylura strongylura	Spottail needlefish	LC
Chacidae		
Chaca chaca	Chaca/angler catfish	LC
Mugilidae		
Rhinomugil corsula	Corsula	LC
Sicamugil cascasia	Yellow tail mullet	LC
Sisoridae		
Exostoma barakensis	–	DD
Exostoma berdmorei	–	DD
Exostoma labiatum	Burmese bat catfish/herpak bellap	LC
Exostoma stuarti	–	DD
Exostoma vinciguerrae	–	DD
Gagata cenia	Cenia/Indian gagata/gang tengra/jungle Magur	LC
Gagata gagata	Gang tengra/hudda/Gangetic gagata	LC
Gagata gasawyuh	Blackfin sisorid catfish	LC
Gagata sexualis	Buhani/koel gagata	LC
Glyptosternon maculatum	–	LC
Glyptothorax annandalei	Patharchatta/kapre	LC
Glyptothorax botius	Telcapre	LC
Glyptothorax saisii	–	VU
Glyptothorax conirostris	–	DD
Glyptothorax brevipinnis	–	DD
Glyptothorax cavia	Kani tengra	LC
Glyptothorax sinensis	–	DD
Glyptothorax platypogonides	–	LC
Glyptothorax chindwinica	–	LC
Glyptothorax granulus		LC
Glyptothorax manipurensis	–	VU
Glyptothorax ngapang	–	LC
Glyptothorax striatus	–	NT
Glyptothorax pectinopterus	River cat/nayid	LC
Glyptothorax telchitta	Telchitta	LC
Glyptothorax ventrolineatus	–	LC
Glyptothorax indicus	Catfish	LC
Glyptothorax gracilis	Catfish	DD
Glyptothorax trilineatus	Three-lined catfish	LC
Gogangra viridescens	Gang tengra	LC
Myersglanis jayarami	–	VU
Nangra assamensis	Koshi nangra	LC
Nangra nangra	Gang tengra/koshi nangra	LC

(continued)

Table 10.1 (continued)

Species name	Common name	IUCN status, 2010
Nangra robusta	–	NE
Oreoglanis setiger	–	DD
Parachiloglanis hodgarti	Torrent catfish	LC
Pareuchiloglanis kamengensis	–	DD
Pseudecheneis crassicauda	–	DD
Pseudecheneis sulcata	Sulcatus catfish/sucker throat catfish	LC
Pseudecheneis ukhrulensis	–	VU
Pseudecheneis sirenica	–	VU
Pseudecheneis koladynae	–	NE
Sisor barakensis	–	VU
Sisor chennuah	–	DD
Sisor rabdophorus	Chenua/sisor catfish/bistuiya	LC
Akysidae		
Akysis manipurensis		DD
Akysis prashadi	Indawgyi stream catfish	LC
Erethistidae		
Erethistes horai	Elongate moth catfish hora/terai hara	LC
Erethistes pusillus	Giant moth catfish	LC
Erethistes hara	Indian moth catfish	LC
Erethistes jerdoni	Anchor catfish	LC
Conta conta	Kuta kanti/conta catfish/konta	DD
Conta pectinata	–	DD
Erethistoides montana	–	DD
Erethistoides sicula	–	DD
Hara hara	Gagot/kosi hara/hara	LC
Pseudolaguvia ferula	–	DD
Pseudolaguvia inornata	–	DD
Pseudolaguvia muricata	–	DD
Pseudolaguvia ribeiroi	Kani tengra/painted catfish/bistuiya/ tinkantiya	LC
Pseudolaguvia shawi	Kani tengra	LC
Pseodolaguvia spicula	–	NE
Osphronemidae		
Osphronemus goramy	Gaint gourami	LC
Ctenops nobilis	Frail gourami	NT
Trichogaster fasciata	Banded gourami	LC
Trichogaster lalius	Dwarf gourami	LC
Trichogaster chuna	Honey gourami	LC
Trichogaster labiosa	Thick-lipped gaurami	LC
Tetraodontidae		
Tetraodon cutcutia	Ocellated puffer fish	LC

LC: Least concern, *DD*: Data deficient, *NT:* Near-threatened, *VU:* Vulnerable, *EN:* Endangered, *NE*: Not evaluated

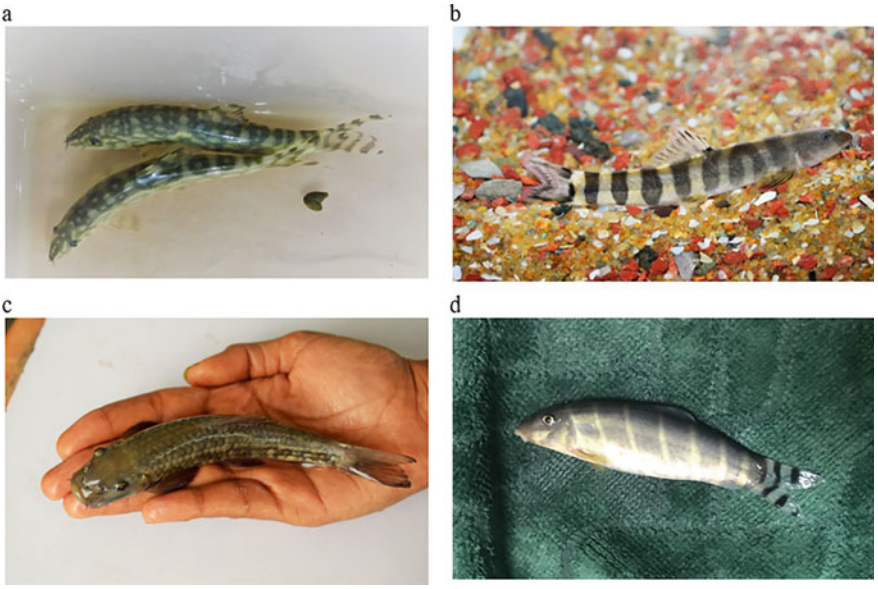

Fig. 10.1 Coldwater ornamental fishes from India: (**a**) *Botia almorhae*, Yoyo loach, Collection source: Ramnagar, Uttarakhand; (**b**) *Schistura beavani*, Creek loach, Collection source: Assam; (**c**) *Garra lamta*, Lamta garra, Collection source: Nainital, Uttarakhand; (**d**) *Botia dario*, Queen loach, Collection source: Assam

species, the greater number of species belongs to the family Cyprinidae (Jayalal and Ramachandran 2012). Around 85% of native fishes are collected from Northeastern India and reared to meet the export demand. Of the total shipping of ornamental fish, only one-tenth comes from organized aquaculture. Hill stream loaches, barbs (Fig. 10.1), and snakeheads contribute the most important share in indigenous ornamental fish export basket on a continuous basis.

10.3 Indigenous Ornamental Fishes of India: Their Importance and Prospects

10.3.1 Snakeheads, *Channa* spp.

Among the endemic ornamental freshwater fish species of India, the export of snakeheads (*Channa* spp.) is showing an emerging trend, with an increase of approximately sixfold (>90,000 no.) than that reported in 2014 (around 15,000 no.) (Harrington et al. 2022). As of now, 21 distinct taxa of channids are reported to occur in India, out of which 18 species belongs to the Gachua group of channids endemic to the Northeastern Himalayan region (Rüber et al. 2020). This Gachua group of *Channa* is primarily caught from the wild for their potential value in the ornamental fish trade but has also been considered as food by the local people.

Channa gachua species-group, viz., *Channa andrao*, *C. aurantimaculata*, *C. barca*, *C. bipuli*, *C. bleheri*, *C. gachua*, *C. pardalis*, *C. pomanensis*, and *C. stewartii*, from Northeastern India are commonly traded in the Indian aquarium hobby (Praveenraj et al. 2019).

Some of the *Channa* spp. are reported to have been induced bred in captivity. Nayak et al. (2020) and Marimuthu et al. (2009) documented the captive breeding of *Channa bleheri* and *C. punctatus* by using the synthetic hormone GnRH (ovasis and ovatide). *Channa aurantimaculata* was induced to spawn naturally by manipulating the habitat, as reported by Hazarika et al. (2014). The exploitation of *Channa* spp. from the wild for the ornamental fish trade and food has to be restricted to conserve the natural resources. Hence, captive breeding program could be undertaken as an ex situ conservational approach for the potential risk spp. and also to support the demand for *Channa* in the ornamental fish trade (Harrington et al. 2022).

10.3.2 Algae Eaters, *Garra* spp.

Algae eater fishes are a popular choice for the fish aquarist to control the algae infestation in aquarium tank. There are around 13 popular algae eater fish group in aquarium tanks, namely, *Otocinclus* or South American algae-eating catfish, black mollies, common pleco or suckermouth catfish, twig catfish, siamese algae eater, and *Garra*, commonly known as stone suckers. In light of the increasing awareness of the limited use of the most popular algae-eating ornamental fish, the common pleco, as a result of its threat to native fishes in a number of countries, including India, it is high time that few *Garra* species are to be chosen as the algae eaters in aquarium tanks. The genus *Garra*, commonly known as stone suckers or patharchatta, is widely distributed, with around 134 species inhabiting in fast-flowing hill streams of Asia and Africa. *Garra* fishes are popularized as algae eaters in the aquarium trade, a few of which are named as *Garra annandalei*, *Garra cambodgiensis*, *Garra ceylonensis*, *Garra congoensis*, *Garra flavatra*, *Garra imberba*, *and Garra rufa*. These groups of fishes are widely recognized as algae eater and popularly used in the fish spa mainly the *Garra rufa*, doctor fish. The price of the *Garra* species in the local market varies between US$ 0.3 to 0.6, depending upon the species and size.

Fry and juveniles of *Garra* spp. feed on insect larvae and planktons, while the adults usually feed upon the detritus and algae grown on the glass in aquaria. Most of the *Garra* species are known to be seasonal spawner, which spawns during May to July. The seed production and larval rearing protocol of *Garra gotyla* (Patiyal et al. 2020), *Garra annandalei*, and *Garra lamta* in captivity have been standardized in India by the Directorate of Coldwater Fisheries Research, Bhimtal, in captivity by inducing hormones.

10.3.3 Loaches

Loaches are important group of freshwater species that have global distribution. These loach fishes are primarily used for aquarium purposes due to the small size, coloration, bright bands, hardiness, and compatibility which make them suitable for rearing in aquarium throughout their life span. The inability of brood fish to reach sexual maturity in captivity is one of the most significant challenges in loach breeding. In addition, the availability of wild loaches is seasonal, with the majority being collected after the monsoon season. The popular loaches which dominate the aquarium markets are of the genera *Botia*, *Balitoria*, and *Schistura*. These loaches lead a nocturnal life but adapt quickly to captive condition.

Botia spp. are popular in the aquarium trade globally due to their colorful bright bands, peaceful nature, and lesser scales. So far, nine species of *Botia* are known to be distributed in India, out of which few have been recognized as vulnerable such as *Botia rostrata* (Gangetic loach or ladder loach) and *B. dario* (queen loach). Important *Botia* species with ornamental value are *Botia dario*, *B. almorhae* (Yo yo loach), *B. histrionica* (golden zebra loach), and *B. lohachata.* The fish feed during the daytime in captivity and prefer live feeds such as *Daphnia*, snail, worms, and brine shrimp.

Schistura represents the largest genus of small, hill stream, stone loach fishes, belonging to the family Nemacheilidae, widely distributed in the streams and rivers of Asia, Europe, and Ethiopia, as documented by Lalronunga et al. (2013). Species of *Schistura* described from the Himalayan regions of India are *Schistura andrewi*, *S. obliquofascia*, *S. corica*, *S. rubrimaculata*, *S. multifasciata*, *S. rupecula*, *S. savona*, *S. nagodiensis*, *S. sharavathiensis*, *S. scaturigina*, *S. tirapensis*, *S. vinciguerrae*, *S. manipurensis*, *S. kangjupkhulensis*, *S. prashadi*, *S. sikmaiensis*, *S. tigrinum*, *S. reticulata*, *S. khugae*, *S. fasciata*, *S. aizawlensis*, and *S. minutes*.

Schistura spp. can be identified by the presence of brown-colored transverse bars against the pale-yellow-colored body, a black bar at the base of the caudal fin base, and two black markings on the base of dorsal fin as reported by (Lokeshwor and Vishwanath 2011). In general, the fish are omnivores like other loaches and show preference toward zooplanktons, especially crustaceans, insects, and worms, and rarely feed on phytoplankton and detritus matter. Under captive conditions, they can accept a mixture of pellet and live, frozen brine shrimp, bloodworm, and daphnia. At present, captive breeding of *Schistura* spp. has not been reported in any study and needs to be emphasized at the earliest.

10.3.4 Hill Trouts

Fish belonging to the genus *Barilius* are commonly known as hill trouts. *Barillius bendelisis*, *B. barila*, *B. barna*, *B. vagra*, and *B. bakeri* are very much popular for their ornamental and food value. The species are beautifully colored with vertical bands or blotches or cluster of dots. These fish fetch prices around US$ 0.3–0.64 per piece in the domestic ornamental market. Out of all *Barilius* species, *Barilius vagra*

and *B. bendelisis* have a wide range of distribution and are found in India, Bangladesh, Pakistan, and Nepal. Some of the *Barilius* species, viz., *B. canarensis*, *B. lairokensis*, and *B. dimorphicus*, are categorized under endangered, near-threatened, and vulnerable category, respectively.

B. bendelisis is known as the "Indian hill trout" or "Hamilton's baril" in the home aquarium trade and is also reported to be exported from India as an ornamental fish. It is also regarded as one of the most important commercial hill stream fish in the majority of streams and rivers in the Eastern, Western, and Central Himalaya. *Barilius* spp. lives on the surface of water streams and swims quickly. While *B. bendelisis*, *B. barila*, and *B. barna* are omnivores, *B. vagra* is a carni-omnivore that prefers largely aquatic annelids, insect larvae, microcrustaceans, rotifers, and soft aquatic plants. After reaching maturity, male *Barilius* acquire breeding tubercles on the snout, lower jaw, or head area of the body. The gonado-somatic index in *B. bendelisis* has a bimodal pattern, with two peaks in March–May and August–September, reflecting the common spawning season of fish (Saxena et al. 2019). *B. vagra* spawns in batches once in a year during August–September (Riyaz 2020).

10.3.5 Barbs

Puntius are the small barb fish species, widely distributed in India, Nepal, Pakistan, Afghanistan, China, Bangladesh, Bhutan, and Myanmar. *Puntius ticto*, *P. sophore*, and *P. gelius* are considered as the important hill stream ornamental fish species among the *Puntius* group. These fish feed upon algae, zooplankton, insects, and plant leaves (Mitra et al. 2022). *Puntius* fish are reported to spawn during July to August in the wild. In captivity, the spawning occurs freely by scattering the eggs on the bottom, exhibiting no parental care. Recent reports have shown a decrease in the population of this species from the natural water bodies due to heavy fishing and anthropogenic causes (Gupta 2015; Sarkar et al. 2019).

10.3.6 *Badis* spp.

Badis is an important genus of ornamental freshwater fish species, distributed in Southeast Asian countries from the family Badidae. Several *Badis* species such as *B. assamensis*, *B. blosyrus*, *B. chittagongis*, *B. badis*, *B. singenensis*, *B. kaladanensis*, *B. dibruensis*, *B. pancharatnaensis*, *B. autumnuam*, *B. kyanos*, *B. kanabos*, *B. tuivaiei*, *B. soraya*, *B. dibruensis*, *B. triocellus*, *B. britzi*, and *B. laspiophilus* inhabit paddy fields, streams, and ponds of all the northeastern states of India (Basumatary et al. 2016; Ramliana et al. 2021).

Badis group can be identified based on the presence of a sharp spine on the opercle, villiform teeth, anal fin with three spines, colour pattern, benthic ecology, habitat, and rounded caudal fin (Geetakumari and Kadu 2011). The fish exhibit parental care and grow up to 5 cm in total length. These dwarf chameleon fishes are gaining popularity among hobbyists due to their beautiful color and easy

maintenance. Their price may vary from US$ 0.1 to 0.2 per piece in Indian markets and US$ 1 to 2 per piece in global markets.

10.4 Conclusion

Ornamental fisheries can benefit greatly from the aquatic resources found in the hills, but only under the scientific intervention these resources be effectively managed. In the national perspective, mountain fish resources and their promotion for better aquaculture and fisheries are extremely important. Nevertheless, emerging anthropogenic pressure, stream flow regimes, and climate change have a negative impact on cold-water fisheries. In countries like India, Pakistan, and Bangladesh, the indigenous ornamental resources are plenty, but most of the farmers concentrate on breeding the exotic fishes which have a high demand and price and are ultimately sold to the internal market rather than the export market. Some exportable ornamental fishes such as barbs are successfully bred under captivity, and there is an immense scope for strengthening the breeding protocol and larval rearing of these ornamental fishes. The lack of a consistent seed production process and the breeders' lack of interest in indigenous fishes are the primary causes for the restricted export of native ornamental fishes. Upscaling of the seed production of fishes having export demand such as *Botia* spp., *Balitora* spp., *Puntius* spp., and *Channa* spp. in homestead ornamental units is the need-based approach in coming years.

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