Sindh Univ. Res. Jour. (Sci. Ser.) Vol. 46 (4):525-530 (2014)

SINDH UNIVERSITY RESEARCH JOURNAL (SCIENCE SERIES)

Ichthyodiversity in relation to physico-chemical parameters of River Swat.

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Received 4th June 2014 and Revised 2nd September 2014

Abstract: The study was conducted on ichthyodiversity in relation to physico-chemical parameters of river Swat, Khyber Pakhtunkhwa. Twelve fish species belonging to ten genera, four families and three orders were recorded during (May to December 2012). Family Cyprinidae was dominant with seven species followed by family Balitoridae with three species, Sisoridae and Salmonidae each with single species. Ichthyodiversity was assessed by calculating the diversity indices. High values for Shannon-Weiner index, Simpson's diversity index and Pielou's evenness were observed in Khwaza Khela, followed by Fatehpur, Madyan and Kalam. High diversity was observed from May to October and low in the months of November and December. Significant correlation ($p < 0.05$) between fish abundance and physico-chemical parameters (Temperature, Dissolved Oxygen) were found. The effects of remaining parameters like pH, Electrical Conductivity, Chlorides, Salinity and Total Dissolved Solids were negligible.

Keywords: Ichthyodiverstiy, Limnology, River Swat

1. INTRODUCTION

The study of fish and their stability is important. Fish population of any aquatic habitat can vary significantly from year to year (Urooj *et al*., 2011). Fish are potential indicators of changing trends in aquatic environment because of the impact they have on the distribution and abundance of other organisms in the water they inhabit. It is therefore, needed to assess the fish distribution and abundance in order to give a good insight into the state of biological production and the physico–chemical characteristics in evaluating future changes that may occur in response to different anthropogenic activities (Ayoola and Kuton, 2009). Fish have also been regarded as an effective biological indicator because of sensitivity to subtle environmental changes and represents a wide range of tolerance at community level (Vijaylaxmi *et al*., 2010).

Monitoring of water quality is the first step that can lead to management and conservation of aquatic ecosystems. It is also true that the management of any aquatic ecosystem is aimed to the conservation of its habitat by suitably maintaining the physico-chemical quality of water within acceptable levels (Garg *et al*., 2010). The seasonal variations in physico-chemical factors have a profound effect on the distribution and population density of both fauna and flora (Rafique *et al*., 2002).

The present study was designed to examine the change in fish species over time period and to document the physico-chemical variables of river Swat. Furthermore, the correlation of physico-chemical variables with fish fauna was also planned to be calculated.

2. MATERIALS AND METHODS

Study area

The Swat valley is situated in the Province of Khyber Pakhtunkhwa Pakistan. It lies between 34°-40′ to 35° N latitude and 72′ to 74°-6′ E longitude at district of Malakand division located 160 Km from Islamabad on the northern side of Khyber Pakhtunkhwa (Zahoor and Butt, 2011). Swat River originates from Swat Kohistan and its main source is the Mahodhand at the elevation of about 3000 m with the confluence of Ushu and Utror Rivers. The total length of Swat River is 250 km from Kalam to Kabul River near Nowshehra (Hayyat, 2007). The present study was carried out on the upper part of River Swat (Kalam to Khwaza Khela).

Sampling

Fish specimens and water samples were collected on monthly basis between May to December 2012, from four sampling stations namely (1) Kalam (2) Bahrain (3) Fatehpur and (4) Khwaza Khela of Swat River. Fish specimens were used for investigation of fish diversity and water samples for limnological studies.

Fish specimens were collected with the help of local fishermen using different types of fishing nets and gears. Fish were preserved in 10% formalin in separate bottles according to size of fish. Smaller fish were directly preserved in 10% formalin whereas larger fish specimens were injected with 5 cc formalin (10%) with disposable syringe (BD 5cc) in belly to avoid decomposition and were brought to laboratory at Department of Zoology, Hazara University, Mansehra for identification. Fish were identified up to the species

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level with the help of standard available literature i.e. Mirza and Sandhu, (2007), Jayaram, (1999), Talwar and Jhingran (1991).

Water sampling for the determination of physicochemical properties

For the determination of physicochemical properties of the river water, samples were collected from surface and bottom layers by using Van Dorn plastic bottles (1.5 L capacity) from 2 spots of each station randomly, were kept in polythene plastic bottles, previously soaked in 10% nitric acid for 24 h and rinsed with ultra-pure water. After reaching at the laboratory 2 water samples collected from each station were mixed in acid washed bucket to make one composite sample, rinsed with ultra-pure water and kept under 4 °C till further analysis. Dissolved oxygen (DO) samples were collected in colored bottles and analyzed by a modified Winkler method. Chlorides were estimated by titration of Silver nitrate ($AgNO_3$) with Potassium chromate ($K_2Cr_2O_7$) as an indicator. Electrical conductivity and total dissolved solids (TDS) were determined with a WTW LF 320 conductivity meter (WTW, Wilhelm, Germany), and salinity was estimated by Mohr's method (Treadwell and Hall, 1919). Temperature was measured with a mercury thermometer and pH was measured with an Orion model 420A pH meter (Fisher Scientific, Cummings Center, USA).

Data analysis

Ichthyodiversity was analyzed using different indices like Shannon-Weiner index (Shannon and Weiner, 1949); Simpson index of diversity (Simpson, 1949) and Pielous Evenness (Pielou, 1966).

Shannon-Weiner Diversity Index

$H = -\sum p_i \ln p_i$

H = Shannon-Weiner Index

P_i = **Ni/N**

Ni = Number of individuals/ total number of samples.

N = Total number of individuals of all species in the sample.

The Shannon diversity index (H) is the index that is commonly used to characterize species diversity in a community.

Simpson Index of Diversity

$D = 1- \sum (p_i)^2$

Simpson diversity index measures the number and abundance of each species present. $P_i = Ni/A$

Pielou's Evenness Index

J= H/lnS

H= Shannon-weiner Index

S= Number of Species

Evenness measures the relative abundance of the different species making up the richness of an area.

Species richness was estimated by the variety of fish species found in four sampling sites from river swat during present studies.

The physico-chemical parameters correlation and regression with abundance of fishes at four sampling stations were calculated. Step-wise selection method was used in a linear multiple regression of fish abundance against the physico-chemical variables (independent variables) using Mini-Tab computer based software.

3. RESULTS

Physico-chemical parameters

The maximum, minimum and mean ± SD results of water quality variables with corresponding sampling sites are given at **(Table 1)**.

Ichthyodiversity

Twelve fish species belonging to ten genera, four families and three orders have been recorded from Swat River. Seven species belonged to Cyprinidae, three species belonged to Balitoridae and one species each to Sisoridae and Salmonidae. The list of identified fish species order, family, genus and species is shown in Table 2. Family Cyprinidae was represented by *Cyprinus carpio, Carassius auratus, Garra gotyla, Crossocheilus dipocheilus, Schizothorax richardsoni, Schizothorax esocinus, Barilius pakistanicus*, Balitoridae by *Triplophysa choprai, Triplophysa naziri* and *Schistura alepidota*. Family Sisoridae and Salmonidae consisted of *Glyptosternum reticulatum* and *Salmo trutta fario* respectively **(Table 2).** Cypriniformes constitute the major portion of observed fish species (86 %) in which 44 % belonged to sub family Shizothoracinae, 15 % to sub family Cyprininae, 10 % to sub family Garrinae and 4 % to sub family Rasborinae of the family Cyprinidae whereas 28 % belonged to sub family Nemacheilinae of the family Balitoridae **(Fig. 1, 2).** Sub-families Schizothoracinae, Cyprininae, Garrinae and Rasborinae consisted 61 %, 20 %, 14 % and 5 % respectively of the family Cyprinidae. *C. carpio* and *C. auratus* constitute 68 % and 32 % respectively of the sub-family Cyprininae, *G. gotyla* and *C. diplocheilus* constitute 28 % and 72 % respectively of the sub-family Garrinea, *S. richardsonii* and *S. esocinus* constitute 85 % and 15 % of the sub-family Schizothoracinae whereas *B. pakistanicus* constitute 5 % of the sub-family Rasborinae. Balitoridae is represented by a single sub-family Nemacheilinae which constitute 38 %, 31 % and 31 % of *T. choprai, T. naziri* and *S. alepidota* respectively. *G. reticulatum* of family Sisoridae and order Cypriniformes constitute 10 %, whereas *S. trutta fario* of family Salmonidae and order Salmoniformes constitute 4 % of the all collected species **(Fig. 1, 2).**

Fish species richness, abundance, relative abundance and diversity indices from sampling stations were calculated for estimation of ichthyodiversity. The highest species abundance (68) has been recorded in Khwaza Khela followed by Fatehpur (17), Madyan (11) and Kalam (14). The relative abundance in all four stations ranged from 0.04 (Kalam) to 0.68 (Khwaza Khela). The relative abundance at Fatehpur was 0.17 and at Madyan was found to be 0.11. The Shannon-Weiner ichthyodiversity index values were ranged from 0 (Kalam) to 2.2 (Khwaza Khela). At Fatehpur the Shannon-Weiner ichthyodiversity index value was 0.94 whereas at Madyan it was 0.58. The Simpson's index of diversity values in the present study ranged from 0 (Kalam) to 0.88 (Khwaza Khela). At Fatehpur the Simpson's index of diversity value was found to be 0.56 and at Madyan it was 0.39. The recorded Pielou's Evennes value is found to be highest at Khwaza khela (0.39), moderate at Fatehpur (0.22), low at Madyan (0.15) and 0 at Kalam **(Table 3).**

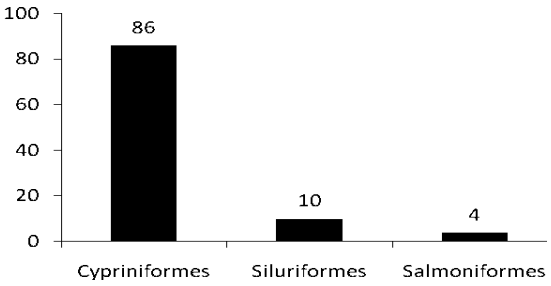

Fig. 1. Percent distribution of the identified fish species.

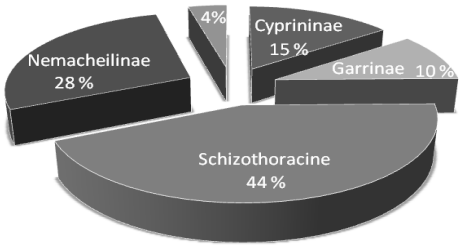

Fig. 2. Percent distribution of order Cypriniformes.

Table 1. Physico-chemical parameters with analytical procedure, maximum, minimum and mean ±SD.

Variables	Units	Minimum - Maximum	Kalam	Madyan	Fatehpur	K. Khela
Temp	°C	15.7 - 9.5	9.5 ± 3.4	11.8 ± 4	13.4 ± 4	15.7 ± 5.6
pH	pH unit	7.2 - 7.0	7 ± 0.19	7 ± 0.11	7.2 ± 0.07	7 ± 0.3
Chlorides	mg/L	86.5 - 68.9	75.9 ± 10.7	72.9 ± 12.2	86.5 ± 11.9	68.9 ± 10.7
EC[1]	µs/cm	245.4-205.9	234.9 ± 15.3	226.5 ± 14.1	245.4 ± 17.9	205.9 ± 14.8
DO[2]	mg/L	9.5 – 6.6	9.5 ± 0.3	9.5 ± 0.4	8.3 ± 0.4	6.6 ± 0.1
TDS[3]	mg/L	164.4 – 137.9	145.3 ± 11.5	153 ± 13.4	164.4 ± 12.4	137.9 ± 10.7
Salinity	‰	0.05 – 0.01	0.02 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.05 ± 0.01

[1] Electrical Conductivity, [2]Dissolved oxygen [3]Total dissolved solids.

Table 2. List of identified fish species, their distribution, abundance, relative abundance and percentage relative abundance in Swat River.

[1]Station, [2]Abundance, [3]Relative abundance

Order	Family	Sub family	Species	[1]St 1	St 2	St 3	St 4	[2]Ab	[3]RA	%RA
Cypriniformes	**Cyprinidae**	**Cyprininae**	*C. carpio*	16	0	0	0	16	0.04	3.8
			C. auratus	0	35	43	57	135	0.32	32.0
		Garrinae	*G. gotyla*	0	13	10	0	23	0.05	5.5
			C. diplocheilus	0	0	20	24	44	0.10	10.4
		Schizothoracinae	*S. richardsoni*	0	0	0	10	10	0.02	2.4
			S. esocinus	0	0	0	26	26	0.06	6.2
		Rasborinae	*B. pakistanicus*	0	0	0	17	17	0.04	4.0
	Balitoridae	**Nemacheilinae**	*T. choprai*	0	0	0	36	36	0.09	8.5
			T. naziri	0	0	0	14	14	0.03	3.3
			S. alepidota	0	0	0	39	39	0.09	9.2
Siluriformes	**Sisoridae**		*G. reticulatum*	0	0	0	31	31	0.07	7.3
Salmoniformes	**Salmonidae**		*S. trutta fario*	0	0	0	31	31	0.07	7.3

The data were also analysed month-wise. The species richness was found to be same (12) in all months of the study period. Highest abundance of fish species (17) was recorded in June and July, followed by May and August (15), September (13), October (11), November (7), and December (6). The month-wise relative abundance ranged from 0.06 (December) to 0.17 (June and July).

The relative abundance for May and August was 0.15, for September was 0.13, for October was 0.11 and for November it was 0.07. The Shannon-Weiner fish diversity values ranged from 1.62 (December) to 2.26 (May). The Shannon-Weiner index for each August and September was 2.24, for June was 2.22, for October was 2.17 and for November it was 1.71. The

Simpson diversity index values ranged from 0.74 (December) to 0.86 (May, August and September). For the months of June, July and October, the Simpson diversity index value was (0.85) whereas in November and December it was recorded 0.76. The Pielou's Evenness values ranged from 0.5 (November and December) to 0.57 (October). In September it was 0.56, for May and August being 0.54, and for June and July it was 0.52 **(Table 4).**

4. DISCUSSION

Twelve fish species belonging to three orders and four families were found during the present study. Cyprinids were found to be most abundant during the present study. Among Cyprnids *Schizothorax richardsonii* was the most abundant species found in the whole study period. The other species found were *Salmo trutta fario, S. esocinus, G. reticulatum, C. auratus, T. choprai* and *T. naziri*, *G. gotyla*, *C. carpio*, *C. diplocheilus*, *S. alepidota* and *B. pakistanicus*. Among these *G. gotyla*, *C. diplocheilus*, *B. pakistanicus*, and *S. alepidota* were not found in November and December, whereas *C. carpio* was not seen in December.

Species richness was calculated to know the ichthyodiversity. We have found that species richness was low at upstream where water temperature was lower. The species and individuals were unevenly distributed throughout the study area

The value of evenness varied between 1 and 0. The values which were closer to 1 indicated the more even populations of fish forming the community. Shannon-Weiner index (H) shows both evenness of population and number of species. Diversity is conducted to be maximum when all the species of a community are equally abundant. Previous literature also reveals that species diversity is directly proportional to higher temperatures, availability and stability of food. Simpson diversity index measures the number and abundance of existing species.

Temperature affects directly fish abundance and distribution (Deekae *et al*., 2010). Every fish species has own temperature tolerance range. The temperature tolerance range for Snow trout fish, Trout and *C. carpio* are 8 – 22 Cº, < 19 Cº and 23 – 29 C° respectively (Butt, 1986). The upstream river Swat (Kalam, Madyan) has very low temperature (9.5 Cº, 11.8 Cº) compared to downstream (Khwaza Khela and Fatehpur) (15.7 Cº, 13.4 Cº). The low temperature limits fish abundance and distribution which is very evident in our study.

Our results revealed that temperature and DO play a vital role in fish abundance and richness after calculation of correlation and regression analysis. The remaining variables like EC, TDS, pH, Salinity and Chlorides role is negligible.

Table 3. Station-wise fish diversity in the study area.

Parameters	Kalam	Madyan	Fatehpur	K.Khela
Species Richness	1	2	3	10
Species Abundance	4	11	17	68
Shannon-Weiner Index	0	0.58	0.94	2.2
Simpson Diversity Index	0	0.39	0.56	0.88
Pielou Evenness	0	0.15	0.22	0.39
Relative abundance	0.04	0.11	0.17	0.68
% RA	3.8	11.4	17.3	67.5

Table 4. Month-wise fish diversity in the study area.

Parameters	May	June	July	Aug	Sept	Oct	Nov	Dec
Species Richness	12	12	12	12	12	12	12	12
Species Abundance	15	17	17	15	13	11	7	6
Shannon-Weiner Index	2.26	2.22	2.2	2.24	2.24	2.17	1.71	1.62
Simpson Diversity Index	0.86	0.85	0.85	0.86	0.86	0.85	0.76	0.74
Pielou Evenness	0.54	0.52	0.52	0.54	0.56	0.57	0.5	0.5
Relative abundance	0.15	0.17	0.17	0.15	0.13	0.11	0.07	0.06
% RA	15.4	16.6	16.6	14.7	12.8	10.7	7.3	5.9

Table 5. Step-wise multiple regression analysis.

Variable X	Variable Y	R	Probable relationship
1. Temp	FA	90.1	Y= 1.68 + 0.938 Temp
2. Temp, DO	FA	95.7	Y= 66.1 + 0.616 Temp - 7.12 DO
3. Temp, DO, Salinity	FA	97.2	Y= 57.8 + 0.470 Temp - 5.85 DO - 91.3 Salinity

Temp= Temperature, DO= Dissolved Oxygen, FA= Fish Abundance

Effects of physico-chemical parameters on ichthyodiversity

The data were calculated statistically using correlation and regression tests **(Table 5)**. In this way effects of different physico-chemical parameters on ichthyodiversity were found. Multiple linear regression and step-wise regression analysis between fish abundance and physico-chemical parameters revealed that variations in fish abundance was mostly caused by temperature and DO, while variation in fish abundance due to variables, such as EC, TDS, pH, Salinity and Chlorides is less.

5. CONCLUSION

A total of 12 species have been identified in the present study. Among the existing families Salmonidae is the least abundant whereas Cyprinidae is the most abundant in the study area. Ichthyodiversity was highest at Khwaza Khela, followed by Fatehpur, Madyan and Kalam. Ichthyodiversity was highest from May to October and lowest in the months of November and December. Physico- chemical properties of the study area were within the tolerance limit for fish fauna, and no excessive concentration of any parameters was recorded during study period. Temperature and DO were the decisive factors in fish abundance and richness.

REFERENCES:

Ayoola, S. O., and M. P. Kuton, (2009). Seasonal variation in fish abundance and physico-chemical parameters of Lagos lagoon, Nigeria. African Journal of Environmental Science and Technology, 3 (5): 149-156.

Butt, J. A., (1986). Fish and fisheries of North West Frontier Province (NWFP) Pakistan. Biologia (Pak), Special Supplement, 21-34.

Deekae, S. N., J. F. N. Abowei and J. F. Alfred-Ockiya, (2010). Seasonal variation of some physical and chemical parameters of Luubara creek, Ogoni land, Niger delta, Nigeria. Research Journal of Environmental And Earth Sciences, 2(4): 208-215.

Garg, R. K., R. J. Rao, D. Uchchariya, G. Shukla and D. N. Saksena, (2010). Seasonal variations in water quality and major threats to Ramsagar reservoir, India. African Journal of Environmental Science and Technology, 4(2): 061-076.

Hayat, R., (2007). Saving River Swat from growing pollution. Dawn the internet Edition.http//www.dawn.com. August 27, 2010, 1-2.

Jayaram, K. C., (1999). The freshwater fish of the Indian region. Nondara Publishing House: Delhi, India, 14-285.

Mirza, M. R. and A. A. Sandhu, (2007). Fishes of the Punjab Pakistan. Polymer Publications Lahore.

Pielou, E. C., (1966). The measurement of diversity in different types of biological collections. J. Bio (online). 13: 131-144.

Rafique, R. M., S. Mahboob, M. Ahmad and S. Saleem, (2002). Seasonal limnological variations in Mangla reservoir at Sukhian, Mirpur (Azad Kashmir). International Journal of Agriculture and Biology, 4 (2): 223–226.

Shannon, C. E., and W. Weiner, (1949). The mathematical theory of communications, Urbana: University of Illinois Press USA.

Simpson, E. H., (1949). Measurement of diversity. Nature, 163: 668.

Talwar, P. K., and A. G. Jhingran, (1991). Inland fishes of India and adjacent countries. Oxford Ibh Publishing Co.Pvt Limited New Delhi, India, (1): 149-511.

Treadwell, P.F., and W.T. Hall, (1919). Analytical chemistry 25th edition.

Urooj, N., G. A. Sahato, K. H. Lashari, A. L. Korai, Z. A. Palh and H. S. Naqvi, (2011). Ichthyodiversity of river Indus, at Jamshoro District, Sindh. Sindh University Research Journal (science series), 43 (1): 13-18.

Vijaylaxmi, C., M. Rajshekhar, and K. Vijaykumar, (2010). Freshwater fishes distribution and diversity status of Mullameri River, a minor tributary of Bheema River of Gulbarga District, Karnataka. Journal of Systems Biology, 2(2): 01-09.

Zahoor, K., and L. Butt, (2011. The Valley of Swat in Fire, terrorism in Pakistan. http://www.valleyswat.net/