ISSN : 0974 - 7427 Volume 7 Issue 4

BioCHEMISTRY
An Indian Journal

Regular Paper

BCAIJ, 7(4), 2013 [131-136]

Comparative assessment of icthyofauna of River Yamuna and River Asan and the impact of heavy metals on fish density and diversity

Fouzia Ishaq[1], Amir Khan[2]*

[1]Limnological Research Lab. Deptt. of Zoology and Environmental Science, Gurukula Kangri University, Haridwar, UK, (INDIA)

[2]Department of Biotechnology & Biochemistry, Division of Life Science, Sardar Bhagwan Singh Post Graduate Institute of Biomedical Sciences & Research, Balawala, 248161, Dehradun, UK, (INDIA)

E-mail : amiramu@gmail.com

ABSTRACT

In the present investigation a comparative study was made on the fish fauna of River Yamuna and River Asan in Dehradun district of Uttarakhand India with the aim to know the status of fisheries in these two rivers and also found the impact of heavy metals on the fish diversity. From our results it was found that the Icthyofaunal diversity of River Yamuna was quite satisfactory and the effect of heavy metals was not observed on the fish density and diversity. However the River Asan was very much polluted due to domestic and industrial effluents and the impact was quite evident from the results. A total of 28 taxa of fishes were reported from River Yamuna and only 19 taxa were reported from River Asan. The concentration of heavy metals was low in River Yamuna as compared to River Asan. Zinc and Iron was also recorded in higher concentration than other heavy metals. Therefore it is very important to establish a proper management for the preservation of fish fauna of River Asan as well as River Yamuna in order to maintain the ecosystem balance and eco-limnological conditions.

KEYWORDS

Eco-limnological;
Heavy metals;
Icthyofauna;
River Asan;
River Yamuna.

INTRODUCTION

Fish have been regarded as an effective biological indicator of environmental quality and anthropogenic stress in aquatic ecosystems. However many ecological disturbances in aquatic ecosystems linked to anthropogenic pressures resulted in loss of biodiversity and decline in fisheries have been well documented. The loss may be also attributed to discharge of industrial effluents contaminated with trace and toxic heavy metals. These are serious pollutants of aquatic environment because of their environmental persistence and ability to be accumulated by aquatic organisms. The trace heavy metal concentrations may lead to toxic effects or biomagnification in the aquatic environment which may impose serious threat to aquatic species as well as humans[11]. The damage to aquatic ecosystem owing to heavy metals is mainly a function of bio-available metal fraction rather than the total amount of metal present in waters or in sediments and a small amount of it could be lethal[8].

MATERIAL AND METHODS

The present study was carried on River Yamuna and River Asan in Doon Valley (Dehradun district) Uttarakhand India. Three sites namely S1 (Kalsi), S2 (Dakpathar), S3 (Asan lake) were selected on River Yamuna and three sites were selected on River Asan which include S4 (Chanderbani), S5 (Asarori) and S9 (Confluence Point between River Yamuna and River Asan). The sampling program was planned taking into account the objectives of the study and the parameters to be analyzed. Efforts were made to centralize the aim of sampling to achieve the representativeness and validity of the samples. The study was conducted on monthly basis for a period of one year from August 2011 to July 2012. Grab water samples for trace heavy metal analysis were collected in high quality brown glass bottles below the surface at a depth of (1-2cm) in the middle of river stream across the river depth at all the selected sites (S1-S6). The trace heavy metals were analyzed in the laboratory by Atomic Absorption Spectrophotometer (AAS 4129 model) following the standard methodology of[1]. The fishes were collected from the selected sites with the fishing nets with the help of local fishermen every month and preserved in 70% formal dehyde in clean sterilized pre-labeled containers. The identification was done by following the keys like Edmondson[4]; Needham and Needham[9]; Tonapi[16], Talwar and Jhingran[15] and Jayaram[7].

RESULTS AND DISCUSSION

Freshwater fish are one of the most threatened taxonomic groups because of their high sensitivity to the quantitative and qualitative alteration of aquatic habits. As a consequence, they are often used as bioindicator for the assessment of water quality, river network connectivity or flow regime[14]. In the present investigation a total of 28 taxa were reported from River Yamuna from station 3 and 25 taxa from station 1 and 2 each. In River Asan only 11 taxa of fishes was reported from site 4, 8 taxa from site 5 and 19 taxa from site 6 (TABLE 1). The taxa were belonging to six families, which include Family Cyprinidae, Family Chandadae, Family Belonidae, Family Cobitididae, Family Mastacembellidae, and Family Sisoridae and four orders. The taxa collected from River Yamuna and Asan include *Barilius bendelisis* (Hamilton-Buchanan), *Barilius vagra* (Hamilton-Buchanan), *Catla catla* (Hamilton), *Cirrhinus mrigala* (Hamilton–Buchanan), *Rasbora daniconius* (Hamilton-Buchanan), *Danio rerio* (Hamilton-Buchanan), *Danio devario* (Hamilton-Buchanan), *Garra gotyla gotyla* (Gray), *Puntius ticto* (Hamilton-Buchanan), *Puntius sarana sarana* (Hamilton-Buchanan), *Laboe gonius* (Hamilton-Buchanan), *Labeo boga* (Hamilton-Buchanan), *Labeo calbusa* (Hamilton-Buchanan), *Tor putitora* (Hamilton-Buchanan), *Tor tor* (Hamilton-Buchanan), *Channa gauchua* (Bloch and Schneider), *Channa puntatus* (Bloch), *Raimas bola* (Hamilton-Buchanan), *Schizothorax plagiostomus* (Heckel), *Schizothorax progastus* (Heckel), *Xenentodon cancila* (Hamilton-Buchanan), *Botia dario* (Hamilton-Buchanan), *Nemachelius savona* (Hamilton-Buchanan), *Nemachelius botia* (Hamilton-Buchanan), *Crossoocheilus latius latius* (Hamilton-Buchanan), *Mastacembelus armatus* (Lacepede), *Bagarius bagarius* (Hamilton-Buchanan) and *Glyptothorax pectinoptrus* (McClelland) (TABLE 1). In River Asan the taxa that were not reported during the study period was *Rasbora daniconius* (Hamilton-Buchanan), *Tor putitora* (Hamilton-Buchanan), *Tor tor* (Hamilton-Buchanan). The absence of these three taxa from River Asan may be attributed to environmental factors as well as the pollution of river due to heavy metal contamination and other anthropogenic activities. The fishes were mostly absent from site 4 and 5 which indication the poor water quality of River Asan. During the course of study Icthyo fauna was diverse in River Yamuna and low or rarely present in River Asan. The present study also revealed that the trace heavy metals as well as other limnological conditions play key role in the distribution of fishes in River Yamuna and the habitat alteration and fragmentation of River Asan brought significantly the endangerment of freshwater fish fauna. Our study depicted presence of 28 genera of the fish diversity recorded in River Yamuna more than a recent report from tributaries of River Ganga[13]. Diversity and richness both were lowered in the lower area in this study like River Asan compared with the upper area like River Yamuna.

Low diversity of fishes was recorded at S4 and S5 in River Asan and the reason of low richness at these sites might be due to effect of discharge of pollutants, sewage, domestic effluents, sedimentation rate, industrial waste water discharge, illegal exploitation of fishes, and exotic species. According to Bunn and Arthington[2] many types of river ecosystem have been lost and populations of many riverine species have become highly fragmented due to human intervention. There are a multitude of factors, which are responsible for the unique distribution and the varying abundances of fishes in the River Yamuna and its tributaries. The anthropogenic activities were dominant in River Asan and have resulted in the decline of the fishes. In the present investigation Cyprinids were the most dominant group which was represented by fifteen genera. Nelson[10] reported the greatest freshwater diversity in the form of Cyprinids in freshwater habitats.

In the present study a total of six heavy metals were reported from River Yamuna and Asan which include Cobalt, Cadmium, Zinc, Chromium, Nickel and Iron (TABLE 2). In River Yamuna the concentration of Cobalt ranged from 0.0043±0.0007 mg/l to 0.0055±0.0006 mg/l whereas in River Asan it varied from 0.0058±0.0012 mg/l to 0.0632±0.0049 mg/l (TABLE 2). The cadmium was recorded highest with the value of 0.0084±0.0005 mg/l and the minimum of 0.0040±0.0008 mg/l in River Yamuna. In River Asan Cd was reported with the highest of 0.0565±0.0069 mg/l and the minimum of 0.0065±0.0013 mg/l. In River Yamuna the concentration of Zinc ranged from 0.0523±0.0087 mg/l to 0.0562±0.0059 mg/l (TABLE 2) and in River Asan it ranged from the highest of 0.7840±0.0788 mg/l to the lowest of 0.0603±0.0087 mg/l. The concentration of Chromium in River Yamuna varied from 0.0064±0.0008 mg/l to 0.0049±0.0008

TABLE 1 : Diversity status of icthyo – fauna of River Yamuna and River Asan from August 2011- July 2012

Icthyo-Fauna	River Yamuna			River Asan		
	S1	S2	S3	S4	S5	S6
Order Cypriniformes						
Family Cyprinidae						
Barilius bendelisis (Hamilton-Buchanan)	+	+	++	-	+	+
Barilius vagra (Hamilton-Buchanan)	+++	++	+	+	+	++
Catla catla (Hamilton)	-	-	++	+	-	-
Cirrhinus mrigala (Hamilton–Buchanan)	-	-	+++	+	-	++
Rasbora daniconius (Hamilton-Buchanan)	+	+	++	-	-	-
Danio rerio (Hamilton-Buchanan)	+	++	++	+	-	-
Danio devario (Hamilton-Buchanan)	+++	++	+++	-	+	+
Garra gotyla gotyla (Gray)	++	+++	++	-	+	++
Puntius ticto (Hamilton-Buchanan)	+++	++	+++	-	-	+
Puntius sarana sarana (Hamilton-Buchanan)	++	+++	+++	+	+	++
Labeo gonius (Hamilton-Buchanan)	++	++	+++	-	-	+
Labeo boga (Hamilton-Buchanan)	++	+++	++	-	-	+
Labeo calbusa (Hamilton-Buchanan)	-	-	+	-	-	+
Tor putitora (Hamilton-Buchanan)	+	++	++	-	-	-
Tor tor (Hamilton-Buchanan)	++	+	+	-	-	-
Family Chandadae						
Channa gauchua (Bloch and Schneider)	++	++	+	+	-	-
Channa puntatus (Bloch)	++	++	++	-	+	+
Sub Family Schizothoracinae						
Raimas bola (Hamilton-Buchanan)	++	++	+++	+	-	-
Schizothorax plagiostomus (Heckel)	+	+	++	-	-	+
Schizothorax progastus (Heckel)	+	+	++	+	+	+

Icthyo-Fauna	River Yamuna			River Asan		
	S1	S2	S3	S4	S5	S6
Order Beloniformes						
Family Belonidae						
Xenentodon cancila (Hamilton-Buchanan)	+	++	++	-	-	+
Family Cobitididae						
Botia dario (Hamilton-Buchanan)	++	+++	++	-	+	-
Nemachelius savona (Hamilton-Buchanan)	++	++	+++	+	-	+
Nemachelius botia (Hamilton-Buchanan)	++	++	++	-	-	-
Crossoocheilus latius latius (Hamilton-Buchanan)	+	+	++	+	-	+
Order Mastacembeliformes						
Family Mastacembellidae						
Mastacembelus armatus (Lacepede)	+	+	++	-	-	+
Order Siluriformes						
Family Sisoridae						
Bagarius bagarius (Hamilton-Buchanan)	++	++	+++	+	-	+
Glyptothorax pectinoptrus (McClelland)	+	+	++	-	-	+
Total number of taxa reported= 28	25	25	28	11	8	19

Abundant: (+++); Present (++); Rare (+); Nil: (-)

mg/l and 0.0621±0.0040 mg/l to 0.0070±0.0011 mg/l in River Asan. In River Yamuna and River Asan the Nickel was recorded with the highest of 0.0069±0.0008 mg/l and 0.0617±0.0075 mg/l and the lowest of 0.0041±0.0007 mg/l and 0.0047±0.0011 mg/l (TABLE 2) respectively. In River Yamuna the concentration of Iron ranged from 0.0701±0.0085 mg/l to 0.0570±0.0068 mg/l whereas in River Asan the concentration of Iron ranged from 0.8050±0.0826 mg/l to 0.0594±0.0093 mg/l. From these results it was found that the concentration of all heavy metals was recorded maximum in River Asan as compared to River Yamuna. The concentration of Zinc and Iron was also maximum than other heavy metals but the overall results showed that the water of River Asan was contaminated with heavy metals much greatly than River Yamuna. The average variation of the heavy metals (Co, Cd, Zn, Cr, Ni and Fe) of River Yamuna and Asan River and data collected on these trace heavy metals analyzed during the study are shown in TABLE 2. The measured concentration of metal levels showed considerable difference associated with the season and month. Zinc and Iron concentration was recorded highest during the study period. Higher values for these metals may be because of the precipitation and discharges of surface water into the rivers. As regards the effect of season on heavy metal concentration in the water of all the rivers, concentrations of metals like Co, Cd, Cr, Zn, Fe, and Ni were maximum during summer, while minimum concentrations were observed during winter season. This trend could be attributed to the evaporation of water during summer and subsequent dilution due to precipitation and run-off from the catchment area during rainy season. The Co, Cd, Cr and Ni were found in possible lesser amounts and had not any great effect on the water quality. The concentration of metals was relatively low in River Yamuna as compared to River Asan. The maximum concentration of metals at S4 and S5 may be attributed to various anthropogenic activities and industrial effluents. There was not any significant temporal variation of all studied heavy metals at all sites but monthly and seasonal variation was significant throughout the study period. However, concentration varied spatially with higher concentration at site S4 and S5. River bodies of Uttarakhand were found to have almost similar concentration of metals as observed by Dixit, *et al*.[3] in water bodies of Delhi and Gaur, *et al*.[5] in River Gomti. Highest value of metals was detected in Asan River and this river is supposed to carry effluent load of the industries situated in the Dehradun district. The concentrations of heavy metals undergo seasonal changes and the values were generally higher

TABLE 2 : Average annual variation of trace heavy metals in River Yamuna and River Asan from August 2011-July 2012

Parameters	River Yamuna			River Asan		
	S1	S2	S3	S4	S5	S6
Cobalt (mg/l)	0.0043±0.0007	0.0055±0.0006	0.0055±0.0006	0.0621±0.0057	0.0632±0.0049	0.0058±0.0012
Cadmium (mg/l)	0.0040±0.0008	0.0084±0.0005	0.0054±0.0006	0.0565±0.0069	0.0529±0.0072	0.0065±0.0013
Zinc (mg/l)	0.0523±0.0087	0.0559±0.0051	0.0562±0.0059	0.6740±0.0412	0.7840±0.0788	0.0603±0.0087
Chromium (mg/l)	0.0049±0.0008	0.0064±0.0008	0.0062±0.0008	0.0621±0.0040	0.0552±0.0108	0.0070±0.0011
Nickel (mg/l)	0.0045±0.0007	0.0041±0.0007	0.0069±0.0008	0.0581±0.0074	0.0617±0.0075	0.0047±0.0011
Iron(mg/l)	0.0701±0.0085	0.0578±0.0048	0.0570±0.0068	0.7383±0.0654	0.8050±0.0826	0.0594±0.0093

±: Standard Deviation

during summer. The problem of heavy metal contamination was not serious in the water of the River Yamuna but in River Asan the conditions were severe and water quality was poor. The highest amount of Zn and Iron was also reported by Jain *et al*.[6] for Hindon River and Sarkar *et al*.[12] for the Ganges.

The one-way ANOVA between sites were significant ($p < 0.05$) between groups and within groups for all the above-mentioned heavy metals in River Yamuna and River Asan (TABLE 3 and 4).

TABLE 3 : Analysis of variance (ANOVA) for trace heavy metals in River Yamuna

ANOVA						
Source of Variation	SS	Df	MS	F	P-value	F crit
Between Groups	7.34	2	3.67	0.000487	0.999513*	3.68232
Within Groups	0.011	15	0.00075			
Total	0.011	17				

*Significant at 0.05

TABLE 4 : Analysis of variance (ANOVA) for trace heavy metals in River Asan

ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	0.284342	2	0.142171	1.658028	0.223586*	3.68232
Within Groups	1.286205	15	0.085747			
Total	1.570547	17				

*Significant at 0.05

CONCLUSION

The present study gives a clear indication on the criteria of water quality, fish diversity and pollution status of River Asan. The low fish diversity and density in River Asan showed the impact of anthropogenic activities. A number of industries and factories in Uttarakhand discharge their effluents contaminated with heavy metals into River Asan and this may be the serious threat for the endangerment of fishes from this river. There could be other environmental and ecological factors responsible for the decline of fishes from River Asan but the main point is that the continuous monitoring is essential and need of River Asan in order to examine its water quality and suggest energy recovery methods. It is also very important to preserve the fish species that are present in the River Asan for the maintenance of ecosystem balance for the sustainable future. Though the fish diversity was profoundly present in the River Yamuna but there is great need of conservation strategies as far as the status of fish fauna is concerned.

ACKNOWLEDGEMENT

The authors are highly thankful to Department of Science and Technology, Ministry of Science and Technology New Delhi for providing financial support in the form of major research project under Women Scientist Scheme (WOS-A).

REFERENCES

[1] APHA, AWWA, WPCF; Standard methods for the examination of water and waste water, 20th Edition, D.C.Washington, New York, **(1998)**.

[2] S.E.Bunn, A.H.Arthington; Basic principles and ecological consequences of altered flow regimes for aquatic biodiversity. Environ.Manag., **30**, 492–507 **(2002)**.

[3] R.C.Dixit, S.R.Verma, V.Nitnaware, N.P.Thacker; Heavy metals contamination in surface and groundwater supply of an Urban city, Delhi. Indian Journal of Environmental Health, **45(2)**, 107–112

(2003).

[4] W.T.Edmondson; Freshwater biology. Second Edition, John Wiley & Sons.Inc., New York, 1248 **(1992)**.

[5] V.K.Gaur, S.K.Gupta, S.D.Pandey, K.Gopal, V.Misra; Distribution of heavy metals in sediment and water of river Gomti. Environ.Monit.Assess., **102**, 1–3 **(2005)**.

[6] C.K.Jain, D.C.Singhal, M.K.Sharma; Survey and characterization of waste effluents polluting river Hindon, Indian J.of Envtl.Prtcn., **22(7)**, 792-799 **(2002)**.

[7] K.C.Jayaram; The freshwater fishes of the Indian Region. Narendra Publishing House, Delhi, 551 **(1999)**.

[8] D.R.Khanna, Fouzia Ishaq; Analysis of Heavy Metals and their interrelationship with some water quality parameters of River Yamuna in Dehradun Uttarakhand. Biochem.Cell.Arch., **12(2)**, 273-280 **(2012)**.

[9] J.G.Needham, P.R.Needham; A guide to the study of freshwater biology, 5th Edition, Holden Inc., San Francisco, USA, **(1962)**.

[10] J.S.Nelson; Fishes of the World, 3rd Edition. John Wiley & Sons, New York, **(1994)**.

[11] C.P.Priju, A.C.Narayana; Heavy and trace metals in Vembanad Lake sediments Int.J.Environ.Res., **1**, 280-289 **(2007)**.

[12] U.K.Sarkar, A.K.Pathak, W.S.Lakra; Conservation of freshwater fish resources of India: new approaches, assessment and challenges. Biodivers Conserv, **17**, 2495–2511 **(2008)**.

[13] U.K.Sarkar, M.B.Bain; Priority habitats for the conservation of large River fishes in the Ganges River basin. Aquat.Conserv.Mar.Freshw., **17**, 349–359 **(2007)**.

[14] A.Shahnawaz, M.Venkateshwarlu, D.S.Somashekar, K.Santosh; Fish diversity with relation to water quality of Bhadra River of Western Ghats (India). Environ Monit Assess, **161**, 83–91 **(2010)**.

[15] P.K.Talwar, A.Jhingran; Inland *fishes of India and adjacent countries*, 2 volumes. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 19 ?, 1158 **(1991)**.

[16] G.T.Tonapi; Freshwater animals of India–An Ecological approach. Oxford and IBH Publishing Co. New Delhi, **(1980)**.