

COLD WATER FISH AND FISHERY OF ARUNACHAL PRADESH, INDIA

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Abstract

The present research paper deals with 108 fish species belonging to 17 families and 54 genera under potential cold water fish category and its economic importance in terms of aquarium; aquarium+food; aquarium+food+game; food; and food+game reported from Arunachal Pradesh. 87 fish species are presently housed at Museum of Arunachal Pradesh Regional Centre (APRC) of Zoological Survey of India, Itanagar and remaining 21 species were consulted from other secondary source and added and prioritized herein to be a potential cold-water fish.

Keyword: Cold-water fish, Check-list, Arunachal Pradesh

INTRODUCTION

Arunachal Pradesh, one of the biodiversity hotspot regions of the world is located between 26.28° N and 29.30° N latitude and 91.20° E and 97.30° E longitude and has 83,743 square km area. The state is covered by Himalaya on the western side and Patkai hill range on the eastern side. The entire territory of the state comprised of complex hill system with varying elevations ranging from the Plains of Brahmaputra with an average elevation of 100m and reaching an elevation of 7089m representing all the three Himalayan zones, viz. (i) The sub-Himalayan zone rising abruptly from the Brahmaputra Plains (ii) The lesser or Lower Himalayas- with an elevation of 2500 to 4000 m. (iii) The Greater or Higher Himalayas with heights greater than 6000m having precipitous slopes and deep gorges (Fig 1). The climatic conditions of the state vary with elevation from sea level. The sub-Himalayan region have sub-tropical climate, temperate in the Middle Himalayas, whereas alpine climate prevails at very high elevation regions.

Altogether the state has 128 rivers/streams and more than 1,406 number of wetlands which includes major ponds, lakes and reservoirs, covering total area of 15,5728 ha (NWIA, 2009). The major wetland types are river/stream accounting for 86 percent of the total wetland area (1,34,244 ha), High altitude wetlands (11,422 ha), and waterlogged (8,146 ha). The mightiest river of the State Siang called 'Tsangpo in Tibet' along with other two major rivers namely the Dibang and the Lohit forms the headwaters of the Major River Brahmaputra, contributing further by other rivers, the Subansiri, the Tirap and the Kameng in mid to lower region that finally debouches to Bay of Bengal. Some important Lakes of the state are known by Sela lake of Bomdila; Pankang Teng Tso, Sangetser, Banggachang lakes of Tawang district, Sally and Mehao lakes of Lower Dibang valley, Ganga Lake Itanagar, etc.

The unique topography, varied physiographical features and watershed patterns of the state in the form of

rivers/streams/drains/lakes and various lentic water bodies occurring from lower to higher altitudinal areas with varied climatic conditions has blessed home to many fish species, so far contributing to 225 species as per Sen and Khyntiam (2014). The literatures show that no attempt has been initiated to assess the fish species available in vast water bodies of Arunachal Pradesh as potential cold water fish, which is the primary objective of this study.

MATERIAL AND METHODS

A list of potential cold water fish were made by consulting with published literatures (Petre and Swar, 2002; Sehgal, 1999) in which cold water fishes of Afghanistan, Pakistan, India, Nepal, Bhutan, China and Myanmar are compiled; and for economic value followed

(Sarkar and Ponniah, 2000). Further possible potential fish species with respect to above two criteria other than above references were added herein after reviewing the potential of each species. Conventional cold-water exotic fishes used for either food or for game fish were also included. Majority of the potential cold water fishes listed here and housed in the APRC museum were collected by the authors from the various scientific tours taken during the last three years. Twenty one species were consulted from other secondary source and not available in the APRC museum however added and prioritized herein to be a potential cold-water fish. The updated scientific names of valid taxa available in this list followed that of online catalog of fishes, California Academy of Sciences.

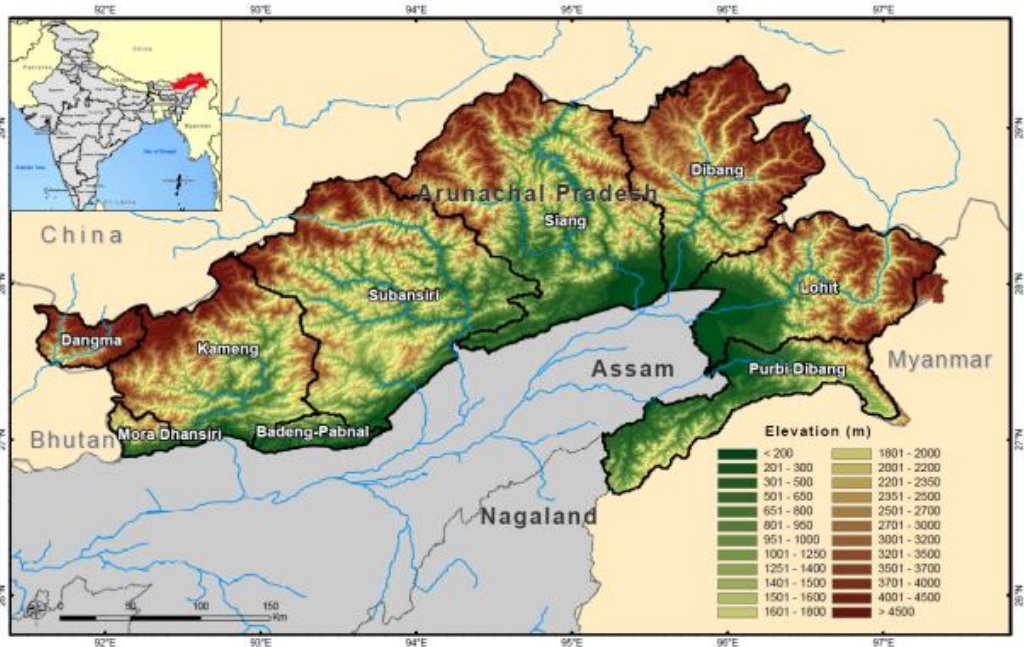


Fig 1. Topography and river basin map of Arunachal Pradesh (Courtesy: Dept. of Fishery, Govt. of AP)

Cold Water Fisheries in Arunachal Pradesh

Cold-water fishery programme in the state of Arunachal Pradesh has been initiated as early as 1967 by the establishment of first Trout Hatchery along the stream of Nuranang at an altitude of about 12000 ft by the Arunachal Pradesh Government. Fishery Department in Tawang District with two exotic species, the Rainbow trout and Brown Trout seed (*Oncorhynchus mykiss* and *Salmo trutta fario*) imported from Jammu and Kashmir followed by another trout hatchery at Shergaon, West Kameng District located at an elevation of 8000 ft. with the Brown Trout seed imported from Himachal Pradesh during 1974-75. The state has become the model for remaining North Eastern state and even could supplied trout seeds to Nagaland, Meghalaya, etc., many a times by this state. However, report of *Oncorhynchus mykiss* from a natural stream far away from the Hatchery area at Papum Pare district by Bagra *et al.* (2009) suggest that the species have already established themselves in natural population probably by escaping from the hatcheries.

Aquatic biome of Arunachal Pradesh provides excellent habitats to at least 225 fish species (Sen and Khyndriam, 2014) distributing from the sub Himalayan zone to the Greater Himalayan mountains. At least 108 species belonging to 54 genera and 17 families including two exotic species (*Oncorhynchus mykiss* and *Cyprinus carpio*) out of 225 reported species from the state have been considered as potential cold water fish and also have economic importance with respect to aquarium; food; aquarium+food; aquarium+food+game; and food+game as provided below (Table 1). Out of these 108 species, 87 species under 15 families and 47 genera are housed at APRC Museum with

specific registration number. The following 28 additional species under 8 families and 18 genera have been added herein as possible potential cold water fish species: Nemacheilidae: *Aborichthys cataracta*, *Aborichthys elongatus*, *Aborichthys kempfi*, *Shistura devdevi*; Amblycipitidae: *Amblyceps apangi*, *Amblyceps arunachalensis*; Cyprinidae: *Barilius arunachalensis*, *Garra arunachalensis*, *Garra arupi*, *Garra birostris*, *Garra kalpangi*, *Garra magnidiscus*, *Garra quadratiostris*, *Crossocheilus burmanicus*, *Neolissochilus hexastichus*, *Danio dangila*, *Rasbora rasbora*, *Semiplotus modestus*, *Tor progeneius*; Balitoridae: *Bhavana arunachalensis*; Psilorhynchidae: *Psilorhynchus arunachalensis*; Bagridae: *Batasio merianiensis*; Sisoridae: *Creteuchiloglanis arunachalensis*, *Creteuchiloglanis kamengensis*, *Creteuchiloglanis payjab*, *Exostoma labiatum*, *Pseudecheneis sirenica*, Siluridae: *Pterocryptis gangelica*.

As per the data provided in the Table 1, it reveals that majority of fish species 36 i.e. (33.3 %) of the total 108 cold water fish species are of ornamental followed by 32 species (29.6 %) which have ornamental as well as food value. 15 species (13.8 %) have food as well as aquarium and sport fish. The least number of species comprises of 10 species (9.2 %) which have only ornamental, food and sport value. The most important indigenous cold water fishes are *Schizothorax richardsonii*, *Schizothorax progastus*, *Schizothorax plagiostomus*, *Neolissochilus hexagonolepis*, *Tor tor* and *Tor putitora* which have both economic and commercial importance with respect to food and recreational value.

DISCUSSION

The state has long been known for its high potential ornamental fish resources in India. Native wild caught ornamental fish was exporting to the state like Assam and Kolkata for this lucrative business for quite some times which have now been controlled by the law enforcement agencies. During the present study, 78 cold water fish species have found out having ornamental fishery potential. Native fish like Channa, Colisa, Barilius, Botia spp are highly demand in both in national and international markets. The price of individual fish even goes up US\$ 4.825 per piece in International aquarium fish market, though the price for breeder or collector may as low as 3/4 per piece. However the price of native ornamental fishes varied from Rs 3 to Rs 50 per piece across the domestic market (Mandal *et al.*, 2007). If we can produce such highly demand fish with ornamental fish farming by propagating artificially, it can be a good source of income for many households.

Since the state is dissected by many rivers and rivulets it provides ample prospect for sports fishery developments and can offer exciting angling opportunities. Sport fishing is fishing for the pleasure or competition and is just the contrast of commercial fishery which is the fishing for profit. The state can earn good source of revenue through this recreational activities by developing sport fishing area. In United states, sport fishing is already a billion dollar industry. The state of Arunachal Pradesh also has many unchartered river terrains virgin to mankind which may have the potential for international tourism opportunity of sport fishing. Some of the places were trout and Mahseer fishing opportunities already available at the state are Bhalukpong and Tipi on the river Kameng,

Pasighat on the river Siang, and Tezu on the river Lohit. Here in this study, we have identified as much as 25 fish species have the potential for sport fishery.

All the fishes are meant to be eaten is the general concept of the people of north eastern India. There is no such a category of trace fish in this region, only the preference of one fish species to another applied. Popular cold water fishes like *Schizothorax richardsonii*, *Schizothorax prograssus*, *Tor tor*, *Tor putitora*, *Neolissochilus hexagonolepis* have high food value costing more than 800/kg in the local fish market. At the same time smaller indigenous cold water fish species though supplied less in quantity and may appear inconspicuous however frequently available in the local market are the mixture of different species of fish like *Barilius* spp, *Botia* spp, *Puntius* spp, *Garra* spp, *Lepidocephalichthys* spp, *Schistura* spp *etc*, and its price is as exorbitant as their bigger counter parts (300/500 gm). A total of 72 cold water fish species available in the state are used as food by the local people are sorted out including highly demand conventional species.

Subsistence fisheries are practiced at different levels of intensity on different water bodies of the state. Most of the captured fish are consumed near the catch localities itself. In order to increase the fish resources of the state the lentic water bodies like homestead ponds, lakes and reservoirs located in middle and high altitude ranges can be considered for aquaculture purposes, mainly for culture of food and ornamental fish. Myriads of rivers and streams crisscrossing the entire landscape of the state and large lakes and reservoirs can be considered for capture fishery purpose mainly for utilization for game fish as well as food fish. However, before opening any aven-

Gurumayum and Tamang, 2017: COLD WATER FISH OF ARUNCAHAL

Table 1. List of voucher specimens of potential cold-water fish of Arunachal Pradesh

SN	Family	Species list	Economic value	Altitude (m)	APRC Reg. no. ZSI/V/APRC	Literature consulted
1.	Nemacheilidae	* <i>Aborichthys cataracta</i> Arunachalam et al, 2014	A	1550	P-1103	1
2.	Nemacheilidae	* <i>Aborichthys elongatus</i> Hora, 1921	A	600	P-347	2,3
3.	Nemacheilidae	* <i>Aborichthys kempfi</i> Chaudhuri, 1913	A	1053	P-870	2,3
4.	Nemacheilidae	* <i>Acanthocobitis botia</i> (Hamilton, 1822)	A	573	P-918	2,3
5.	Amblycipitidae	* <i>Amblyceps apangi</i> Nath and Dey, 1989	A	615	P-630	2,3
6.	Amblycipitidae	<i>Amblyceps arunachalensis</i> Nath and Dey 1989	A	-	P-413	2,3
7.	Amblycipitidae	<i>Amblyceps mangois</i> (Hamilton, 1822)	A	-	P-005	3,4
8.	Cyprinidae	<i>Amblypharyngodon mola</i> (Hamilton, 1822)	A, F	-	P-374	2
9.	Badidae	<i>Badis badis</i> (Hamilton, 1822)	A	1540	P-616	3,4
10.	Balitoridae	<i>Balitora brucei</i> Gray, 1830	A	173	P-860	2,3
11.	Cyprinidae	<i>Bangana ariza</i> (Hamilton 1807)	F	-	NA	5
12.	Cyprinidae	<i>Bangana dero</i> (Hamilton, 1822)	F, G	1500	P-287	2,3
13.	Cyprinidae	* <i>Barilius arunachalensis</i> Nath, Dam and Anil Kumar, 2010	A, F, G	-	P-502	6
14.	Cyprinidae	<i>Barilius barila</i> (Hamilton 1822)	A, F	-	NA	5
15.	Cyprinidae	<i>Barilius barna</i> (Hamilton, 1822)	A, F, G	199	P-970	2,3
16.	Cyprinidae	<i>Barilius bendelisis</i> (Hamilton, 1807)	A, F, G	650	P-265	2,3
17.	Cyprinidae	<i>Barilius tileo</i> (Hamilton, 1822)	A, F, G	143	P-997	2,3
18.	Cyprinidae	<i>Barilius vagra</i> (Hamilton 1822)	A, F, G	676	P-552	2,3
19.	Bagridae	<i>Batasio batasio</i> (Hamilton 1822)	A	-	NA	2,3
20.	Bagridae	* <i>Batasio merianiensis</i> (Chaudhuri, 1913)	A	408	P-1022	7
21.	Balitoridae	* <i>Bhavana arunachalensis</i> Nath et al., 2007	A	-	P-488	8
22.	Cyprinidae	<i>Cabdio morar</i> (Hamilton, 1822)	F	500	P-010	2,3
23.	Cyprinidae	<i>Chagunius chagunio</i> (Hamilton, 1822)	F, G	650	P-256	2,3
24.	Channidae	<i>Channa gachua</i> (Hamilton, 1822)	A, F, G	1540	P-606	9
25.	Channidae	<i>Channa orientalis</i> (Bloch and Schneider, 1801)	A, F, G	700	P-040	2, 3
26.	Channidae	<i>Channa punctatus</i> (Bloch, 1793)	A, F, G	650	P-240	2,3
27.	Channidae	<i>Channa striata</i> (Bloch, 1793)	A, F, G	373	P-041	2
28.	Schilbeidae	<i>Clupisoma garua</i> (Hamilton 1822)	F	-	NA	3
29.	Sisoridae	* <i>Creteuchiloglanis arunachalensis</i> Sinha and Tamang, 2014	A, F	1600	P-844	7
30.	Sisoridae	* <i>Creteuchiloglanis kamengensis</i> (Jayaram, 1966)	A, F	1586	P-863	2,3

31.	Sisoridae	* <i>Creteuchiloglanis payjab</i> Darshan et al, 2014	A, F	1932	P-921	10
32.	Cyprinidae	# <i>Crossocheilus burmanicus</i> Hora 1936	F	-	NA	11
33.	Cyprinidae	<i>Crossocheilus latius</i> (Hamilton, 1822)	F	650	P-255	2,3
34.	Cyprinidae	<i>Cyprinion semiplotum</i> ((McClelland, 1839)	F, G	348	P-964	2,3
35.	Cyprinidae	<i>Cyprinus carpio</i> (Linnaeus, 1758)	A, F	1555	P-525	2,3
36.	Cyprinidae	* <i>Danio dangila</i> (Hamilton, 1822)	A	1512	P-750	2,3
37.	Cyprinidae	<i>Danio rerio</i> (Hamilton, 1822)	A	1540	P-541	2,3
38.	Cyprinidae	<i>Davario devario</i> (Hamilton, 1822)	A	118	P-730	2,3
39.	Cyprinidae	<i>Devario aequippimatus</i> (McClelland, 1839)	A	1124	P-869	2,3
40.	Cyprinidae	<i>Esomus danricus</i> (Hamilton 1822)	A	-	NA	2
41.	Sisoridae	* <i>Exostoma labiatum</i> (McClelland, 1842)	A, F	1594	P-751	2
42.	Cyprinidae	<i>Garra annandalei</i> (Hora, 1921)	A, F	1000	P-615	2,3
43.	Cyprinidae	* <i>Garra arunachalensis</i> Nebeshwar and Vishwanath, 2013	A, F	406	P-959	12
44.	Cyprinidae	* <i>Garra arupi</i> Nebeshwar et al., 2009	A, F	529	P-1027	14
45.	Cyprinidae	* <i>Garra birostris</i> Nebeshwar and Vishwanath, 2013	A, F	-	P-1111	12
46.	Cyprinidae	<i>Garra gotyla gotyla</i> (Gray, 1830)	A, F	676	P-548	12
47.	Cyprinidae	* <i>Garra kalpangi</i> Nebeshwar et al. 2012	A, F	573	P-1084	16
48.	Cyprinidae	<i>Garra lamta</i> (Hamilton 1822)	A, F	-	NA	2
49.	Cyprinidae	<i>Garra lissorhynchus</i> (McClelland, 1842)	A, F	272	P-565	2
50.	Cyprinidae	* <i>Garra magnidiscus</i> Tamang, 2013	A, F	429	P-622	16
51.	Cyprinidae	* <i>Garra quadratirostris</i> Nebeshwar and Vishwanath, 2013	A, F	522	P-1128	12
52.	Sisoridae	<i>Glyptothorax cavia</i> (Hamilton, 1822)	A	-	P-400	2
53.	Sisoridae	<i>Glyptothorax conirostris</i> (Steindachner, 1867)	A	-	P-060	11
54.	Sisoridae	<i>Glyptothorax pectinopterus</i> (McClelland, 1842)	A	-	P-404	3, 11
55.	Sisoridae	<i>Glyptothorax telchitta</i> (Hamilton, 1822)	A	127	P-878	2
56.	Sisoridae	<i>Glyptothorax trilineatus</i> (Blyth, 1860)	A	296	P-585	17
57.	Heteropneustidae	<i>Heteropneustes fossilis</i> (Bloch, 1794)	F, G	1500	P-289	2,3
58.	Cyprinidae	<i>Labeo calbasu</i> (Hamilton, 1822)	F	650	P-250	2
59.	Cyprinidae	<i>Labeo dyocheilus</i> (McClelland 1839)	F	-	NA	2
60.	Cyprinidae	<i>Labeo goniis</i> (Hamilton, 1822)	F	650	P-243	2,3
61.	Cyprinidae	<i>Labeo pangusia</i> (Hamilton, 1822)	F	600	P-224	2,3
62.	Cyprinidae	<i>Laubuca laubuca</i> (Hamilton, 1822)	A	650	P-251	2,3
63.	Cobitidae	<i>Lepidocephalichthys guntea</i> (Hamilton, 1822)	A, F	600	P-348	2,3
64.	Mastacembelidae	<i>Mastacembalus armatus</i> (Lacepede, 1800)	A, F	500	P-079	2,3
65.	Bagridae	<i>Mystus bleekeri</i> Day, 1877	A, F	172	P-979	2
66.	Bagridae	<i>Mystus cavasius</i> (Hamilton, 1822)	A, F	143	P-1000	2

Gurumayum and Tamang, 2017: COLD WATER FISH OF ARUNCAHAL

67.	Bagridae	<i>Mystus vittatus</i> (Bloch, 1794)	A, F	500	P-351	2
68.	Nandidae	<i>Nandus nandus</i> (Hamilton, 1822)	A, F	1500	P-290	2
69.	Cyprinidae	<i>Neolissochilus hexagonolepis</i> (McClelland, 1839)	F, G	1500	P-286	2,3
70.	Cyprinidae	* <i>Neolissochilus hexastichus</i> (McClelland 1839)	F, G	-	NA	11
71.	Siluridae	<i>Ompok bimaculatus</i> (Bloch 1794)	F	-	NA	2
72.	Siluridae	<i>Ompok pabda</i> (Hamilton, 1822)	F	168	P-686	2
73.	Salmonidae	<i>Oncorhynchus mykiss</i> (Walbaum 1792)	F	-	NA	2
74.	Cyprinidae	<i>Osteobrama cotio</i> (Hamilton 1822)	F	-	NA	2
75.	Sisoridae	<i>Parachiloglanis hodgarti</i> (Hora, 1923)	A, F	1586	P-864	2,3
76.	Cyprinidae	<i>Pethia conchoni</i> (Hamilton, 1822)	A	1540	P-540	2,3
77.	Cyprinidae	<i>Pethia ticto</i> (Hamilton, 1822)	A	1594	P-755	2,3
78.	Sisoridae	# <i>Pseudecheneis sirenica</i> Vishwanath and Darshan, 2007	A	429	NA	15
79.	Sisoridae	<i>Pseudecheneis sulcata</i> (McClelland 1842)	A, F	173	P-851	2,3
80.	Psilorhynchidae	<i>Psilorhynchus balitora</i> (Hamilton, 1822)	A	650	P-258	2,3
81.	Psilorhynchidae	* <i>Psilorhynchus arunachalensis</i> (Nebeshwar, Bagra and Das, 2007)	A	1586	P-865	18
82.	Siluridae	* <i>Pterocryptis gangetica</i> Peters, 1861	A, F	300	P-915	2
83.	Cyprinidae	<i>Puntius chola</i> (Hamilton, 1822)	A, F	132	P-716	2,3
84.	Cyprinidae	<i>Puntius sophore</i> (Hamilton, 1822)	A, F	650	P-263	2,3
85.	Cyprinidae	<i>Raiamas bola</i> (Hamilton, 1822)	A, F, G	229	P-1024	2
86.	Cyprinidae	<i>Rasbora daniconius</i> (Hamilton, 1822)	A	199	P-967	2
87.	Cyprinidae	# <i>Rasbora rasbora</i> (Hamilton, 1822)	A, F	-	NA	2,3
88.	Cyprinidae	<i>Salmophasia bacaila</i> (Hamilton 1822)	A, F	-	NA	2
89.	Cyprinidae	<i>Salmostoma phulo</i> (Hamilton, 1822)	A	143	P-996	11
90.	Nemacheilidae	<i>Schistura beavani</i> (Gunther 1868)	A	A	NA	19
91.	Nemacheilidae	* <i>Schistura devdevi</i> (Hora, 1935)	A	450	P-601	3,11
92.	Nemacheilidae	<i>Schistura rupecula</i> (McClelland, 1838)	A	615	P-627	2,3
93.	Nemacheilidae	<i>Schistura savona</i> (Hamilton, 1822)	A	218	P-982	11
94.	Nemacheilidae	<i>Schistura scaturigina</i> McClelland, 1839	A	143	P-999	11
95.	Cyprinidae	<i>Schizopygopsis stoliczkai</i> Steindachner 1866	F, G	-	NA	3
96.	Cyprinidae	<i>Schizothorax esocinus</i> Heckel 1838	F, G	-	P-207	11
97.	Cyprinidae	<i>Schizothorax molesworthii</i> (Chaudhuri 1913)	F, G	-	NA	13
98.	Cyprinidae	<i>Schizothorax plagiostomus</i> Heckel 1877	F, G	-	NA	5
99.	Cyprinidae	<i>Schizothorax progastus</i> (McClelland, 1839)	F, G	1088	P-101	2,3
100.	Cyprinidae	<i>Schizothorax richardsonii</i> (Gray, 1832)	F, G	290	P-767	2,3
101.	Cyprinidae	# <i>Semiplotus modestus</i> (Day 1870)	F	-	NA	5
102.	Bagridae	<i>Sperata seenghala</i> (Sykes, 1839)	A, F	700	P-009	2
103.	Cyprinidae	<i>Systemus sarana</i> (Hamilton, 1822)	A, F	148	P-1015	2,3

104.	Cyprinidae	# <i>Tor progeneius</i> (McClelland 1839)	F, G	-	NA	5
105.	Cyprinidae	<i>Tor putitora</i> (Hamilton 1822)	F, G	619	P-586	2,3
106.	Cyprinidae	<i>Tor tor</i> (Hamilton, 1822)	F, G	1500	P-294	2,3
107.	Siluridae	<i>Wallago attu</i> (Schneider, 1801)	F	135	P-790	2,3
108.	Belonidae	<i>Xenentodon cancila</i> (Hamilton, 1822)	A	229	P-1023	2

[A: Aquarium; F: Food; G: Game; NA: Species not available in APRC Museum; #: Additional species considered as potential cold-water fish; *: Species available in APRC Museum; 1: Arunachalam *et al.*, 2014; 2: Bagra *et al.*, 2009; 3: Nath and Dey, 2000; 4: Sen, 1985; 5: Sen and Khyntiam, 2014; 6: Nath *et al.*, 2010; 7: Tamang and Sinha, 2014; 8: Nath *et al.*, 2007; 9: Vishwanath and Geeta kumar, 2009; 10: Darshan *et al.*, 2014; 11: Sen, 2000; 12: Nebeshwar and Vishwanath, 2013; 13: Chaudhuri, 1913; 14: Nebeshwar *et al.*, 2009; 15: Vishwanath and Darshan, 2007; 16: Nebeshwar *et al.*, 2013; 17: Tesia and Bordoloi, 2012; 18: Nebeshwa *et al.*, 2007; 19: Sen, 1985]

-ue of the aquatic fishery resources of the state, sustainability and environmental concern should be given priorities as already two exotic species, *Oncorhynchus mykiss* and *Cyprinus carpio* have established in the natural water bodies of the state.

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Bangana dero captured by angling from Dikrong river



Experimental rearing of *C. gachua*, *B. rostrata*, *G. annadalei*, *T. puitora*, *B. bendelisis* inside a fish tank



Barilius bendelisis inside a fish tank at APRC laboratory



Experimental rearing of *Garra* spp (fry stage) inside a fish tank at APRC laboratory



P. ticto and *D. aequippinnatus* from Sally Lake, Roing



Schizothorax plagiostomus: A highly priced cold-water fish selling at Ganga market, Itanagar