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RESEARCH ARTICLE

DISTRIBUTION, HABITAT AND CONSERVATION STATUS OF SOME THREATENED FISHES IN SONKOSH RIVER, BODOLAND TERRITORIAL COUNCIL, INDIA

[1]Daud Chandra Baro and [2]Dr. DandadharSharma

[1]Department of Zoology, Gossaigaon College, Gossaigaon, Kokrajhar-783360, India
[2]Department of Zoology, Gauhati University, Guwahati-781014, India

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ABSTRACT

The river Sonkosh or Sankosh enters India at Jamduar (89°51′39.4″ E and 26°43′59.8″ N) of Kokrajhar district of Assam streaming from the snow fed upstream of Bhutan. It extends up to the Feshimari-Jaldhuaghat (89°47′26″E and 26°22′39″ N) of West Bengal state. From the confluence point with another river called Raidak, It is known as Gangadhar river which flows through Dhubri district of Assam and joins with the Brahmaputra River. It has overlapping fishery resources of both warm and cold water nature, providing favourable conditions for many endemic fish species of Eastern Himalayan range. The spatial and temporal distribution of threatened freshwater fishes of Indian region that is enlisted by National Bureau of Fish Genetic Resources (NBFGR, 2010) was investigated at four sampling stations along the stretch of the river from April, 2014 to March, 2015. From the study, the conservation status of 11 fishes were recorded as endangered (EN) and 19 were vulnerable (VU) out of 30 numbers different fish species which are categorically in the status of threatened fresh water fishes of Indian region as described by NBFGR, Lucknow, India. *Crossocheilus latius* was recorded highest 10.62 % of relative abundances (RA) and less than 1% of RA was recorded for *Channa barca, Ompok pabo*, *Sisor rhabdophorus, Tor tor, Bagarius bagarius, Ctenops nobilis*, *danio dangila, Eutropiichthys vacha and Ompok pabda*. Their conservation status was also studied as comparison of CAMP, 98 and IUCN, 2014. We assessed diverse habitat characteristics in certain study sites of the river and are the natural breeding grounds of these threatened fish species. But due to installation Hydro-electrical power project in upstream of the river in Bhutan, the chance of changing its flow regimes, substrates, depth, sedimentation and any other unknown biophysical and biochemical alteration may leads to more threats to its endemic species. So the present information will serve as comparative hydro-biological assessment in future. It will also help in understanding the threat level and sustainability of threatened fishes. The river is important as it has the distribution of many endemic fish species of Eastern Himalayan region. So we recommend for protection and conservation of the Sankosh river and its fishery resources on priority basis. The study provides baseline scientific data which may be helpful in formulating new policies for conservation and sustainable development of lotic freshwater fishery resources of the region.

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INTRODUCTION

India is one of the mega biodiversity hot spots contributing to the world's biological resources from the long stretches of Eastern Ghat on the east, the greater Himalayan range on the Northern Plains and Western Ghat on the west and has been bestowed with vast and varied fish germplasm resources (Lakra *et al.*, 2010). The country has rich freshwater fish genetic resources constituting 756 species which have been recorded in the INDFISH (2009), a NBFGR database. During the recent past, the natural and anthropogenic activities, like habitat alterations, over exploitation of resources, reduction of natural habitat areas, construction of dams, stream and river diversion or reclamation of river beds for urbanization, unsustainable fishing, introduction of exotic fishes and global climate changes etc. directly declining the endemic fishes of India. The overall fish germplasm is getting depleted and many freshwater fishes have become threatened. In view of its significance and to achieve sustainable utilization of these resources, appropriate planning for biodiversity conservation and management strategies are of utmost importance and the greatest challenge is to secure the Intellectual Property Rights, related to fisheries so that the region is able to maintain its stake on its natural habitat (Lakra *et al.*, 2010). The livelihood crisis from biological loss is another global concern in which human

***Corresponding author: Daud Chandra Baro**
Department of Zoology, Gossaigaon College, Gossaigaon, Kokrajhar-783360, India

beings are mostly dependent on biodiversity resources. For which International Union for Conservation on nature and Natural Resources (IUCN), established in 1963, set a standard for global species listing and conservation assessment efforts. Over the time, the IUCN recognised a more objective and scientific system for determining threats status. The most precise and quantitative Red list categories and criteria were adopted by IUCN in 1994. The overall aim of the Red list is to convey the urgency and scale of conservation problems to the public and policy makers, and the global community to try to reduce species extinctions. In recent years, the international community has also become sensitive to conservation on natural resources, rights of native inhabitants etc.as it is evident from the Convention on Biodiversity (CBD). To respond to new challenges and developments, Govt. of India has legislated the Biological Diversity Act 2002 (BDA, 2002) and Biodiversity Rules (2004), which aims at conservation of our natural biological heritage and ensures the sharing of benefits of the utilization of biological resources in an equitable manner. The National Biodiversity Action Plans, 2008 is the most recent publication with policies towards the biodiversity conservation.

According to the IUCN (2008) Red list of all life forms, 16,928 species are threatened globally and of these 1275 species are fishes. In Asia, 6106 organisms are threatened of which 688 are fin fishes. Overall, the conservation status of the endemic fish species in Asia can be considered to be relatively satisfactory. India contains 659 species of animals listed as globally threatened by IUCN (2008) which is approximately 3% of worlds total number of threatened faunal species (16928 species). The 659 Globally threatened Indian species includes 42 species of fishes as per IUCN classification (iucnredlist, 2014.) under different categories. Among Asian countries, India possess the maximum number of endemic fresh water fin fish species (27.8%) followed by China, Indonesia and Maynmar. The number of indigenous and endemic fresh water fin fishes recorded from the biodiversity hot spots and major rivers like Ganges and Brahmaputra (Lakra *et al.*, 2010).

Taking the views that all the rivers are more or less impacted by different natural and manmade factors, there are reports of working on different objectives for collecting baseline data from the water bodies of sub Himalayan regions. Among them Acharjee and Barat (2010), Jhingran and Sehgal (1978), Uniyal *et al*. (2002) and Srivastava *et al.* (2002) have worked on illegal fishing methods used in the Himalayan rivers causing decline in fish population. Goswami (2000, 2005) and Goswami *et al.,* (2007) reported that fish fauna of North-east India is facing serious threats and hazards from either environmental and natural or man-made problems. The significant study of fresh water fish diversity of Assam was reported by Dey (1973, 1982), Nath (1987), Boruah (1999), Biswas (2006), Das (2007), Das and Biswas (2006, 2008), Das (2009), Das and Sharma (2010, 2012), Das & Bordoloi (1012). Baro and Sarma (2014) reported 83 fish species from Sonkosh river. Baro *et al.* (2014, 2015) reported status of total 49 ornamental fishes and 65 species diversity and abundances of coldwater fishes from the Sonkosh river.

But the conservation of the threatened fishes has never been adequately addressed in India which has been mainly due to lack of scientific data and perception about the criteria to be used for the characterization and designing their conservation status. This paper presents current information on the distribution, abundance and habitat of the threatened fishes in Sonkosh river. The data reports will help in the formulation of management plans and selection of priority areas for conservation of threatened fish species in Sonkosh river of Assam.

MATERIALS AND METHODS

Study area

This study was conducted from April, 2014 to March, 2015 through space and time along the stretch of Sonkosh (or Sankosh) river of Kokrajhar district at three spots covering one kilometre fishing distance for each spot. The river extends from Jamduar to Feshimari-Jaldhuaghat (Latitude 26°43/ N - 26°21/ N, Longitude 89°47/ E - 89°51/ E and altitude 35 - 101 m.). It flows from downstream of Himalayan mountain of Bhutan by touching the two inter states boundary, the Assam in the east and the West Bengal in the western part. The river is large with perennial water, snow fed origin with rapid water current, sandy, pebbly and rocky bottom. In the middle reaches, the river has braided channels forming deep pools at some regions and small islands which inhabit diverse species of fishes. Potential fishes as food, ornamental and sports value are captured from the Sonkosh river and its tributaries (Dainamari, Demdema, Burasara and Harafuta rivers in the eastern bank and Gholani, Jorai, Khulkhuli and Raidak rivers in the western bank). The survey area was conducted in the three selected catchment sites by discussion with the hired local fishermen. They are (Site-1) Gamarighat (26°43/ N and 89°51/ E; 89 m elevation), (Site-2) Surendrapur (26°32/ N and 89°53/ E; 53 m elevation) and (Site-3) Majedabri (26°24/ N and 89°50/ E; 37 m elevation).

Sampling

Monthly field survey was carried out with the help of hired professional fishermen in the study area. These fishermen harvested fishes with some selected fishing gears and catch per unit effort (CPUE) was measured as the amount of harvest in gram per hour per fishing unit. A digital balance (500 g capacity) and spring balance of 5 kg capacity were used to measure the weight and a digital Slide Caliper was used to measure the standard length of each individual fish. A fishing unit constitutes three fishermen; four fishing nets and a bamboo trap for the sampling purposes. Fishing nets were *BerJal* (Seine net, mesh size 0.05 cm) *Fashijal* (Gill net, mesh size 2-5 cm), *Khewalijal* (Cast net, mesh size 2 cm), *Thelajal* (Push net, mesh size 0.5-1.5 cm). Fishing trap (Sepa: made of bamboo splits) was used for night hour catch. For maximum accuracy of sampling of the specimens, random samplings were made from different habitats of each sampling spot from both the day and night shift fishing. At the site of fish catch, GPS coordinates, altitude, and sampling areas were estimated, and the characteristics of habitat and the physical and chemical parameters of water were assessed with the aid of portable devices; pH, dissolved oxygen (mg/l), conductivity (µmhos/sec), TDS (ppm), temperature (°C), transparency (cm; Secchi disk), water velocity (m/sec) and depth (m) were recorded. The distribution pattern and habitat structure of fishes were studied according to Menon (1954) by observing morphological adaptive characteristics. On the basis of

dominant fish species and the hydrographical features of habitats were studied (Sehgal, 1988).

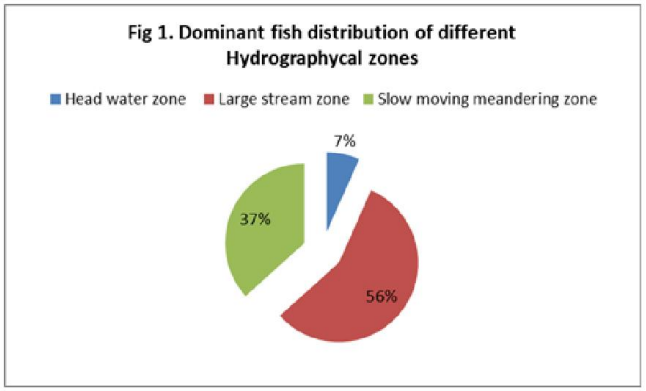
Fish identification and Data analysis

The specimens collected were photographed in fresh condition and recorded their morphological characters, then fixed individually in 10% buffer formalin solution. For identification and classification Talwar and Jhingran (1991), Jayaram (1999), Vishwanath (2000) and Nath and Dey (2000) were followed. The category of threatened status for the identified fish species was made by following the List of Threatened freshwater fishes of India (NBFGR, 2010) and site wise percentage of relative abundance of fishes and correlation among the physical attributes were calculated by Microsoft Excel, 2010. Shannon-Weiner diversity index (H) was estimated with the help of PAST (version 2.19), a software package for Paleontological data analysis.

RESULTS

The River shows rich ichthyo-faunal diversity. The table (1) shows only the threatened category fishes representing from total collected species of River Sonkosh and with their relative abundance and conservation status according to NBFGR (2010), CAMP (1998) and IUCN (2014). From the study conservation status of 11 fishes are recorded as endangered (EN) and 19 are vulnerable (VU) out of 30 species collected, which fall under critical consideration of threatened categories enlisted by NBFGR (ICAR), 2010, Lucknow, India. Based on several workshop discussions on conservation, categorization and management of fresh water fishes of India, NBFGR, Lucknow listed total 120 fresh water fish species under threatened category. Out of these 120 fishes, the Sonkoshriver was recorded having the distribution of 30 species during study year. *Crossocheiluslatius* was recorded highest 10.62 % of relative abundances (RA) andless than 1% of RA was recorded for *Channabarca,Ompokpabo,Sisorrhabdophorus, Tor tor, Bagariusbagarius, Ctenopsnobilis*, *daniodangila, Eutropiichthysvacha and Ompokpabda.* Among the Endangered species *Glyptothoraxcavia*(8.05%) and *Chacachaca*(7.08%) were recorded highest RA and among Vulnerable categories *Crossocheiluslatius* (10.62%), *Glyptothoraxtelchita*(9.66%), *Cyprinionsemiplotum*(8.24%) and *Badisbadis*(7.92%) were highest. According to CAMP (1998) the conservation status of these 30 fish species were as EN (7), VU (6), LRnt (3), NE (12), DD (2). But recently in 2014 the update of IUCN status of these fishes were considered as only 2 species in EN, 7 species as NT, 2 species as VU, 19 species as LC and no species were in the status of NE, DD and LRnt from the Sonkosh river (Table 2).The site-(1) was recorded as having maximum richness (25) with maximum diversity index (2.88), abundances (704) and mean CPUE (1.01) and followed by Site-2; richness (18), diversity index (2.64), abundances (531) and mean CPUE (0.64) and Site-3 with minimum diversity index (2.30), richness (13), abundances (318) and mean CPUE (0.63) of threatened fishes (Table 3).

Table 4 shows statistical analysis of correlation between threatened fish species richness and certain hydrological parameters like pH, dissolved oxygen, conductivity, total dissolved solids and transparency had negative impact on fish species richness and abundances, except the positive impact of total dissolved solids on richness observed at S1. But the physical factors like water temperature, velocity and depth of the river were recorded positive impact on richness of fish species at all the study sites.



From the study of fish dominant nature of different hydrographical zones, the fish representatives were mostly dominated by the fishes of (ii) Large stream zone (56%) followed by (iii) slow moving meandering zone (37%) and (i) head water zone only (7%) species (Figure 1).

DISCUSSION

(Lakra *et al*., 2010) described many systems of categorization and criteria's for assessing conservation status, like World Conservation Union (IUCN), American fishery society (AFS) and Australian Society for Fishery Biology (ASFB). According to the World Conservation Union (IUCN, 2001), any of the five criteria's within the categories has to be satisfied for a taxon to be included as "threatened". These are: (A) Population reduction, (B) Restricted distribution, (C) Population estimates, (D) Restricted population and (E) Probability of extinction. The AFS system is the simplest system without any supporting conditions by which the categories can be assessed (William and Miller, 1990; Miller *et al*., 1989 Miller *et al*.). In ASFB more importance has been given to population size, habitat and distribution range (Pollard *et al*., 1990). Other systems like categorizing based on the probability of extinction within a set time period (Mace and Lande, 1991) and occurrence ranking (Master, 1991). Knowledge of species and communities reveal crucial facts necessary to the management of ecosystem and habitats. Identification, listing and prioritization of species and their conservation status are one of the important tasks in conservation and sustainable utilization of natural resources receiving global attention. Our assessment showed that the fishes with abundances less than 1% (*Channa barca, Ompok pabo*, *Sisor rhabdophorus, Tor tor, Bagarius bagarius, Ctenops nobilis*, *danio dangila, Eutropiichthys vacha and Ompok pabda*) are to be considered under most threatened category among the fishes in Sonkosh river.

Variation in species diversity in different sampling sites indicated that altered habitat support less biological communities, while less disturbed sites are characterized by a diverse fish fauna in a variety of habitat (Lakra *et al*. 2010). So it is similar to that the site-1 is having maximum diversity and abundances of fishes which is covered by forest areas and no permission for human habitation. It has the fewer disturbances

Table 1. Distribution and relative abundances of fish catch and threatened status as per NBFGR, 2010 comparing CAMP, 98 and IUCN, 2014 (April, 2014-March, 2015)

NAME OF SPECIES	CATCH IN NUMBER	R.A %	S. L. (mm.)	NBFGR, 2010	CAMP, 98	IUCN, 14
Amblycep mangois	30	1.93	46-62	EN	LRnt	LC
Chaca chaca	110	7.08	71-163	EN	NE	LC
Chagunius chagunio	66	4.25	52-214	EN	NE	LC
Channa barca	6	0.39	56-133	EN	NE	LC
Channa bleheri	33	2.12	102-179	EN	NE	NT
Glyptothorax cavia	125	8.05	103-228	EN	EN	LC
Ompok pabo	4	0.26	88-102	EN	NE	NT
Sisor rhabdophorus	2	0.13	112-146	EN	EN	LC
Tor putitora	44	2.83	107-265	EN	EN	EN
Tor progenius	55	3.54	116-291	EN	DD	EN
Tor tor	10	0.64	66-214	EN	EN	NT
Badis badis	123	7.92	32-41	VU	NE	LC
Bagarius bagarius	3	0.19	186-334	VU	VU	NT
Botia daro	18	1.16	84-96	VU	NE	LC
Crossocheilus latius	165	10.62	72-192	VU	DD	LC
Ctenops nobilis	4	0.26	34-71	VU	NE	NT
Cyprinion semiplotum	128	8.24	61-118	VU	VU	VU
Danio dangila	12	0.77	54-78	VU	NE	LC
Eutrophiicthys vacha	11	0.71	182-216	VU	EN	LC
Garra gotyla	78	5.02	104-126	VU	VU	LC
Garra lamta	44	2.83	66-89	VU	NE	LC
Glyptothorax telchita	150	9.66	62-91	VU	LRnt	LC
Labeo pangusia	45	2.90	135-214	VU	LRnt	NT
Olyra kempi	30	1.93	38-103	VU	NE	LC
Olyra longicaudata	65	4.19	44-100	VU	NE	LC
Ompok pabda	3	0.19	82-104	VU	EN	NT
Pangio pangia	42	2.70	49-52	VU	EN	LC
Puntius sarana	35	2.25	62-174	VU	VU	LC
Rhinomugil corsula	45	2.90	89-137	VU	VU	LC
Shizothorax rechardsonii	67	4.31	181-298	VU	VU	VU

Note: EN (Endangered), NT (Near threatened), VU (Vulnerable), LRnt (Lower risk near threatened), LC (Least concern), NE (not evaluated), DD (data deficient), RA (Relative abundance and SL (Standard length).

Table 2. Conservation assessment according to NBFGR (2010), CAMP (1998) and IUCN (2014)

Conservation Assessment	EN	NT	VU	LRnt	LC	NE	DD	Total
NBFGR, 2010	11	0	19	0	0	0	0	30
CAMP, 98	7	0	6	3	0	12	2	30
IUCN, 2014	2	7	2	0	19	0	0	30

Table 3. Site wise species richness, Shannon-wiener index and mean CPUE of threatened fishes

Sites	Abundance	Richness	Diversity indices	CPUE (g/hr/unit)			
				Min	Max	Mean	SD(±)
S1	704	25	2.88	0.17	1.25	1.01	0.33
S2	531	18	2.64	0.12	0.65	0.64	0.19
S3	318	13	2.30	0.15	0.55	0.63	0.11

Table 4. Site wise correlation coefficient (*r*) of fish species richness with selected hydrological parameters

Parameters	Sampling Sites		
	S1	S2	S3
pH	-0.26	-0.44	-0.22
DO	-0.58	-0.47	-0.41
Conductivity	-0.02	-0.66	-0.01
TDS	0.09	-0.52	-0.03
Water Temp.	0.39	0.72	0.13
Transparency	-0.19	-0.68	-0.19
Velocity	0.04	0.63	0.10
Depth	0.06	0.60	0.32

from different human activities and so maintaining the natural habitat. Site 2 and 3 are having disturbances of various day-to-day human activities and occurring similar type of sub-habitats while the site-1 haves different types of sub-habitats like deep pools, fast water, braided channels causing slow water- shallow zones and confluences of streams and channels to the embankments, which inhabits diverse type of fishes.

From earlier studies it was reported that the diversity indices are related to abundance, richness which measures the catch per unit effort of that habitat. Shannon-Weiner index of three different study sites indicated a relationship with fish abundances and richness. Variations in mean CPUE are also dependent on species richness and abundance of study sites showing increasing CPUE with increasing abundances,

richness and diversity index. Maximum fish diversity index 2.88 (S1) was recorded with maximum number of abundances 704 for S1 followed by S2 and S3. The monthly CPUE variations were occurred in decreasing trend from upper stream to lower. The decreasing trends of CPUE indicate less abundances and diversity of the lower stretches causing threatening of its species.

Fish communities in riverine system typically follow a pattern of increasing species richness, diversity and abundance from upstream to downstream (Welcomme, 1985). But this typical pattern of distribution is contrary to river Sonkosh, the species richness, abundances, diversity and CPUE, all were lowered in lower stretches. The reasons of lower species richness at site 1 and 2 might be due to illegal exploitation of fishery resources like electro- fishing, fishing brooders of rare fishes and disturbances at breeding grounds. Sreekantha and Ramachandra (2005) also reported the cause of low fish richness due to degradation of breeding ground from Sharavathi River, India. In the study of Bunn and Arthington (2002) it was reported that many types of river ecosystem had been lost and populations of many riverine species have become highly fragmented due to human intervention only.

Sehgal (1988) identified several zones on the basis of dominant fish species and the hydrographical features: (i) headwater zone inhabited by rheophilic species of loaches and catfishes, (ii) large stream zone, formed by the joining of headwater streams, inhabited by *Noemacheilus* spp. and *Schizothorax spp.* occur. The intermediate reaches of the large stream zones and the least rapid reaches of this zone are occupied by *Garra gotyla*, *Crossocheilus spp.*, *Labeo dero* and *L. dyocheilus* ctc. and (iii) slow moving meandering zone inhabited by a large number of cold to eurythermal species such as *Barilius* spp., *Tor* spp., cat fishes, (*Homaloptera* spp.) and snakeheads (*Channa* spp.). Assessment of the dominant species nature of the Sonkosh river was revealed that the study sites were hydrographically a slow moving meandering zone.

Conclusion

The Sonkosh river (the western most largest tributary of the Brahmaputra river system) is very important as an overlapping fishery resources of both warm and cold water nature, providing favourable conditions for many endemic fish species of Eastern Himalayan range. The river stretch having the diverse type of habitats contributes the maximum number of diversity (like site-1, Gamarighat). So we recommend for protection and conservation of this particular habitat and fishery resource on priority basis. But, due to lack of previous study information on abundances of the fishes it is not possible to quantify the rate of decline in fish resources of the river**.** The threatened fishes collected from the river are all endemic to the Eastern Himalayan range. The river Sonkosh is very important in the point of its diversity of endemic fish species of Eastern Himalayan range. But the increasing demands of the fishes as food or ornamental is causing sustainable threat to the region, mostly the unconventional and illegal methods of fishing like electro-cutting, poisoning and blasting. The river is in tremendous pressure by increasing number fish catch as well as the fishermen day by day. On the other hand the rapid development sweeping over Bhutan and the planned for mega-hydropower projects to harness 10,000 Megawatts by the year 2020, is expected to have a significant negative impact on riverine biodiversity of Bhutan as well as Indo Bhutan foot hill areas of Assam. The 1200 Megawatts (Sonkosh) Punatsangchu-I and the 1020 Megawatts (Sonkosh) Punatsangchu-II Hydro Electrical Projects are under construction and are scheduled to be commissioned by 2018. The habitat fragmentations by damming in the Sonkosh river, may be a serious consequences in near future. The chance of changing its flow regimes, substrates, depth, sedimentation and any other unknown biophysical and biochemical alteration may leads to more threats to its endemic species. So the present information will serve as comparative hydro-biological assessment in future. It will also help in understanding the threat level and sustainability of threatened fishes. It is suggested to conduct periodical studies for enlisting or delisting of the species based on various conservation management criteria adopted by national and international organizations. The respective conservation authorities may initiate developing species and habitat wise specific strategies for conservation and sustainable utilization of fish genetic resources by new policies for conservation and sustainable development of the threatened species in priority basis.

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REFERENCES

Acharjee, M.L. and Barat, S. 2010. Impact of fishing methods on conservation of ichthyofauna of river Relli in Darjeeling Himalaya of West Bengal. J Env Bio., 31:431-434.

Bandyopadhyay, N. and Mondal, K. 2014. Present Status of Icthyofaunal Diversity of Different Rivers of Duars of North Bengal, India. *JTBSRR*, 3(1), pp.1-8.

Baro, D.C. & Sharma, S. 2014. Ichthyofaunal diversity from Sonkosh river, Assam, India. The Clarion, 3(1):18-24.

Baro, D.C., Sharma, S. and Baishya, R. A. 2014. Status of ornamental fish diversity of Sonkosh river, Bodoland Territorial Council, Assam, India. Sci Vis, 14(1): 28-33.

Baro, D.C., Sharma, S. and Sharma, D. 2015. Coldwater fish diversity and abundance of upper reaches of Sonkosh river, Kokrajhar, Assam. Sci Vis, 15(1): 8-18.

Bhagabati, A. K., Kalita, M. C., Baruah, S. 2006. Biodiversity of Assam: Status strategy and action plan for conservation. EBH Publishers (India).

Das, B. and Sharma, S. 2012. A comparison of fish diversity of Kopili and Jamuna rivers of Karbi Anglong District, Assam. The Science Probe. 1(1): 21-29.

Das, M.K. and Bordoloi, S. 2012. Ichthyofaunal resources of Inland water bodies of the river island Majuli, Assam, India. Asian J. Exp. Biol. Sci. Vol. 3(1): 51-58.

Dey, S. C. 1973. Studies on the distribution and taxonomy of the ichthyofauna of the hill streams of Kamrup Khashi Garo regions of Assam with special references to functional morphology of some rheophilic fishes. D.Sc. Thesis, University of Calcutta.

Goswami, U.C. 2000. Establishment of exotic fishes in natural water bodies of North East India. Fish Biodiversity of North East India edited by A.G. Ponniah and U.K. Sarkar. pp.150-154.

Goswami, U.C. 2005. Constrain analysis in propagation and conservation of fresh water fish germplasm resources of North East India. Nature Conservators, 9: 103-111.

Goswami, U.C.; Vishwanth, W.; Jayaram, K.C. and Datta Munshi, J.S. 2007. Fish fauna of North East India: Natural and Anthropogenic Hazards on Fish and Fisheries. Pp. 21-45. Narendra Publishing House, Delhi.

Gupta, S.K. and Gupta, P.C. 2008. General and Applied Ichthyology (fish and fisheries). S.Chand and Company Ltd. Ramnagar, New Delhi-110 055.

Harper, DAT, (1999). *Numerical Paleobiology*. John Wiley and Sons.

http://www.iucnredlist.org.in

Jayaram, K.C. 1999. The fresh water fishes of the Indian Region. Narendra Publishing House, New Delhi, 1-322.

Jhingran, V.G. and Sehgal, K.L. 1978. Cold water fisheries of India. Inland Fisheries Society of India, Barrackpore, West Bengal, India.

Lakra, W. S., Sarkar, U.K.; Gopalakrishnan, A. and Kathirvelpandian, A. 2010. Threatened fihes of India. NBFGR (ICAR), Lucknow, India.

Menon, A.G.K. 1954. Fish Geography of the Himalayas. *Proceedings of the National Institute of Science*, India. 20: 467-493.

Mohsin, A.B.M., Md, Sk., Haque, M., Muhammad, G.S., Hassan, F.; Chaki, N.; Islam, M. and Rahman, M. 2013. Seasonal Abundance of Fin Fishes in the Padma River at Rajshahi District, Bangladesh. *World Journal of Fish and Marine Sciences* 5 (6): 680-685.

Nath, P. & Dey, S.C. 2000. Fish and Fisheries of North Eastern India, Vol. I: Arunachal Pradesh, 217.

Sehgal, K.L. 1988. *Ecology and fisheries of mountain streams of the north-western Himalayas*. Thesis for the award of D.Sc. degree, University of Meerut, India.

Sreekantha, K.V. and Ramachandra, T.V. 2005. Fish diversity in Linganamakki Reservoir, Sharavathi River. Ecol Environ Conserv. 11:337–348

Talwar, P.K. & Jhingran, A. 1991. Inland fishes of India and adjacent countries. Oxford and IBH Publishing House, Co. Pvt. Ltd., New Delhi 1 and 2: 115-116.

Vishwanath, W. 2000. Fishes of North East India, ICAR Govt. of India, New Delhi.

Vishwanath, W., Lakra, W. S and Sarkar, U. K. 2007. Fishes of North East India, A NBFGR publication, Lucknow, pp. 1-290.

Volcan, M.V., Goncalves, A. C. and Lanes, L. E. K. 2011. Distribution, habitat and conservation status of two threatened annual fishes (Rivulidae) from southern Brazil, ENDANG SPECIES RES. 13: 79–85.

Welcomme, R.L. 1985. River fisheries. FAO Fish Tech Pap. 262:1–318

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