International Journal of Applied and Pure Science and Agriculture
ISSN Online - 2394-5532 Impact Factor: 3.762 by SJIF ISSN Print - 2394-823X

Seasonal variation of aquatic diversity of a lotic ecosystem – A case study of River Churni, West Bengal

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Abstract
Biodiversity of any aquatic body indicates its productivity and its ecological health. Both lotic and lentic aquatic systems of the World are now reported to be threatened by several environmental hazards like pollution, over exploitation etc causing loss to the biodiversity.River Churni is not an exception to this. The river is under the threats of pollution from diffused sources. The total diversity of fish, phytoplankton, zooplankton, macrophytes, emergent are studied during the survey. The studies have revealed that the river is much more affected by pollution in its upstream rather than middle and lower part. Further, it can be concluded that absence of immediate and prompt initiatives can be make the river diversity more vulnerable in near future.
Keywords: Diversity, Fish, Phytoplankton, Zooplankton, Macrophytes, River Churni, Lotic aquatic system.

I. INTRODUCTION

Biodiversity means the diversity of life forms. The term 'biodiversity', a contraction of biological diversity, introduced in the mid-1980s by environmentalists because of the up growing threat of the rapid destruction of natural environments such as tropical rainforests. It has also been demanded in several conventions that society take measures to protect this heritage (Le´veˆque and Mounolou, 2003).Diversity in aquatic system has another great issue of interest because it provides huge resources to human beings. The healthy aquatic ecosystem is dependent on the physico-chemical and biological characteristics (Venkatesharaju*et al*., 2010). Rivers, reservoirs canals, wetlands are the chief sources of inland fisheries in India as well as in the whole World. Panigrahi and Bakshi (2014) have already published that fish and fisheries is asignificant sector of most of the developing and developed countries throughout the World from the stand point of earnings and occupation generation. Thus, changes in the ecological and environmental condition may exert some role on the river diversity as well as on the river-side societies. River with degrading ecological conditions has also shown a sharp decrease in river diversity (Das and Chakrabarty, 2007).

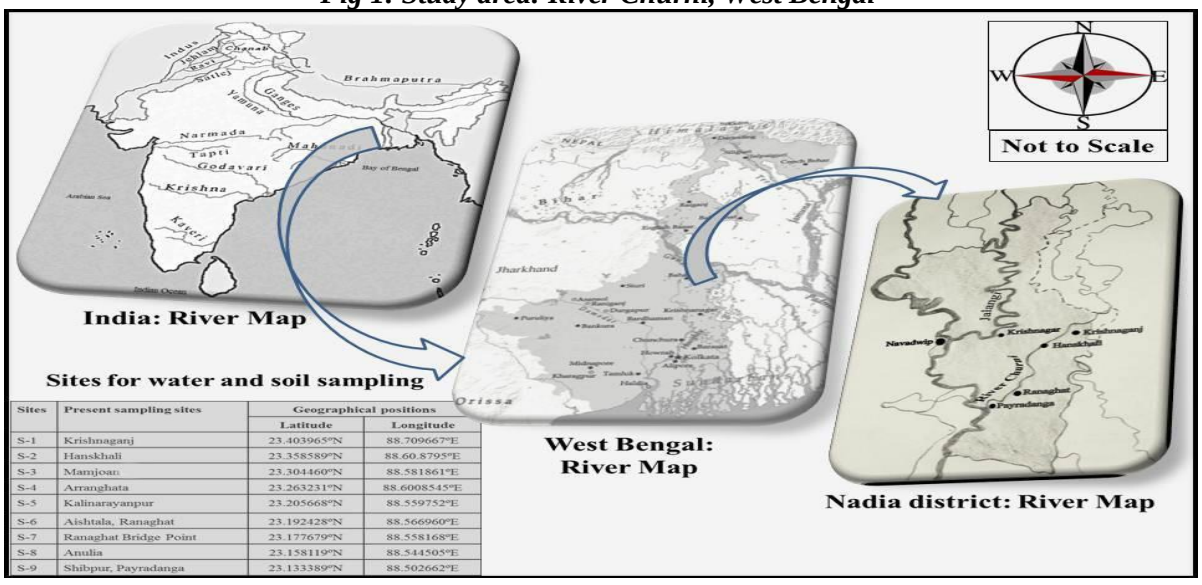
Nadia district, one of the important districts of West Bengal is situated at the eastern bank of the river Bhagirathi- Hooghly. Among several numbers of confluences, River Churni is one of the most important sources of the surface water of the district. The river originates as a distributary of River Mathabhanga near Krishnaganj (23°23'26"N, 88°44'31"E), Nadia and after about 54 km stretch, it joins with Bhagirathi- Hooghly near Payradanga (23°7'40"N 88°30'7"E), Nadia(Fig. 1). The river is further more important as thousands of fishermen from river side areas depend on the productivity of the

river.River Churni is most probably an artificial canal not a true river. According to local people especially those who are associated with fishing, the river had a great biological diversity in the past. It was well known for availability of giant tiger prawn (*Penaeusmonodon*), Hilsa (*Tenualosailisha*), and Pabda (*Ompokpabo*) fish in the past (Ghosh, 2002). Crabs and other aquatic arthropods were very much available along with a variety of fish species. But, this river has been suffering from ecological degradation and biodiversity loss since last two to three decades fundamentally because of anthropogenic disturbances. Owing to this, we have tried to compile the present status of pollution stress and impact on the river biota.The focal identified pollution sources for this river are basically anthropogenic in nature i.e. caused due to human interferences. The river gets the discharges of Sugar cane Mill Complex of Darshana, Bangladesh and Keru Wine Factory, Bangladesh at the upper part of its stretch which is found to be the most fatal reason behind the ecological degradation of the river (Panigrahi*et al*., 2015). Beside this, small scale industries like dyeing factories bucket factories etc., present at both banks, also pour its discharges directly into the river. Digging of soil at river side areas for several brick manufacturing plants is also responsible for changing geomorphological character of the river. Fly ash dumping into the confluence is also evident at some places. Apart from these, two middle populated municipalities i.e., Ranaghat and Birnagar municipality discharge their semi-treated or completely untreated wastes directly into the river stream causing severe changes in chemical character of the river water. About 24000 litres of effluent is poured per day into this river from these sources (Das and Chakrobarty, 2007). The water chemistry of the river is also influenced by agricultural wastes from riverside crop fields, burningghat effluents, dumped solid wastes, jute retting procedure during monsoon and post monsoon period etc (Panigrahi et al., 2015).

II. STUDY AREA

The sampling has been conducted in the 3 study areas (stations) or major catchment sites of the River during January, 2012 to Dec, 2015. The sampling sites have been selected in such a manner that all the three parts viz., up-stream(Mamjoan, Nadia, 88°58´N;23°30´E), mid-stream(Gajantala, Nadia 88°53´N;23°15´E) and lower-stream (Kayet Para, Nadia 88°56´N; 23°19´E) must contain a site.

Fig 1: Study area: River Churni, West Bengal



Sites	Present sampling sites	Geographical positions	
		Latitude	Longitude
S-1	Krishnaganj	23.403965°N	88.709667°E
S-2	Hanskhali	23.358589°N	88.60.8795°E
S-3	Mamjoan	23.304460°N	88.581861°E
S-4	Arranghata	23.263231°N	88.6008545°E
S-5	Kalinarayanpur	23.205668°N	88.559752°E
S-6	Aishtala, Ranaghat	23.192428°N	88.566960°E
S-7	Ranaghat Bridge Point	23.177679°N	88.558168°E
S-8	Anulia	23.158119°N	88.544505°E
S-9	Shibpur, Payradanga	23.133389°N	88.502662°E

III. MATERIALS AND METHOD

Names of the presently available fish species as well as eliminated fishes of the river have also been recorded from the resource persons of various sites like fishermen and fish market vendors. Visit to the main catchment areas and different fish markets of riverside areas at regular interval have also been undertaken during the survey. The total data of fish diversity of the river has been constructed after compiling all the available results.

A qualitative plankton study has been done to estimate the seasonal (Pre-monsoon, Monsoon, Post-monsoon) availability of different phytoplankton and zooplankton. Water samples have been collected on monthly basis by the use of plankton net. 20 litre of water has been concentrated to 20ml of sample and then observed under compound microscope (Magnüs MLX-B Sr.76515) for identification. Only generic identification of the plankton has been done.

Macrobenthic invertebrates have also been collected seasonally and identified. All the specimens have been classified under the following groups: Bivalve, gastropod, diptera, hemiptera, coleoptera and oligocheata (according to Das *et. al*., 2007).

IV. RESULTS AND DISCUSSION

Ecological degradation of any river leads to loss of its diversity. Sharp decrease in ichthyofaunal diversity is found to be a sign to disturbances in aquatic ecosystem both lotic and lentic. The fish diversity of any aquatic system is very much related to the diversity of the fish food organisms like phytoplanktons, zooplanktons etc. Several authors have advocated earlier that River Churni has been cited as a river with ecological degradation.According to Ghosh and Konar (1991), the river has been facing some problem of loss of fish species and ecological degradation over past 15-20 years. According to Das and Chakrabarty (2007), 63.6% of fish species appeared to have been eliminated from the polluted Churni River since 1983 in 20 years. The authors have informed about the presence of 44 species of fishes in both River Churni and River Jalangi in 1983. In 2007, the available amount of fish species has been found 16 in River Churni (Das and Chakrabarty , 2007). Though, Bakta and Bandyopadhyay (2007) has contradictorily reported that River Churni comprises 48 fish species under 29 genera, 18 families and 8 orders including 8 species of exotic fish under 3 orders, 4 families and 6 genera. But detailed descriptions of available fish species have not been given by the authors. A long stretch of the lower part of River Ganga resides as the western boundary of this district. Ghosh (2008) has reported that River Ganga comprises about 156 fish species in its lower stretch. According to Bakta and Bandyopadhyay (2007), eight numbers of exotic or alien species viz., *Oreochromismossambicus, O. niloticus, Hypophthalmicthysmolitrix, H. nobilis, Cyprinuscarpio, Ctenopharyngodonidella, Clariasgariepinus, Pangasiussutchi,* have beenreported during an extensive survey. According to Das andChakrabarty (2007), 28 number of fish species *viz.*, *Labeobata,Puntiussophore,Amblypahyngodonmola, Mystusaor etc.* havebeen reported to be eliminated. An extensive study has been carriedout by Bakshi and Panigrahi (2015) to find the exact scenarioof river Churni, which reflects the presence of maximum of 38fish species in the lower part of the river. Current study has been done in more extensive manner and also has been treated as continued part of the previous studies. But no further increase in the number of available fish has been foundto be observed (Table 1).

Table. 1: Average seasonal and spatial availability of different fishes throughout the river during four annual years (Jan, 2012- Dec, 2015)

Sl. No.	Scientific name	Native /Exotic	Red list Status	Up-Stream			Mid-Stream			Down-stream		
				PrM	M	PoM	PrM	M	PoM	PrM	M	PoM
1.	*Catlacatla*	Native	LC	0	+	0	+	+	0	+	+	0

2.	*Labeorohita*	Native	LC	0	+	0	+	+	0	+	+	+
3.	*Labeobata*	Native	LC	0	0	0	0	0	0	+	+	0
4.	*Labeocalbasu*	Native	LC	0	0	0	0	+	0	+	+	+
5.	*Cirrhinusmrigala*	Native	LC	0	0	0	0	+	0	+	+	+
6.	*Amblypharyngodonmola*	Native	LC	0	+	0	+	+	0	+	+	0
7.	*Puntiussaranasarana*	Native	LC	0	0	0	0	+	0	0	+	0
8.	*Puntiusticto*	Native	LC	0	0	0	+	+	+	0	+	+
9.	*Chelalaubuca*	Native	LC	0	0	0	+	+	+	0	+	+
10.	*Securiculagora*	Native	LC	0	+	0	+	+	+	+	+	+
11	*Cyprinuscarpio*	Exotic	Vu	0	0	+	+	+	+	+	+	+
12.	*Hypophthalmichthysmolitrix*	Exotic	LC	+	+	+	+	+	+	+	+	+
13.	*Aristichthysnobilis*	Exotic	LC	0	+	0	0	+	0	+	+	+
14.	*Ctenopharyngodonidella*	Exotic	LC	+	+	+	+	+	+	+	+	+
15.	*Sperataaor*	Native	LC	+	+	+	0	+	0	+	+	0
16.	*Sperataseenghala*	Native	NT	0	0	0	0	+	0	+	+	0
17.	*Rita rita*	Native	LC	+	+	+	+	+	+	+	+	+
18.	*Wallagoattu*	Native	NT	0	0	0	0	+	0	0	+	0
19.	*Ailiacoila*	Native	LC	0	0	0	0	+	0	0	+	+
20.	*Siloniasilondia*	Native	LC	0	0	0	0	+	0	+	+	+
21.	*Eutropiichthysvacha*	Native	LC	0	+	+	0	+	0	0	+	+
22.	*Clariasbatrachus*	Native	LC	+	+	+	+	+	+	+	+	+
23.	*Heteropneustesfossilis*	Native	LC	+	+	+	+	+	+	+	+	+
24.	*Awaousgrammepomus*	Native	LC	0	0	0	+	+	0	0	+	0
25.	*Anabas testudineus*	Native	DD	+	+	+	+	+	+	+	+	+
26.	*Colisafasciata*	Native	LC	+	+	+	+	+	+	+	+	+
27.	*Channapunctatus*	Native	LC	0	+	+	+	+	+	+	+	+
28.	*Channastriata*	Native	LC	+	+	+	+	+	+	+	+	+
29.	*Channagachua*	Native	LC	+	+	+	0	0	+	+	+	+
30.	*Oreochromismossambicus*	Exotic	LC	+	+	+	+	+	+	+	+	+
31.	*Oreochromisniloticus*	Exotic	NE	+	+	+	+	+	+	+	+	+
32.	*Nandusnandus*	Native	LC	+	+	0	+	+	0	+	+	0
33.	*Macrognathuspancalus*	Native	LC	+	+	+	+	+	+	+	+	+
34.	*Monopteruscuchia*	Native	LC	+	+	+	+	+	+	+	+	+
35.	*Nematalosanasus*	Native	LC	0	0	0	0	+	+	+	+	+
36.	*Setipinnaphasa*	Native	LC	0	0	0	0	0	+	+	+	+
37.	*Xenentodoncancila*	Native	LC	0	0	0	0	0	+	+	+	0
38.	*Notopterusnotopterus*	Native	LC	0	0	0	0	0	0	0	+	0
Total* Here 0 means "not available" and + means "available"				15	22	17	22	33	21	30	38	27

*** LC- Least Concern , Vu-Vulnerable, NT-Not Threatened, DD- Data Deficient, NE- Not Evaluated.*

Fish fauna study has explored the fact that upper part or upstream of the river is highly affected by the pollution as only 15 species have been found in Pre Monsoon seasons and only 17 in post monsoon time. 22 number of fish species have been evident in the upstream during the monsoon period (Table 1). The probable reason behind this situation may be the over flow of the water from river side beels or other water bodies. Mid-Stream of the river has found to possess 22, 33 and 21 species in the Pre monsoon, monsoon and post monsoon time respectively. Presence of 6 exotic species has been listed

during the study. The total available 38 genera of fishes can be grouped into 7 orders and 17 families. Presence of six number exotic species is an indicator of ecological degradation. A total of 23 species have been found in Up-stream, 36 in Mid-stream and 38 in Down-stream in all seasons. Among 38 numbers of total available fish species, 9 species have been found to be carnivore whereas; planktivore (13 species), benthic eater (5 species) and omnivorous (11 species) have also been found. Presence of 23.68% of carnivore species depicts about river's degrading situation.

Trophic level study and habitat orientation study have been done earlier to measure the ecological condition of different part of the river by Bakshi and Panigrahi (2015). Trophic level score has revealed that omnivore fishes (34.78%) are predominant in upper stretch of the river and are followed by carnivore (30.43%), planktivore (26.08%) and benthic feeder (8.69%). In mid-stream, the trophic level score is found to be oriented in the following manner i.e., PL (33.33%)> OM (30.55%) > CA (22.22) > BE (8.69%)(Bakshi and Panigrahi, 2015). Study of average trophic level score confirms that it is higher in the up-sream than mid and lower stream of the river.According to Rapport (1998), this situation states that up-stream is much more affected by pollution than the other parts. According to Rapport (1995), trophic level study is an important way to evaluate the level of degradation of any ecosystem. They confirmed that omnivore fishes are abundant in disturbed ecosystem as the fishes can consume a wide variety of food sources in changing environment. On the contrary, other trophic levels, in order of sensitivity to degradation, beginning with the least sensitiveplanktivores followed bypelagic insectivores, benthic insectivores (e.g., benthic feeders)general insectivores or piscivores and finally carnivores at the topmost part of the trophic structure (Karr and Dudley, 1981).Habitat orientation score has also been measured for each part of the river. But according to Das and Chakrabarty (2007), the habitat orientation score cannot be used as a useful indicator of ecosystem stress as Wichert and Rapport (1998) also established a similar finding in case of lotic system. The study reveals that most of the fishes in all the three parts of the river are pelagic in nature. Second position is occupied by the generalists or column feeder fishes. Benthic dwellers are least in number in all the three parts. Moderately high diversity of fish species in the downstream of the river represents a variety of appropriate habitat and food types to sustenance many different species, which reflects the similar finding with a report by Washington (1984).

According to Bakta and Bandyopadhyay (2007), major phytoplankton groups of river Churni are classified into the genera *Pleodorina, Eudorino, Volvox, Nostoc, Oocystis, Pediastrum, Dactylococcopsis, Coelastrum, Zygenma, Spirogyra, Ulothrix, Scenedesmus, Stigeoclorium, Cladophora, Anabaena, Wollea, Nitella, Mougeotia, Microcystis, Lynabya, Aphanothece, Syechococcus, Merismopedia, Oscillatoria, Oedogonium, Schizothrix, Symploca, Microcoleus, Gloeotila, Aradaera, Scytorema, Oscillatoria, Raphidiopsis, Spirulina, Chlorella, Eudoria*and *Gloeotrichia.*

According to Bakta and Bandyopadhyay (2007), zooplankton genera of this river are *Heliodiaptomus, Neodiaptomus, Diaptomus, Cyclops, Mesocyclops, Macrocyclops, Microcyclops, Cypris, Stenocypris, Cyclestheria, Macrochaetus, Rotaria, Pleuretra, Anuraeossia, Embata, Brachionus, Keratella, Euchlanis, Dipleuchlanis, Triplechilanis, Platyias, Mytilina, Diplois, Epiphane, Monostyla*, and *Chironomids.*But qualitative study during the survey does not reflect the same result as many of these planktons are not found even after extensive study.Extensive study shows that the river 15 genera of phytoplankton and 25 genera of zooplankton are mostly available in the total river stretch. Available phytoplankton (Table 2) and zooplankton (Table 3) are represented according to its seasonal presence in the following tables.

Table 2: Seasonal availability of different Phytoplankton species throughout the river during four annual years (Jan, 2012-Dec, 2015).

Phytoplankton	Availability		
	Pre Monsoon	Monsoon	Post Monsoon
Eudorina sp.	+	+	0
Pleodorina sp.	+	+	0
Volvox sp.	+	+	+
Nostoc sp.	+	+	+
Oocystis sp.	0	+	+
Zygnema sp.	+	+	+
Spirogyra sp.	+	+	+
Ulothrix sp.	+	+	+
Scendesmus sp.	+	+	+
Cladophora sp.	+	+	+
Anabaena sp.	+	+	+
Nitella sp.	0	0	+
Mougeotia sp.	0	0	+
Microcystis sp.	0	0	+
Oscillatoria sp.	+	+	0
Oedogonium sp.	0	+	0
Gleotia sp.	0	0	+
Spirullina sp.	0	+	0
Chlorella sp.	+	+	0
Total number of genera	**12**	**15**	**13**

Table 3: Seasonal availablity of different Zooplankton species throughout the river durin four annual years (Jan, 2012-Dec, 2015).

Zooplankton	Availability		
	Pre Monsoon	Monsoon	Post Monsoon
Brachionus sp.	+	+	+
Asplanchna sp.	+	+	+
Keratella sp.	0	+	+
Lecane sp.	+	+	0
Fillinia sp.	+	+	0
Polyarthra sp.	+	+	+
Alona sp.	+	+	0
Alonella sp.	0	+	+
Daphnia sp	+	+	+
Moina sp.	+	+	+
Cyclops sp.	+	+	+
Mesocyclops sp.	+	+	+
Paracyclops sp.	0	+	+
Microcyclops sp.	0	+	+
Macrocyclops sp.	+	+	0
Heliodiaptomus sp.	0	+	+

Neodiaptomus sp.	0	+	0
Diaptomus sp.	0	0	+
Cypris sp.	+	+	+
Stenocypris sp.	+	+	+
Euchlanis sp.	+	+	0
Triplechanis sp.	0	+	0
Rotaria sp.	0	0	+
Diplois sp.	0	+	+
Monostylasp	+	0	0
Macrochaetus sp.	+	+	0
Monostyla sp.	0	+	0
Chironomid larvae	+	+	+
Total number of genera	**17**	**25**	**18**

Presence of different macrophytes has been found to be evident during the survey. Invasion of *Eicchorniacrassipes* has been found to be another threat to the ecosystem (Table 4). Presence of adequate *Chara sp.* (rooted submerged plant) and Chironomid larvae may be described as indicator of aquatic pollution. Among benthic macro invertebrates, gastropods have been found to be predominant mostly in the lower stretch of the river. Total availability of fish food organisms have also been found to be very poor in content which describe the degrading condition of the river food chain.

Seasonalavailabilityof different macrophytic species throughout the river during three annual years (Jan, 2012- Dec, 2014).

Macrophytes	**Availability**		
	Pre Monsoon	**Monsoon**	**Post Monsoon**
a. Free floating			
Pistia sp.	+	+	+
Lemna sp.	+	+	+
Spirodella sp.	+	+	0
Trapa sp.	+	+	+
Azolla sp.	0	+	+
Eicchorniacrassipes	+	+	+
Total number of genera	**5**	**6**	**5**
b. Rooted Submerged			
Hydrillasp	+	+	+
Chara sp.	+	+	+
Vallisneria sp.	+	+	+
Total number of genera	**3**	**3**	**3**
c. Emergent			
Typha sp.	+	+	+

Scirpus sp.	0	+	1
Ipomia sp.	+	+	0
Total number of genera	**2**	**3**	**2**

+ means available, 0 means not available.

The complete study has revealed that upstream of the total stretch is much more affected by the pollution than the lower part. A very low but effective tidal current has been found to play the key role behind this.

V. ACKNOWLEDGEMENT

We are very much thankful to the fishers of riverside areas who extend their unconditional support throughout the survey period. We again wantto acknowledge DST-PURSE, New Delhi for their financial support during the survey. We further wish to thank to Dr. S. Paul for his kind cooperation during the identification of phytoplankton and zooplankton.

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