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Checklist of endemic ichthyofauna of North-east India

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ABSTRACT

North-eastern India is one of the ichthyofaunal hotspots of the country and is characterised by the presence of varied endemic freshwater fishes. Extensive ichthyological field and laboratory studies conducted during 2007 to 2016 in the major river drainages, upland lakes, reservoirs and wetlands revealed the occurrence of 138 fish species which belonged to 54 genera, 18 families and 6 orders, endemic to the region. Of these, the maximum fish endemism was recorded in river Irrawaddy and Chindwin basins (91 species) of Manipur, followed by Assam in the Brahmaputra and Barak valley (29 species), Arunachal Pradesh (26 species), Meghalaya (23 species), Nagaland (14 species), Mizoram (8 species) in Kolodyne river system, Tripura (7 species) and Sikkim (5 species). In view of their economic importance, 58 species were found to have food value, 43 species of ornamental value, 27 species having both ornamental and food value and 10 species having both food and sports value. According to IUCN status (2016), 7.97% of the assessed species are listed in the Endangered category, 24.64% Vulnerable, 10.14% Near Threatened, 0.72% Critically Endangered, 34.06% Least Concern, 18.84% Data Deficient and 3.62% under Not Evaluated category. Many of these endemic fishes can be considered as potential candidate species for freshwater aquaculture in the hilly region, which in turn will help in species propagation, generating livelihood for the people and to conserve germplasm from extinction.

Keywords: Checklist, Coldwater, Endemic, Fish diversity, Hilly region, North-east India

Introduction

Endemism is the ecological state of a species being unique to a defined geographic location, such as an island, nation, country or other defined zone, or habitat type (Darlington, 1957; Lagler *et al.,* 1962). The fishes inhabiting such a particular geographical location or in a defined place are referred as "Endemic fishes". However, the area of endemism may be either relatively large, with a wide distribution range, or very small with a narrow distribution range with respect to the fish species and water resource body. The North-eastern region of India, comprising the eight landlocked states of Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, is known for its rich biodiversity (World Conservation Monitoring Centre, 1998) and is the convergence of two important fish biodiversity hotspots in the world, the Eastern Himalayas and the Indo-Burma region.

Earlier studies on icthyofaunal diversity in the North-eastern region of India are scanty. Hora (1921a,b; 1930, 1936, 1937, 1938, 1939, 1940, 1941, 1943, 1951a-c, 1953) was one of the pioneering workers on the fishes of North-eastern India. Ghosh and Lipton (1982) had reported 172 species of fishes with reference to their economic importance. Sinha (1994) compiled a list of 230 species of fishes from North-eastern India. Sen (1982, 1995, 1999a,b, 2000) compiled a comprehensive list of 267 species of fishes whereas Goswami *et al*. (2012) reported 422 fish species belonging to 133 genera and 38 families from North-east India. Sen (1985) reported 187 species of fishes from Assam and Sarma *et al*. (2012) reported 97 species from lower reaches of river Brahmaputra. Nath and Dey (1997, 2000) and Bagra *et al*. (2009) recorded 131 and 213 species of fishes from the drainages in Arunachal Pradesh respectively. Viswanath and Singh (1986), Viswanath *et al.* (1987, 1998), Viswanath and Sarojnalini (1988), Viswanath (1993), Viswanath and Kosygin (1999, 2000a,b; 2001) made valuable contributions to the ichthyofauna of Manipur. Fishes of Tripura State has been reviewed by Barman (1988, 1989, 1990, 1991, 2002, 2004) who compiled a list of 129 species with respect to drainage pattern of the river systems of Tripura. Surveys conducted by Kar (2000, 2001, 2002, 2003, 2004, 2005a-d, 2006); Kar *et al.* (1996, 2002a-c) and Kar and Sen (2007), reported fish diversity of some parts of Mizoram, Tripura and Barak drainage in Assam. In Sikkim, Hooker (1854) reported on the Cyprinids fishes of river Rangit while *Schizothorax* spp. were reported by Talwar and Jhingran (1991). Tamang (1993) reported about 48 species of fish; 37 species were recorded in 2001 (MOEF, 2002). Das and Mukherjee (2005) observed a strong decline in the diversity of fish fauna in the river Teesta; Menon *et al.* (2008) described 19 threatened species of India which

also inhabit in Teesta waters in Sikkim. The ichthyofaunal diversity of upland water resources in India comprises 258 species, belonging to 21 families and 76 genera. Out of these, a maximum of 255 coldwater fish species are recorded from Eastern Himalayas, 203 from the West and Central Himalayas and 91 from the Deccan plateau (Vass *et al*., 2005). In contrast to the high species diversity of the Indian ichthyofauna, no detailed systematic fish inventory has been available on the endemic ichthyofauna, particularly to the North-eastern region of India. The present study attempted for the first time, to prepare a detailed systematic checklist of the endemic fishes occurring in the major river systems, lakes, reservoirs and wetlands of North-eastern India based on extensive field surveys spanning over a period of one decade.

Materials and methods

Extensive field surveys were conducted from 2007 to 2016 in all the eight North-eastern states of India at various fish landing centres, fishing villages, fishing zones and fish markets accessible by road and foot track. Primary information were collected by personal interaction with the fishermen, *mohaldars*, lessees, wholesalers, retailers and anglers at each randomly selected sampling station (Table 1) along the length of the rivers and associated wetlands as depicted in the maps (Fig. 1). Upland lakes and reservoirs in certain states were also surveyed. Small fish specimens (<150 mm in total length) were preserved directly in 10% formaldehyde while the larger specimens (>150 mm in total length) were preserved with preservative by slitting the abdomen as per sampling procedure. Fish were identified in the laboratory on the basis of morphometric and meristic characters and a few voucher specimens were preserved in the fish museum. Fish identification, taxonomic review of identification and preparation of systematic checklist on endemism was made based on published literatures of Hora (1937); Ghosh and Lipton (1982); Sen (1985); Sen (2000, 2003); Kottelat (1990); Talwar and Jhingran (1991); Nath and Dey (1997, 2000); Jayaram (1999); Menon (1999); Sarkar and Ponniah (2000); Ng and Rainboth (2001); Ng (2005, 2006); Tamang *et al*. (2006, 2007); Vishwanath and Darshan (2007); Nebeshwar *et al*. (2007); Bagra *et al*. (2009), Ramanujam *et al*. (2010), Goswami *et al*. (2012), Acharjee *et al*. (2012), Bakalial *et al*. (2014), Humtsoe and Bordoloi (2014) and FishBase (http//www.fishbase.org). Status of some of the fish species in the studied rivers was preliminarily ascertained after Menon (1994) as well as based on Molur and Walker (1998), Viswanath *et al*. (2014) and the IUCN Red List of Threatened Species (http//www.iucnredlist.org). Habitat inventory of the rivers was made after Armontrout (1990), ICAR-DCFR Atlas and Nath and Dey (1997). The identified endemic fishes in this checklist has been classified as of food, sport and ornamental value based on their usage by the local consumers as reported in each of the sampling sites and based on secondary information collected.

Results and discussion

As an area can be defined by political boundaries such as country, or by ecological boundaries such as a species endemic to a distinct drainage basin (Teimori *et al*., 2016), the term 'endemic' is defined here as any fish species found only in the drainage basins within Indian geographical regions and political boundaries. Altogether, 6 orders, 18 families and 54 genera were recorded, enlisting 138 endemic species which represents about 32.7% of total reported fish species of North-east India (422 species) and about 53.5% of total upland species (258 species) recorded from India. The greatest endemicity was found in the family Cyprinidae with 51 species (or 37% of the endemics), followed by Nemacheilidae with 26 species

Table 1. Major drainage systems of North-eastern region of India surveyed during the investigation

State	River systems	Surveyed sites	Altitude range (m asl)
Arunachal Pradesh	Kameng, Ranganadi, Subansiri, Siang, Lohit and Tirap	Bhalukpong, Tenga, Shergaon, Dirang, Sela, Tawang, Doimukh, Ziro, Itanagar, Lohit, Deomali	210-4114
Assam	Brahmaputra and Barak	Balipara, Nameri, Tezpur, Lakhimpur, Nagaon, Guwahati, Goalpara, Dibrugarh, Dima Hasao, Nalbari, Barpeta, Silchar	23-544
Manipur	Iril, Thoubal and Tuivai	Imphal, Thoubal, Ukhrul	50-791
Meghalaya	Umiam, Digaru, Dudhnoi, Krishnai and Jinjiram	Umiam, Myrang, Umshning, Umlareng, Jowai, Shillong, Tura	57-1438
Mizoram	Kolodyne, Mat, Tuirini and Serlui	Aizwal, Lengpui, Champhai, Kolasib	662-1053
Nagaland	Jhanzi, Dikhow, Diphu, Diyung and Dhansiri	Dimapur, Kohima, Jharnapani, Mokokchung	99-288
Tripura	Longi, Juri, Deo, Khowai, Howrah, Gumti and Feni	Agartala and nearby areas	32-850
Sikkim	Teesta and Rangeet	Gangtok, Bagua, Uttarey, Makha, Dikchu, Lachung, Memencho	112-2615

M asl = Meters above sea level

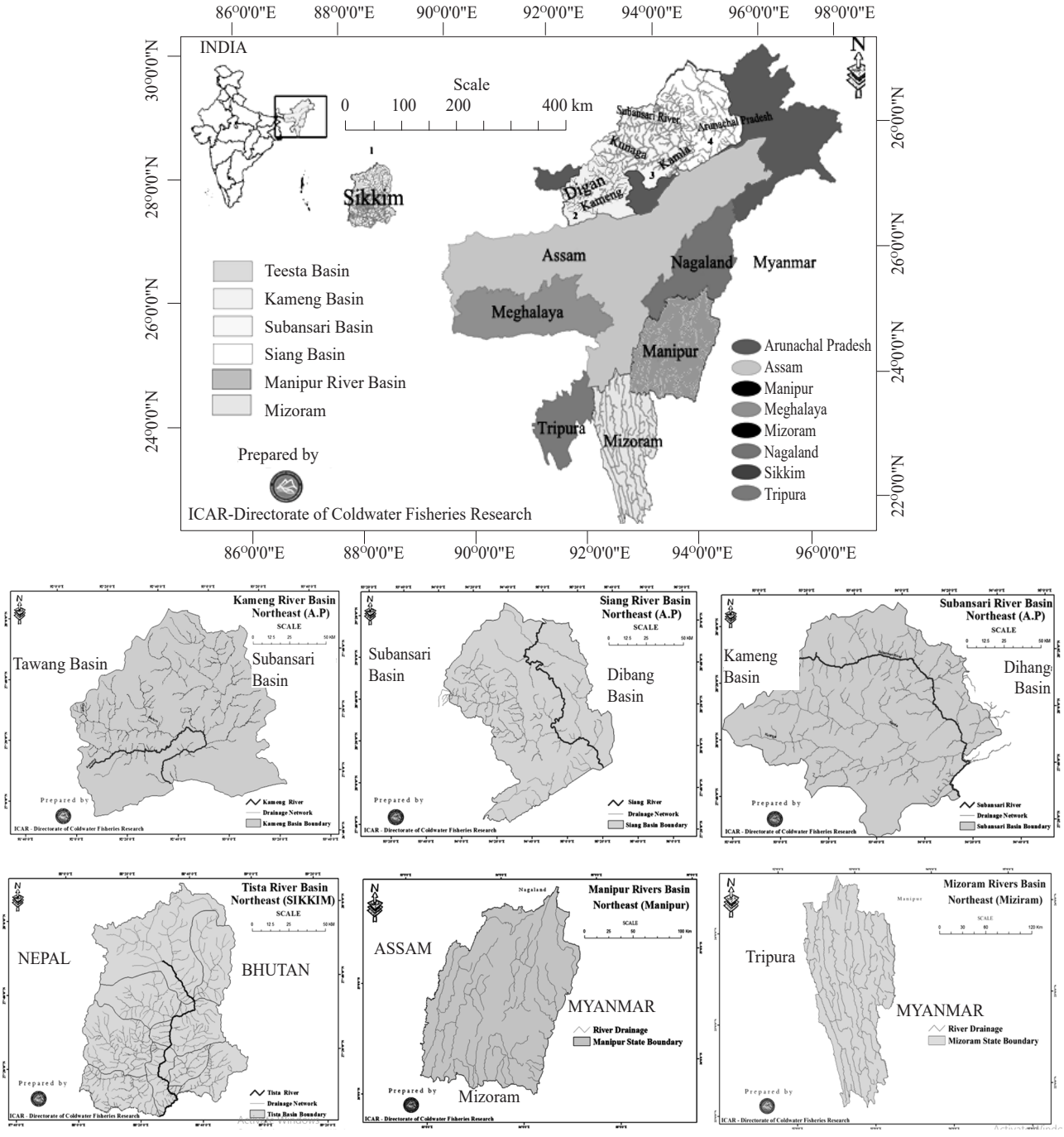

Fig. 1. Map showing the important drainges for endemic fishes of North-east India

(19% of the endemics) and Sisoridae with 21 species (15% of the endemics). The remaining endemic species are contributed by the families Bagridae (6 species), Cobitidae (5 species), Badidae (5 species), Amblycipitidae (4 species), Channidae (3 species), Siluridae (3 species), Balitoridae (3 species), Psilorhynchidae (2 species), Akysidae (2 species), Choudhuriidae (2 species), Mastacembelidae (1 species), Clupeidae (1 species), Synbranchidae (1 species), Osphronemidae (1 species) and Botiidae (1 species). The genera which showed high endemicity are *Schistura* (Nemacheilidae, 17 species), *Garra* (Cyprinidae, 11 species), *Pethia* (Cyprinidae, 8 species) and *Glyptothorax* (Sisoridae, 8 species) as represented in Fig. 2. In terms of economic importance, 58 species were found to have only food value, 43 species of ornamental value, 27 species with both ornamental

and food value and 10 species have both food and sports value. State-wise distribution of endemic fish species (Fig. 3) was maximum in river Irrawaddy and Chindwin basins of Manipur (91 species), followed by Brahmaputra and Barak Valley in Assam (29 species), Arunachal Pradesh (26 species), Meghalaya (23 species), Nagaland (14 species), Mizoram (8 species) in Kolodyne River system, Tripura (7 species) and Sikkim (5 species). However, some of the fish species have a wide area of endemism and therefore have a relatively large distribution range, crossing the political boundaries of the states of the North-eastern region. The systematic checklist of endemic fish species along with their distribution in different drainages and waterbodies, economic value and conservation status are presented in Table 2.

The North-eastern region is a hotspot for endemic freshwater biota. Native species under fish groups such as mahseers, minor carps, barbs, loaches and catfishes recorded in the North-eastern region play an important role in the economy of local fishermen in hilly region (Sarma and Singh, 2015). The high degree of endemism in the region is thought to have resulted from its long period of isolation and complex evolutionary history, which promoted *in situ* diversification (Darlington, 1957). Majority of North-eastern region of India is covered by mountains with variant climatic conditions and most of the water bodies are perennial except some in Assam which are seasonal. The hills and the undulating valleys of this region give rise to a large number of torrential hill streams, which lead to big rivers that finally become part of the Ganga-Brahmaputra-Barak-Chindwin-Kolodyne-Gomati-Meghna system (Kar, 2003). The Brahmaputra and Barak drainages along with their tributaries form more than half of the rivers in North-east. In addition to the rivers, the floodplain wetlands (beels) are known for their fisheries potential in Assam, Manipur, Arunachal Pradesh, Meghalaya and Tripura and are spread in an area of 1.0 lakh ha, 0.21 lakh ha, 0.025 ha, 0.084 ha and 0.045 ha respectively. The reservoirs (about 0.92 lakh ha) and ponds and mini barrages (about 0.4 lakh ha) offer great scope for coldwater aquaculture (Singh and Sarma, 2015). The presence of different types of habitat and climatic conditions make the North-eastern region an ideal place for diverse ichthyofauna.

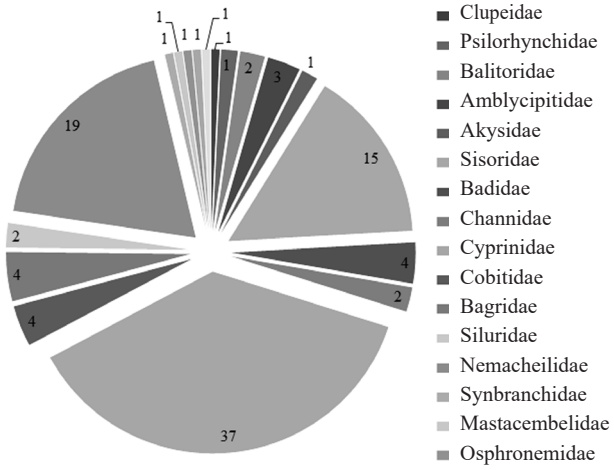

Fig. 2. Family-wise distribution of endemic fish species (nos.) of north-eastern region of India

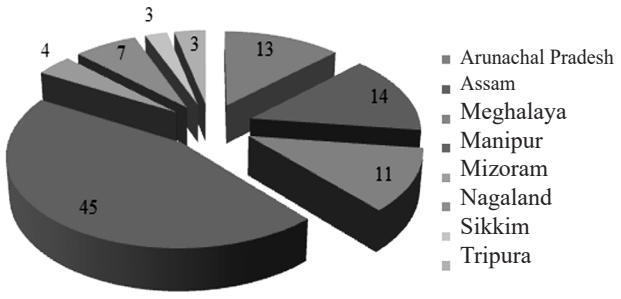

Fig. 3. State-wise distribution of endemic fishes (nos.) of north-east India

Within the faunistic units, *Gudusia variegata, Balitora burmanica, Neonoemacheilus labeosus, Akysis manipurensis, Glyptothorax chindwinica, Badis ferrarisi, Bangana devdevi,* a few *Danio* spp., *Devario* spp., *Neolissochilus stracheyi* and a few *Puntius* spp. inhabiting large river mainstreams, wetlands and slow flowing waters tend to have wide ranges (wide-range endemism) that may encompass several major drainages such as Irrawaddy and Chindwin basins while wide distribution range of *Amblyceps apangi, Sisor chennuah, Badis kanabos*, a few *Channa* spp. and *Tor* spp. are found in the Brahmaputra river system. Fishes like *Schistura sikmaiensis, Exostoma labiatum, Channa stewarti, Garra naganensis, G. nasuta, Neolissochilus hexagonolepis, N. paucisquamatus* and *Lepidocephalichthys irrorata* are extensively found in almost all drainage systems of the North-eastern region.

On the other hand, fish species inhabiting a particular drainage(s), tend to have a narrow range (narrow-range endemism) and are often endemic to a single sub-drainage such as the *Psilorhynchus arunachalensis* (Psilorhynchidae) found only in river Dirang of Arunachal Pradesh; *Aborichthys garoensis* in Garo hills; *Schistura reticulofasciata* in Umiam reservoir; *Neonoemacheilus morehensis* in river Lokchao in Manipur; *Schistura khugae* and *S. minuta* in river Khuga and river Iyei in Manipur; *S. papulifera* restricted only to the cave of Krem Synrang Pamiang system in Meghalaya; *S. singhi, S. sijuensis* confined to Kiphire District of Nagaland and Siju cave in Garo hills of Meghalaya (Balitoridae); *Glyptothorax sinensis* found only in upper reaches of river Siang in Arunachal Pradesh; *G. chimtuipuiensis* restricted only

Table 2. Checklist of endemic ichthyofauna in drainage systems of North-east India

Family	Species	Distribution	Economic significance	IUCN Status
Clupeidae				
1	*Gudusia variegata* (Day, 1870)	River Irrawaddy and its tributaries in Manipur.	Food	LC
Psilorhynchidae				
2	*Psilorhynchus arunachalensis* (Nebeshwar *et al.*, 2007)	River Dirang of Arunachal Pradesh	Food	DD
3	*Psilorhynchus microphthalmus* (Vishwanath & Manojkumar, 1995)	Chakpi Stream in Manipur	Food	EN
Balitoridae				
4	*Balitora burmanica* (Hora, 1932)	Irrawaddy Basin in Manipur	Food and ornamental	LC
5	*Homalopteroides modestus* (Vinciguerra, 1890)	Rivers of Manipur	Ornamental	DD
6	*Homalopteroides rupicola* (Prashad & Mukerji, 1929)	Rivers of Manipur	Ornamental	LC
Nemacheilidae				
7	*Aborichthys garoensis* (Hora, 1925)	Streams of Garo Hills in Meghalaya and Dikrong River in Arunachal Pradesh	Food	VU
8	*Paracanthocobitis zonalternans* (Blyth, 1860)	Brahmaputra and Chindwin basins	Ornamental	LC
9	*Schistura reticulofasciata* (Singh and Banarescu, 1982)	Recorded in Umiam Reservoir, streams near Shillong of Meghalaya	Ornamental	VU
10	*Neonoemacheilus assamensis* (Menon, 1987)	Pagladia River of Brahmaputra Basin and Jiri River in Manipur	Food and ornamental	NT
11	*Neonoemacheilus labeosus* (Kottelat, 1982)	Rivers of Manipur	Food and ornamental	LC
12	*Neonoemacheilus morehensis* (Arunkumar, 2000)	River Lokchao of Manipur	Food and ornamental	DD
13	*Acanthocobitis pavonacea* (McClelland, 1839)	Brahmaputra Basin in Assam	Food and ornamental	VU
14	*Aborichthys tikaderi* (Barman, 1985)	Rivers Kalpangi, Subansiri, Labia, Sipu, Naodihing and Namdapha Wildlife Sanctuary in Arunachal Pradesh	Food and ornamental	VU
15	*Physoschistura elongata* (Sen & Nalbant, 1982)	Rivers of Manipur.	Ornamental	NE
16	*Schistura chindwinica* (Tilak & Husain, 1990)	Rivers Barak and Iyei of Manipur	Ornamental	VU
17	*Schistura cincticauda* (Blyth, 1860)	Drainages of Manipur and Arunachal Pradesh	Ornamental	DD
18	*Schistura devdevi* (Hora, 1935)	Eastern Himalayas; small streams below Sikkim	Ornamental	NT
19	*Schistura kangjupkhulensis* (Hora, 1921)	Chindwin Basin of Manipur	Ornamental	EN
20	*Schistura khugae* (Vishwanath and Shanta 2004)	River Khuga in Manipur	Ornamental	VU
21	*Schistura manipurensis* Chaudhuri (1912)	Manipur Valley and streams of Nagaland	Ornamental	NT
22	*Schistura minuta* (Vishwanath and Shantakumar, 2006)	River Iyei in Manipur	Ornamental	EN

(Contin.....)

Family	Species	Distribution	Economic significance	IUCN Status
23	*Schistura nagaensis* (Menon, 1987)	Chindwin Basin in Manipur and Nagaland	Ornamental	VU
24	*Schistura papulifera* (Kottelet, *et al*., 2007)	Found with certainty only from the cave of Krem Synrang Pamiang system in Meghalaya	Ornamental	CR
25	*Physochistura prashadi* (Hora, 1921)	Brahmaputra and Chindwin drainages (Thoubal and Sikmai stream)	Ornamental	VU
26	*Schistura reticulata* (Vishwanath & Sharma, 2004)	Rivers of Manipur	Ornamental	NE
27	*Schistura sikmaiensis* (Hora, 1921)	Chindwin-Irrawady Basin of Manipur and streams of Assam, Meghalaya, Tripura and Nagaland	Ornamental	LC
28	*Schistura singhi* (Menon, 1987)	Streams of Kiphire District of Nagaland	Ornamental	VU
29	*Schistura sijuensis* (Menon, 1987)	Siju Cave and Garo Hills in Meghalaya	Ornamental	EN
30	*Schistura tigrina* (Vishwanath and Nebeshwar, 2005)	Barak drainages in Manipur	Ornamental	EN
31	*Schistura reticulofasciata* (Singh & Banarescu, 1982)	Brahmaputra Basin in Jaintia Hills Meghalaya and Assam	Ornamental	VU
32	*Schistura vinciguerrae* (Hora, 1935)	Irrawaddy and Chindwin drainages of Manipur	Ornamental	LC
Amblycipitidae				
33	*Amblyceps apangi* (Nath and Dey, 1989)	Dikrong River in Arunachal Pradesh and Brahmaputra drainage	Food	LC
34	*Amblyceps arunachalensis* (Nath & Dey, 1989)	Dikrong and Subansiri rivers in Arunachal Pradesh	Food	EN
35	*Amblyceps torrentis* (Linthoingambi & Vishwanath, 2008)	River Yu (Laniye) headwaters in Chindwin drainage in Manipur	Food	DD
36	*Amblyceps tuberculatum* (Linthoingambi & Vishwanath, 2008)	Chindwin drainage in Manipur	Food	DD
Akysidae				
37	*Akysis manipurensis* (Arunkumar, 2000)	Chindwin drainage in Manipur	Food	DD
38	*Akysis prashadi* (Hora, 1936)	Lokchao area (Chindwin river system) in Manipur	Ornamental	LC
Sisoridae				
39	*Exostoma barakensis* (Vishwanath and Joyshree, 2007)	River Iyei, a tributary of the Barak River in Manipur	Food	DD
40	*Exostoma labiatum* (McClelland, 1842)	Streams of Mishmi Hills in Meghalaya, Brahmaputra drainage in Arunachal Pradesh and Meghalaya	Food	LC
41	*Exostoma vinciguerrae* (Regan, 1905)	Irrawaddy drainage of Manipur	Food	DD
42	*Glyptosternon maculatum* (Regan, 1905)	Upper reaches of Brahmaputra drainage and Arunachal Pradesh	Food	LC
43	*Glyptothorax sinensis* (Regan, 1908)	Upper reaches of river Siang of Arunachal Pradesh	Food	DD
44	*Glyptothorax chindwinica* (Vishwanath & Linthoingambi, 2007)	Chindwin drainage in Manipur (in the Iril, Thoubal, Ithai and Lokchao rivers)	Food	LC
45	*Glyptothorax granulus* (Vishwanath & Linthoingambi, 2007)	Chindwin drainage in Manipur	Food	LC

(Contin.....)

Family	Species	Distribution	Economic significance	IUCN Status
46	*Glyptothorax manipurensis* (Menon, 1955)	Barak drainage in Manipur	Food	VU
47	*Glyptothorax ngapang* (Vishwanath & Linthoingambi, 2007)	Rivers Iril, Lokchao and Imphal in Manipur	Food	LC
48	*Glyptothorax striatus* (McClelland, 1842)	Khasi hills and Brahmaputra drainages	Food	NT
49	*Glyptothora*x *ventrolineatus* (Vishwanath and Linthoingambi, 2006)	Rivers Iril and Lokchao of Chindwin drainage in Manipur	Food	LC
50	*Glyptothorax chimtuipuiensis* (Anganthoibi & Vishwanath, 2010)	River Kaladan (Chimtuipui) of Mizoram	Food	DD
51	*Myersglanis jayarami* (Vishwanath and Kosygin, 1999)	River Laniye at Jessami of Chindwin drainage in Manipur	Food	VU
52	*Creteuchiloglanis kamengensis* (Jayaram, 1966)	River Norgum at Kalaktang of Arunachal Pradesh.	Food	DD
53	*Pseudecheneis ukhrulensis* (Vishwanath & Darshan, 2007)	Chindwin river drainage of Manipur	Food	VU
54	*Pseudecheneis sirenica* (Vishwanath and Darshan, 2007)	River Siren of Upper Siang district of Arunachal Pradesh	Food	VU
55	*Pseudecheneis koladynae* (Anganthoibi & Vishwanath, 2010)	River Kolodyne in Mizoram	Food	NE
56	*Sisor barakensis* (Vishwanath & Darshan, 2005)	Barak drainage	Food	VU
57	*Sisor chennuah* (Ng & Lahkar, 2003)	Upper Brahmaputra drainage in Assam	Ornamental	DD
58	*Conta pectinata* (Ng, 2005)	Brahmaputra drainage in Assam and Meghalaya	Ornamental	DD
59	*Erethistes hara* (Vishwanath & Kosygin 2000)	Rivers Barak and Jiri in Manipur and Brahmaputra drainage	Food and ornamental	LC
Badidae				
60	*Badis assamensis* (Ahl, 1937)	Upper reaches of the river Brahmaputra in India	Ornamental and food	DD
61	*Badis chittagongis* (Kullander & Britz, 2002)	Hill streams in the states of Tripura and Mizoram	Ornamental and food	DD
62	*Badis ferrarisi* (Kullander & Britz, 2002)	Chindwin and Irrawaddy drainages in Manipur	Food	LC
63	*Badis kanabos* (Kullander & Britz, 2002)	Middle and lower reaches of Brahmaputra drainage (River Bhoroli, Janali, and Sukajan and rivers of Kokrajhar District in Assam)	Food	DD
64	*Badis tuivaiei* (Vishwanath & Shanta, 2004)	Rivers Tuivai and Irang of Manipur	Food	EN
Channidae				
65	*Channa aurantimaculata* (Musikasinthorn, 2000)	Brahmaputra Basin in Assam and River Lohit in Arunachal Pradesh	Food and ornamental	DD
66	*Channa bleheri* (Vierke, 1991)	Brahmaputra drainage at Dibrugarh and River Dikrong in Aruanchal Pradesh	Ornamental	NT
67	*Channa stewartii* (Playfair, 1867)	Rivers of Assam (Cachar), Nagaland, Meghalaya, Manipur, Tripura and Arunachal Pradesh	Food and ornamental	LC

(Contin.....)

Family	Species	Distribution	Economic significance	IUCN Status
Cyprinidae				
68	*Bangana devdevi* (Hora, 1936)	Drainages of Manipur.	Food	LC
69	*Barilius chatricensis* (Selim & Vishwanath, 2002)	River Chatrickong in Manipur	Food and ornamental	VU
70	*Opsarius dogarsinghi* (Hora, 1921)	Chindwin drainage of Manipur and Nagaland	Food and ornamental	VU
71	*Barilius lairokensis* (Arunkumar & Tombi Singh, 2000)	Drainages of Manipur	Food	NT
72	*Danio albolineatus* (Blyth, 1860)	Irrawaddy drainages	Ornamental	LC
73	*Danio choprae* (Hora, 1928)	Irrawaddy drainages	Ornamental	LC
74	*Danio nigrofasciatus* (Day, 1870)	Drainages of Manipur	Ornamental	DD
75	*Devario shanensis* (Hora, 1928)	Drainages of Manipur	Food	DD
76	*Devario sondhii* (Hora & Mukerji, 1934)	Drainages of Manipur	Ornamental	DD
77	*Chagunius nicholsi* (Myers, 1924)	Rivers Manipur, Lokchao, Maklang and Chatrickong in Manipur, river Meguiki and Tizu in Nagaland	Food	LC
78	*Laubuka khujairokensis* (Arunkumar, 2000)	Khujairok stream of Manipur	Food	VU
79	*Tariqilabu burmanicus* (Hora, 1936)	Chindwin basin of Manipur	Food	LC
80	*Cyprinion semiplotum* (McClelland, 1839)	Rivers of Arunachal Pradesh and Assam	Food and sports	VU
81	*Danio jaintianensis* (Sen, 2007)	River and streams of Rangriang Jowai, Jaintia Hills districts of Meghalaya	Ornamental	VU
82	*Devario acuticephala* (Hora, 1921)	Ukjhang sang in the state of Manipur and from River Dikhu in Nagaland	Ornamental	VU
83	*Devario naganensis* (Chaudhuri, 1912)	Lungting River in Manipur and Nagaland	Ornamental	VU
84	*Devario yuensis* (Arunkumar & Singh, 1998)	River Lokchao in Manipur	Ornamental	VU
85	*Garra abhoyai* (Hora, 1921)	Chindwin basin in Manipur.	Ornamental and food	NE
86	*Garra rupicula* (McClelland, 1839)	Drainages of Arunachal Pradesh (Mishmi Hills) and Meghalaya (Khasi Hills)	Ornamental and food	NT
87	*Garra compressus* (Kosygin & Vishwanath, 1998)	Wanze stream of Manipur	Ornamental and food	VU
88	*Garra kalpangi* (Nebeshwar, Bagra and Das, 2012)	River Kalpangi of Lower Subansiri District of Arunachal Pradesh	Ornamental and food	NE
89	*Garra lissorhynchus* (McClelland, 1842)	Drainages of North-eastern region, preferably in Meghalaya	Ornamental and food	LC
90	*Garra litanensis* (Vishwanath, 1993)	Litan stream of Chindwin basin in Manipur	Ornamental and food	VU
91	*Garra manipurensis* (Vishwanath & Sarojnalini, 1988)	River Manipur and Barak drainage	Ornamental and food	VU
92	*Garra naganensis* (Hora, 1921)	Rivers of North-eastern region.	Ornamental and food	LC
93	*Garra nambulica* (Vishwanath & Joyshree, 2005)	Ireng Lok and Conchak Lok streams of Nambul River of Manipur	Ornamental and food	VU
94	*Garra nasuta* (McClelland, 1838)	River and streams of North-eastern region	Ornamental and food	LC
95	*Garra paralissorhynchus* (Vishwanath & Shanta Devi, 2005)	River Khuga of Manipur	Ornamental and food	VU

(Contin.....)

Family	Species	Distribution	Economic significance	IUCN Status
96	*Neolissochilus blythii* (Day, 1870)	Drainages of Manipur	Sports and food	DD
97	*Neolissochilus hexagonolepis* (McClelland, 1839)	Drainages of North-eastern Himalayas	Sports and food	NT
98	*Neolissochilus hexastichus* (McClelland, 1839)	Brahmaputra and Barak drainages of Assam	Sports and food	NT
99	*Neolissochilus paucisquamatus* (Smith, 1945)	Drainages of North-eastern Himalayas	Sports and food	LC
100	*Neolissochilus stracheyi* (Day, 1871)	Drainages of North-eastern region	Sports and food	LC
101	*Osteobrama belangeri* (Valenciennes, 1844)	Chindwin basin of Manipur	Food	NT
102	*Pethia atra* (Linthoingambi & Vishwanath, 2007)	River Iril in Manipur	Food	VU
103	*Pethia meingangbii* (Arunkumar & Singh, 2003)	Chindwin and Irrawaddy drainage of Manipur	Food	LC
104	*Pethia yuensis* (Arunkumar & Singh, 2003)	River Yu system of Manipur at the lower zones of River Maklang and River Lokchao near Moreh, Manipur	Ornamental	VU
105	*Puntius jayarami* (Viswanath & Singh, 1986)	Chakpi and Chakpikarong stream in Manipur	Food	LC
106	*Pethia khugae* (Linthoingambi & Vishwanath, 2007)	Only known from River Khuga (Chindwin basin) in Churachandpur District of Manipur	Food	VU
107	*Pethia manipurensis* (Menon, Devi & Vishwanath, 2000)	Only found from Loktak Lake of Manipur	Food	EN
108	*Pethia ornatus* (Vishwanath & Laisram, 2004)	River Lokchao of Moreh, Manipur	Ornamental	VU
109	*Pethia shalynius* (Yazdani & Talukdar 1975)	Streams of Khasi and Jaintia hills in Meghalaya	Food and ornamental	VU
110	*Pethia stoliczkana* (Day, 1871)	Chindwin basin in Manipur	Ornamental	LC
111	*Poropuntius burtoni* (Mukerji, 1933)	Hill streams in Manipur, draining to the Chindwin basin	Food	LC
112	*Raiamas guttatus* (Day, 1870)	Irrawady river basin	Food and sports	LC
113	*Rasbora ornata* (Vishwanath & Laisram, 2005)	River Chatrickong and river Lokchao, both tributaries of River Yu, Manipur	Ornamental	VU
114	*Salmophasia sladoni* (Day, 1870)	Rivers of Manipur near the Myanmar border	Food	LC
115	*Salmophasia phulo* (Hamilton, 1822)	Lower reaches of rivers of Brahmaputra drainage	Food	LC
116	*Semiplotus manipurensis* (Vishwanath & Kosygin, 2000)	River Challou and Wanze stream in the Chindwin drainage of Manipur	Food	DD
117	*Semiplotus modestus* (Day, 1870)	River Kolodyne and River Mat of Mizoram	Food	DD
118	*Tor progeneius* (McClelland, 1839)	Brahmaputra river drainage of Assam, Manipur, Meghalaya and Nagaland	Sports and food	NT
Cobitidae				
119	*Acantopsis multistigmatus* (Vishwanath & Laisram, 2005)	River Lokchao in Manipur	Food and ornamental	NT
120	*Acantopsis choirorhynchos* (Bleeker, 1854)	Rivers of Manipur	Food and ornamental	LC

(Contin.....)

Family	Species	Distribution	Economic significance	IUCN Status
121	*Lepidocephalichthys arunachalensis* (Dutta & Barman, 1984)	Namdapha Wildlife Sanctuary, Tirap District of Arunachal Pradesh	Food and ornamental	EN
122	*Lepidocephalichthys berdmorei* (Blyth, 1860)	Irrawaddy drainage of Manipur	Food and ornamental	LC
123	*Lepidocephalichthys irrorata* (Hora, 1921)	Rivers of Meghalaya, Manipur and Assam	Food	LC
Botiidae				
124	*Syncrossus berdmorei* (Blyth, 1860)	Chindwin basin of Manipur	Ornamental	NT
Bagridae				
125	*Hemibagrus microphthalmus* (Day, 1877)	Irrawaddy drainage of Manipur	Food	LC
126	*Hemibagrus peguensis* (Boulenger, 1894)	Chindwin drainage in Manipur	Food	LC
127	*Mystus falcarius* (Chakrabarty & Ng, 2005)	Chindwin drainage of Manipur	Food	LC
128	*Mystus rufescens* (Vinciguerra, 1890)	Irrawaddy and Chindwin rivers in Manipur	Food	LC
129	*Sperata acicularis* (Ferraris & Runge, 1999)	River Irrawaddy and some parts of Imphal and Lakchao rivers and their tributaries in Manipur.	Food	LC
130	*Olyra longicaudata* (McClelland, 1842)	Streams of Khasi Hills in Meghalaya and from the Brahmaputra drainage	Food	LC
Siluridae				
131	*Pterocryptis barakensis* (Vishwanath & Sharma, 2006)	Barak drainage in Manipur.	Food	EN
132	*Pterocryptis berdmorei* (Blyth, 1860)	Streams draining into River Yu, a tributary of the Chindwin in Manipur	Food	LC
133	*Pterocryptis indicus* (Datta, Barman & Jayaram, 1987)	Namdapha Wildlife Sanctuary, Arunachal Pradesh	Food and ornamental	DD
Synbranchidae				
134	*Moringua hodgarti* (Chaudhuri, 1913)	Upper Rotung, Abor Hills, Arunachal Pradesh and Assam	Food	DD
Mastacembelidae				
135	*Macrognathus morehensis* (Arunkumar & Singh, 2000)	River Maklang, Chindwin drainage in Manipur	Food and ornamental	LC
Chaudhuriidae				
136	*Pillaia indica* (Yazdani, 1972)	Streams of Khasi and Jaintia hills and from Umsing River of Meghalaya	Ornamental	EN
137	*Garo khajuriai* (Talwar, Yazdani & Kundu, 1977)	Garo Hills in Meghalaya	Food	NT
Osphronemidae				
138	*Trichogaster labiosa* (Day, 1877)	Chindwin drainage, Manipur	Ornamental	LC

LC=Least Concern; DD=Data Deficient; VU=Vulnerable; NE=Not Evaluated; NT=Near Theatened; EN=Endangered; CR=Critically Endangered

to river Kaladan (Chimtuipui) in Mizoram; *Myersglanis jayarami* in river Laniye in Manipur; *Creteuchiloglanis kamengensis* specific to river Norgum in West Kameng District of Arunachal Pradesh; *Sisor barakensis* in Barak valley (Sisoridae); *Barilius chatricensis* in river Chatrickong in Manipur; *Garra kalapangi* in river Kalapangi of Lower Subansiri District of Arunachal Pradesh; *Pethia manipurensis* restricted only to Loktak Lake (Cyprinidae) and *Moringua hodgarti* of Abor hills in Arunachal Pradesh (Synbranchidae). Although the number of species in these water resources is quite low, a significant number are likely to be endemic to that drainage.

Elevation, slope, width, depth, flow dynamics and geomorphology, physico-chemical parameters such as pH and temperature of water resources are identified to be important factors responsible for such varied distribution of endemic fishes in the North-east region of India. Similar results are consistent with studies from other regions showing that ecological boundaries of stream fishes are strongly influenced by elevation, gradient, stream size and flow velocity (Sen, 1999a, b; Kar, 2001, 2003; Sen, 2003; Tamang *et al*., 2007; Ramanujam *et al*., 2010). For example, *Schistura,* the largest genus of the family Balitoridae which encompasses 17 nominal endemic species across the North-east are typically found amongst stones in moderate to fast flowing streams and rivers from foothills to mountainous habitats. Effect of moderately high pH and temperature with altitude had a strong effect for the spatial variation in fish availability in states like Arunachal Pradesh and Meghalaya, mostly determining the upstream boundaries of fishes from foothills to high-altitude regions. Freshwater fishes thriving in areas with topographical variations (foothills to high-altitude) exhibit high morphological divergence, suggesting that they evolved to adapt to specific habitats that differ in environmental stressors. The fishes recorded in this study have distinct body forms with laterally compressed bodies to adapt to life in slow flowing waters, anguilliform and slender bodied fishes for exploiting reaches at higher elevation, expecting reduced energy expenditure necessary to maintain their position in fast flowing water. The effect of riparian and aquatic vegetation in influencing the distribution of stream fishes is also important. Riparian vegetation provides shade and allochthonous organic debris, while aquatic vegetation provides instream cover and increases habitat diversity. While some ecological patterns of stream fishes may be common among different geographic regions, some patterns may also be specific to particular regions. This makes it difficult to make broad ecological generalisations.

However, majority of the native stream fishes of the North-east region rank amongst the most imperilled freshwater taxa in India. Nearly all native freshwater fishes of the North-east region are listed in threatened categories of the IUCN, because their historical distributions have declined as a result of multiple anthropogenic impacts, including hydrological modifications, degradation of habitats and widespread invasion of rivers by some of the alien fish species. These impacts have collectively resulted in sharp decline of fish abundance in a number of mountain tributaries of almost all mainstem populations of native freshwater fishes. Among the fish species assessed, 7.97% fall under the Endangered category, 24.64% Vulnerable, 10.14% Near Threatened, 0.72% Critically Endangered, 18.84% Data Deficient and 3.62% under Not Evaluated category. It is noteworthy to mention that majority of the endemic species (34.06%) are under the Least Concern category of the IUCN conservation status (IUCN, 2015) which indicates their abundance in drainages and stability of the aquatic environment (Fig. 4). However, for rest of the species, effective management and conservation strategy is an urgent need (Mahanta and Sarma, 2010).

Since aquaculture is one of the fastest growing sectors in the region, many of the hill stream species can be considered as candidate species for diversification in freshwater aquaculture in the hilly region. Farming of these fishes would help in generating livelihood for the people as well as to conserve germplasm from extinction. Considering the anthropogenic interference and climate vagaries, there is growing concern over the resource assessment, breeding, production and management of the endemic species of the North-east Himalayan region. At the same time, there is paucity of information on the present status and proper documentation of the available species. Further, there are certain technical, social and environmental issues warranting immediate attention.

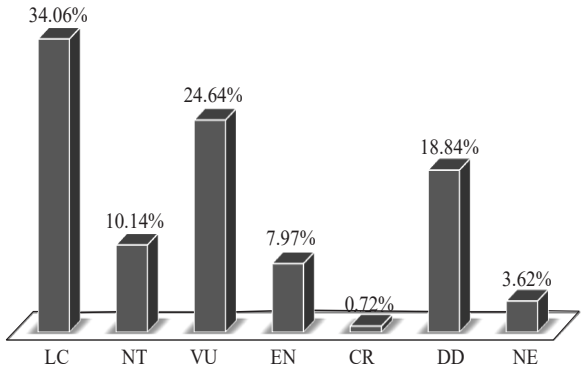

Fig. 4. IUCN status of endemic fishes of north-east region

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