INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 15, No. 1, p. 439-447, 2019

RESEARCH PAPER OPEN ACCESS

Effect of some basic physicochemical parameters of water on diversity of ichthyofauna in Jinnah Barrage, Mianwali district Punjab, Pakistan

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Key words: Jinnah barrage, Physicochemical parameters, Oligotrophic condition, Fish fauna, Diversity.

http://dx.doi.org/10.12692/ijb/15.1.439-447 Article published on July 18, 2019

Abstract

In this context, a study was conducted to evaluate how the physicochemical parameters of water affect the diversity of fish fauna in Jinnah Barrage. A sampling data were collected of six months from July to December 2017 on every weekend survey to the barrage. The standard method of AOAC [1] was used for the determination of different water parameters including (temperature, dissolved oxygen, pH, turbidity, ammonia, nitrites and nitrates). The result was compared to the standard values, which showed that the nitrogen compounds and other parameters of water in Jinnah barrage were in proper limit. This indicates favorable conditions for fish growth and diversity. During this six month time about twenty six types of species were identified from the Jinnah Barrage which were belonging to ten families including Cyprinidae, Bagridae, Schilbediae, Sisoridae, Siluridae, Cichlidae, Channidae, Notopteridae, Mastacembelidae and Clupeidae. That was the highest diversity which was first time recorded in Jinnah barrage.

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Introduction

Jinnah Barrage is situated about 5 km away from the Kalabagh town in District Mianwali. The Barrage is located on the Indus River and is locally called Sindhu is one of the longest river in Pakistan. It is natural scenic area and important for the biodiversity of fish fauna and migratory birds. To observe the fish fauna of that region it is important to understand as it gives us idea more about the biodiversity of that area. Biodiversity is not only important for overall environmental quality and stabilization of ecosystem but for understanding the basic importance of all species on the earth as well (AOAC. 1990; Ehrlich, P.R, 1991). About 21,723 of living fish species have been recorded, Out of that total 8,411 are freshwater and 11,650 are marine (Rankhamb SV.2011). Pakistan is rich of fishery products. More than 186 freshwater fish species are present in Pakistan (Mirza, M.R, 2007). In Pakistan different studies were carried out to know about the fish diversity in different areas (Mirza, M.R, 2003). These studies describe about different species distribution pattern and provide baseline information about endangered species. But the drawback of this study is that no one studies comprehensively the importance of species and conservation method of endangered species (Rafique, M. 2012). A serious failure in distribution of numerous fish species might be as a result of habitat loss, pollution, illegal hunting, exploitation, water abstraction, saltation, changes in environmental condition, intrusion of exotic species and harvesting.

The sustainability of fish diversity and its abundance is based on the hydrological parameters as well as plankton diversity (Rafique, M.2001). Water quality of rivers and streams in Pakistan is generally poor and rapidly getting deteriorated due to pollution from industrial, municipal and agricultural sources. The protocol of Water quality gives necessary scientific knowledge about water quality parameters and ecologically compatible toxicological threshold values to conserve specific water uses (Lawson EO, 2011). All aquatic organisms have bearable limits of water quality variables in which they perform optimally and attain adequate growth. Any up and down within these limits of water quality parameters has negative effects on their body growth and function (Davenport Y, 1993, Kiran BR.2010). Poor water quality can result in low profit, low product quality and potential human risks.

The production of aquatic life is low when the water contains containments that can impair development, growth, reproduction or even cause death to the aquatic species. Some contaminants can accumulate to the point where it threatens human health even in low quality cause no obvious adverse effects (Philminaq, 2014). The most common source of human impact is chemical pollution, sewage discharge and industrialization that affect the biodiversity (EEA, 2006). The main objective of the study was to analyze the water quality variables and to check its effect on fish diversity.

Materials and methods

Sampling area specifications

The present study focuses on Jinnah Barrage (32.9201° N, 71.5191° E) tributaries of Indus River and it originates near the Mansarovar Lake in the Tibetan Plateau, on the Northern slopes of Kailash Mountain Range as shown in the Figure 1. Jinnah Barrage is located on the Indus River near Kalabagh town in district Mianwali. Mianwali is situated in province Punjab and is almost 200 m above the sea level. The climatic condition of the district in June July rises to 51 °c during summer season and minimum -2 °c in winter season is recorded with usual rainfall 250 mm(Jabeen,2010).

The construction on the barrage was begun in 1939 and was completed in 1946. The spillway capacity of the Barrage is 950,000 cu ft/s (27,000 m^3/s). Jinnah Barrage play important role in flood control, power generation and also used for irrigation purposes. On the right side of the barrage there is Hydel Power Station which installed capacity is 96 MW. The topography of the surrounding areas of the barrage is rough sandy soil and the dominant crops in the area are wheat, rice, cotton and sugarcane. It is important wetland for migratory birds.

Fig. 1. Satellite map of jinnah barrage.

Collection and sampling

A sampling data were collected of six months from July to December 2017 in Jinnah Barrage. For water quality analysis random samples of water were collected on weekly basis (Saturday) of every month.As Jinnah barrage is divided into two banks.The sampling sites were selected randomly but to those siteswere given more preference which was already a fishing site for many fishermen's.

Sampling of water

The samples of water were collected in polypropylene bottles. Before collection of samples all the bottles were washed with dilute acid and flowing water of Indus River. All the bottles were properly labeled with time and date for water variables analysis. About 1 liter water samples were collected from about 35 cm depth of the surface water. The standard method of AOAC (AOAC. 1990) was used for the determination of different water parameters. A standard method as described by SMEWW (S.M.E.W.W.1989) was used to determine Dissolved oxygen (DO). The parameters like Dissolved oxygen (DO), Temperature, Turbidity and pH were measured in situ. The Dissolved oxygen (DO) was measured by using DO meter (model: DO-5510). The Check-Temp model-100 (HANNA Instruments Italy) was used to measured water temperature. Turbidity was measured through turbidity meter (model: TB-400, Italy). PH was measured by using pH meter model (pH-220A, Romania). The other water quality variables including (Ammonia, Nitrite and Nitrate) were measuredin the laboratory of Soil and Water Analysis Mianwali. These chemical parameters of water were brought in polypropylene bottles for checking these chemical parameters concentration in the water with the help of HATCH kit.

Fish sampling

Different methods were used for fish collection in Jinnah barrage. Fishes were collected with the help of local fishermen which was working under contractor who get contract of fishing in barrage by using different nets and hooks. The fishes which were caught by hook using earth worm as food resource or using bait. Different nets like cast nets, drag nets, gill nets were used by using motor and wooden boats. During each survey the fish fauna diversity was observed and data was collected after catch on a weekend.

Statistical analysis

The data was subjected for statistical analysis by using Microsoft Excel 2007 and version 12.0, which is statistical package for social sciences (Corston, R. 2000).

The mean and standard deviation of the water quality variables were calculated simply in Excel. The data accuracy and verification of the results according to each month sampling was confirmed by applying the different diversity indices separately. The abundance of different species data was calculated for Shannon diversity Index and other different diversity indices including Simpson's diversity index, Species richness and Evenness.

Results

Water quality parameters

The detail result of physiochemical parameters of Jinnah barrage are given in the (table 1) which shows the fluctuation in each survey.

Table 1. Physicochemical parameters of Jinnah Barrage.

Surveys	Parameters						
	Temperature (°C)	DO(mg/L)	Turbidity (NTU)	PH (H+)	Ammonia (NH3)	Nitrites (ppm)	Nitrate (ppm)
1	33.3	5.6	13.4	8.3	0.8	00	00
2	30.0	5.8	13.0	6.9	0.9	00	00
3	31.4	6.0	13.0	7.4	1.0	0.02	0.01
4	29.5	6.8	10.0	8.9	0.9	0.1	0.2
5	28.6	7.0	13.0	7.5	0.7	0.1	0.1
6	27.8	7.5	12.0	7.8	0.7	00	00
7	28.2	7.6	10.0	9.5	0.6	0.004	0.03
8	26.6	7.8	9.0	7.0	0.6	0.005	0.003
9	25.8	8.0	9.56	8.0	0.5	0.03	0.01
10	25.0	8.3	9.0	7.5	0.3	0.003	0.001
11	24.5	8.5	8.88	8.9	0.4	00	00
12	24.2	8.9	8.23	9.0	0.3	00	00
13	23.4	7.5	8.0	8.8	0.4	00	00
14	22.5	6.0	9.5	7.5	0.2	00	00
15	22.5	6.5	10.0	8.0	0.1	00	00
16	21.2	6.0	10.0	8.0	0.1	00	00
17	21.0	5.5	10.5	8.0	0.2	00	00
18	21.0	5.0	9.5	7.5	0.1	00	00
19	20.0	5.5	11.5	7.5	0.1	00	00
20	19.0	6.5	11.5	8.0	0.2	00	00

Temperature

The temperature values of the waters of Jinnah barrage resulted in the interval (table 1) with a mean value of 26.51 (Figure 2).

PH

The pH recorded in water samples collected in Jinnah barrage ranged from 6.9 to 9.5 with a mean value of 8.04 (Table 1 and Figure 2).

Turbidity

The turbidity noted in the water quality of Jinnah barrage ranged from 8-13.5 with a mean value 5 as shown in the (Table 1 and Figure 2).

Dissolved oxygen

The quantity of DO in the water of Jinnah barrage ranged from 5.0 – 8.9 mg/L with a mean value of 6.61. As it can be seen in (Table 1 and Figure 2).

Nitrates and nitrites

In figure 3 and table 1 it is shown that nitrate and

nitrite content in Jinnah Barrage water fluctuated between 0.0 mg/L to 0.1 mg/L and 0 mg/L to 0.2 mg/L respectively with a mean value 0.01 mg/L.

Ammonia

In samples analyzed, ammonium content fluctuated between 0.1 to 1.0 mg/L with mean 0.49mg/L (Figure 3).

Diversity of ichthyofauna

About twenty six different species of the fishes were collected from the study area. A total of 1805 specimens of fish were collected randomly from Jinnah barrage. The detail of fish species collected on weekly basis for the period of six month (July 2017 to December 2017) is given in (Table 2). In the current study about twenty six species were recorded after proper identification. Among them about twelve species belonged to family Cyprinidae, three species to Bagridae, two species to each one of the families Schilbediae, Sisoridae, Siluridae and one specie to each one of the families Cichlidae, Channidae, Notopteridae, Mastacembelidae, Clupeidae respectively (Table 2).

Table 2. Fish diversity and population observed at Jinnah barrage.

Family	Species	Jul	Aug	Sep	Oct	Nov	Dec	Total
Cyprinidae	*Cirrhinus mrigala*	15	21	19	23	30	60	168
	Labeo rohita	12	31	19	33	38	48	181
	Labeo calbasu	10	7	11	13	19	29	89
	Cirrhinus reba	21	12	16	14	9	19	91
	Cyprinus carpio	28	35	27	28	56	78	252
	Labeo gonius	8	12	5	11	18	27	81
	Puntius sophore	2	0	4	2	2	6	16
	Ctenopharyngodon idella	0	4	0	0	3	7	14
	Hypophthalmichthys molitrix	0	0	2	4	3	9	18
	Barbodes sarana	1	0	0	0	3	7	11
	Puntius chola	0	0	0	2	0	4	6
	Osteobrama cotio	0	0	0	1	3	2	6
Bagridae	*Aorichthysaor*	9	14	18	21	25	39	126
	Rita rita	9	22	19	30	14	37	131
	Mystusbleekeri	0	0	6	13	27	12	58
Schilbediae	*Eutropiichthysvacha*	11	4	0	7	23	29	74
	Clupisomagarua	0	0	5	8	9	14	36
Cichlidae	*Oreochromis aureus*	0	0	5	8	9	14	36
Channidae	*Channapunctuate*	0	0	5	12	6	4	27
Siluridae	*Wallagoattu*	15	13	14	28	31	48	149
	Ompokpabda	4	2	0	5	7	5	23
Mastacembelidae	*Mastacembelusarmatus*	0	4	7	9	19	30	69
Clupeidae	*Gadusiachapra*	12	6	0	3	7	10	38
Notopteridae	*Notopterusnotopterus*	0	8	4	11	13	9	45
Sisoridae	*Glyptothorax punjabensis*	0	0	3	1	0	8	12
	Bagariusbagarius	2	7	9	13	6	11	48
Grand Total		159	202	198	300	380	566	1805
Percentage population		8.69%	11.19%	11.08%	16.62%	21.5%	31.35%	

The different diversity indices in (Table 3) were used to calculate the abundance of species. The Shannon's Diversity Index (H') was highest during the month of December (2.90) followed by November (2.85)> October (2.82). The maximum species richness was noted during the month of December 26 followed by November and October 24. While the maximum Simpson's diversity index (I/D) was recorded in the month of November 16.11 and after that in the month of October 15.92 and then followed by December 14.89 and was minimum during the month of August 10.65. However the maximum value of Evenness (H/S) recorded in the month of July 0.164 and was lowest during the month of December 0.111

respectively.

Discussion

This study was conducted to evaluate how the physicochemical parameters and nutrient contents in the water affect the distribution and growth of fish in Jinnah barrage.As we know that temperature is the most important driving physical variable affecting the metabolic rate of all living organism and fish is a limbless cold-blooded vertebrate animal with gills and fins living wholly in water.

Table 3. Different diversity indices were calculated from the data and the result was recorded in table.

Index	Jul	Aug	Sep	Oct	Nov	Dec	Total
No. of specimens	159	202	198	300	380	566	1805
Species Richness (S)	15	16	19	24	24	26	124
Shannon's diversity (H')	2.47	2.50	2.71	2.82	2.85	2.90	16.25
Simpson's diversity index (I/D)	11.03	10.65	13.8	15.92	16.11	14.89	82.4
Evenness (H/S)	0.164	0.156	0.142	0.117	0.118	0.111	0.808

In this study the temperature values resulted were slightly lower than the optimal water temperatures 28 – 30 ℃, within which maximal growth rate, efficient food conversion, best condition of fish, resistance to disease and tolerance of toxins (metabolites and pollutants) are enhanced.Low temperature value might have negative effects in photosynthetic processes and the amount of dissolved oxygen in water, consequently in fish growth. Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent (X. Wang,2001). Fish have an average blood pH of 7.4; a little deviation from this value, generally pH between 7 to 8.5 is ideal for biological productivity, so in the current study the pH values recorded was good for fish growth.

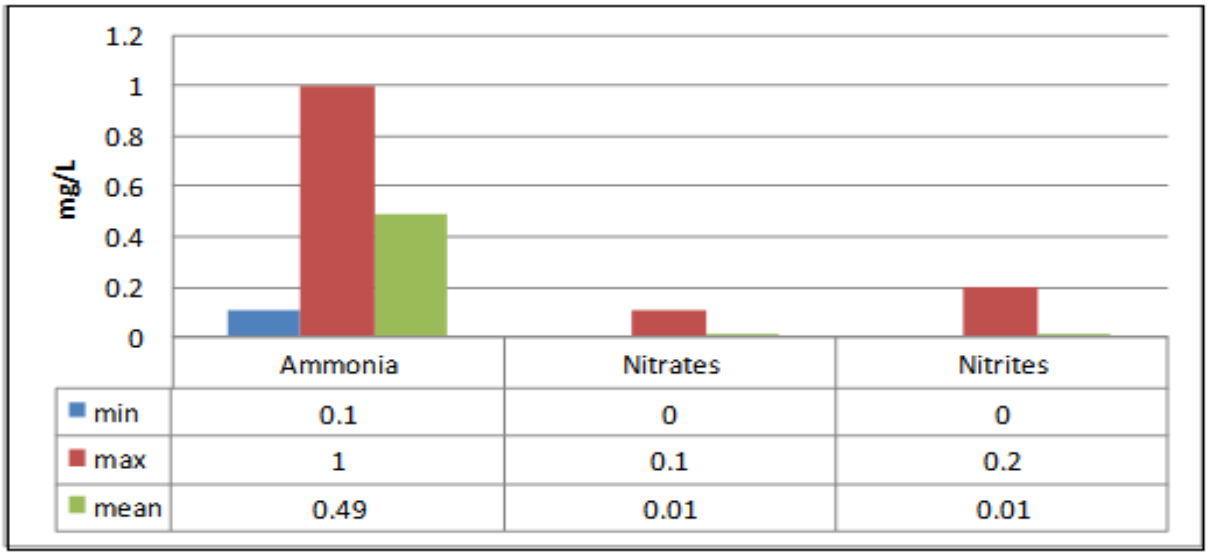
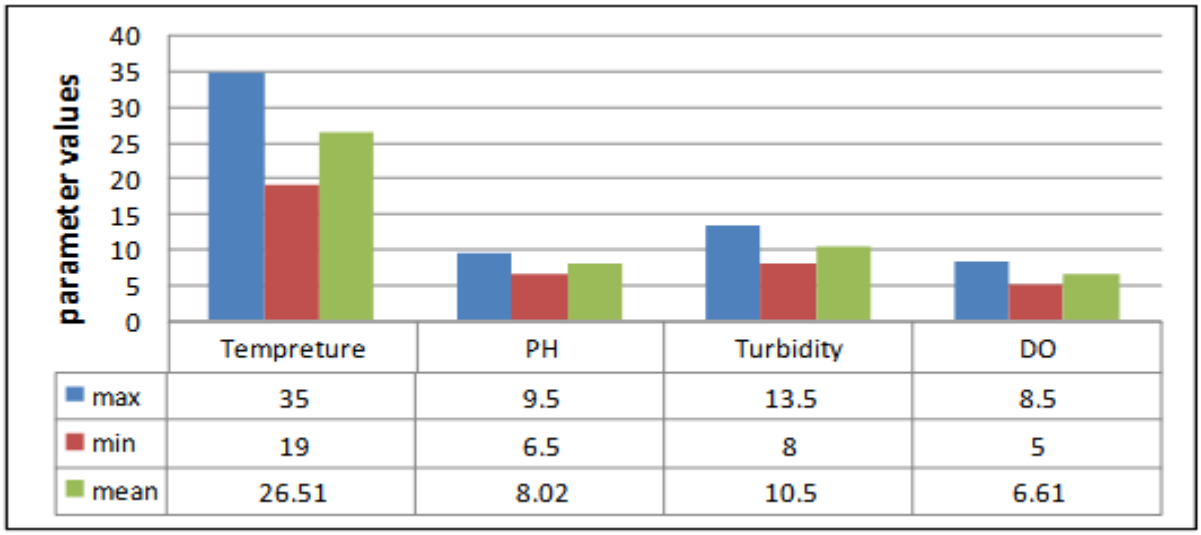


Fig. 2. Water quality parameters.

According to the water qualities standards parameter for aquaculture DO concentration of 5.0 mg/L and above are desirable for fish survival, which means DO levels measured in this study were considered suitable for the aquatic biodiversity.Hoetzel and Croome(Hoetzel, G.1994)explain that the excess of lotic turbidity can cause the light penetration limited and reduce the production of phytoplankton. The size of suspended particulates matter is usually smaller than 62 µm. Sediments of high sustained level can

cause alternation in the structure of community. The value in this study was suitable but if the pollution around the Jinnah barrage is not controlled than soon it will affect the photosynthetic activities in the water.Nitrites and nitrate are a form of nitrogen and a vital nutrient for growth, reproduction, and the survival of organisms. Santhosh and Singh (Santhosh, B. 2007) described the favorable range of both 0.1 mg/L to 4.0 mg/L in fish culture water. However, (OATAOATA, 2008) recommends that nitrate levels in marine systems never exceed 100 mg/L. High content of nitrates in the Barrage may be not considered critical as they are the mainnutrient for the aquatic biota and its intensive development causes rapid reduction of nitrates. Based on the recommended values about nitrate content in water, Jinnah Barrage is considered favorable for the fish growth. Figure2 referred to the recommended values for ammonia content, this parameter resulted acceptable for fish growth. Compared to standard values nitrogen compounds and phosphates in Jinnah barrage were in low content. This indicates favorable conditions for fish cultivation. Due to suitable conditions of the Jinnah barrage support as vast varieties of fishes including the following diversity.



	Tempreture	PH	Turbidity	DO
max	35	9.5	13.5	8.5
min	19	6.5	8	5
mean	26.51	8.02	10.5	6.61

Fig. 3. Water quality parameters.

About twenty six types of species were identified from the Jinnah Barrage which was belonging to ten families, eight orders and seven genera. Table 2shows different diversity indices used to calculate the species abundance. Highest species richness was recorded during the month of December>November> October>September>August>July. The highest species richness in these months may be attributed due to lowest water level results in easy approach for fish sampling. Similarly the highest values for Shannon's Diversity Index (H') was represented during, December>November> October>September>August>July (Table3). Highest Simpson diversity index (I/D) was recorded during the month of November, whereas the maximum value of Evenness (H/S) was recorded in the month of July as shown in the table 2.

Conclusion

It is shown that the Jinnah barrage is characterized by generally oligotrophic conditions and is suitable for fish growth. But, in future there should be a constant monitoring of the physical and chemical parameters of water in Jinnah barrage, because of the increase of anthropogenic activities around the area which will increase the pollution and it will affect the water quality parameter and in turn it will affect the distribution of the ichthyofauna. Due to favorable condition of Jinnah barrage, from thecurrent result it had been concluded that Jinnah Barrage has high diversity of freshwater fish fauna which represent the appropriate aquatic environment for fish growth and

survival. Hence, it needs proper management, knowledge and attention to educate the people about their breeding season and proper fish handling as to enhance the diversity and production. Thus, the trade would be enhanced which in turn improve the earnings and life quality of local fishermen.

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