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Seasonal Limnological Variations in Mangla Reservoir at Sukhian, Mirpur (Azad Kashmir)

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ABSTRACT

The seasonal variations of Mangla reservoir at Sukhian, Mirpur were studied for a period of one year. Air and water temperature varied from 18-43^{0}C and 16-41^{0}C, respectively. The other variables were varied as light penetration 18-29 cm; pH 7.9-8.6; electrical conductivity 0.17-1.9 dsm^{-1}; dissolved oxygen 1.8-3.6; total alkalinity 230.6-310.6; carbonates 46-85; bicarbonates 189-220; total hardness 177.9-247.0; calcium 34.08-47.0; magnesium 19.38-40.0; sodium 13.11-27.32; potassium 1.7-5.7; phosphates 0.0-0.104; nitrates 0.46-3.56; total solids 945-1198; total dissolved solids 806-993 mgL^{-1}. Productivity based on dry weight of planktonic biomass was ranged from 102-249.7 mgL^{-1}. The total thirty-three genera of phytoplankton and zooplankton were recorded which varied significantly during different periods of the study because of season.

Key Words: Physico-chemical; Biomass; Phytoplankton; Zooplankton

INTRODUCTION

In the broadest sense, water quality is determined by myriad of biological, physical, and chemical variables that affect the desirability of water for any particular use. In recent years attempts in the country are being made to utilize reservoirs, lagoons, estuaries and other water bodies for fish culture practices by which the protein uptake for our masses could be increased. Freshwater resources are used to meet the day-to-day requirements of human settlement, for production of hydropower and most important of all, for agricultural, fisheries and industrial needs.

Pakistan has one of the most extensive canal systems in the world. It must be recognized that in under developed and densely populated countries, which have the most pollution problems, the importance of healthy freshwater environment has increased. All the aforesaid activities are expected to have a significant impact on the water quality. The study of limnological factors is of great significance in removing the constraints, which impede production of inland fish. The seasonal variations in Physico-chemical factors have a profound effect on the distribution and population density of both fauna and flora (Mahboob, 1986, 1988a, b, 1992; Latif, 1990; Hassan, 1998; Mahboob & Sheri, 2001).

Singh and Pandey (1990) pointed that the population of planktonic life adversely effected in the polluted lake. They further mentioned that protozoan were unaffected by pollution. The abundance of phytoplankton and zooplankton in the freshwater bodies is greatly regulated by the physico-chemical factors (Muhlhauser *et al.*, 1995; Jersabek & Schabetsberger, 1996).

The present work was, therefore, planned to study the annual limnological variations in the Mangla reservoir at Sukhian in order to find its suitability for fish culture.

MATERIALS AND METHODS

The study was carried out at Sukhian, Mangla reservoir. Mangla Dam is situated on the river Jhelum about 34 km upstream from Jhelum city. Mangla reservoir is a large water body of about 160 sq. km with gross storage capacity of 5.88 MAF. Its lake is a eutrophic and fish fauna is very large. Fishes used for the food are of 13 species commonly found in this reservoir. There is a fish Hatchery for the production of fish seeds for stocking in Mangla reservoir. Fish production is fairly large and good. The maximum depth of the water in this reservoir is 91.4 m. Water mostly remains above 20^{0}C throughout the year. It is a deep reservoir with plain mountainous banks situated at about 1200 level. Major tributaries joining the reservoir are Jhelum, Kanshi, Poonch, Kanhar and Neelum. Aquatic vegetation includes water plants like *Hydrilla, Verticillates, Potamogeton, Crispus, Utricularia and Spiralex* are found in upper streams of the reservoir. The water samples were colleted on monthly basis for a period of one year i.e. from May 1998 through April 1999.

Water samples were collected from surface, column and bottom of each of the ponds (using Kemmerer). To make the samples representative, six samples were collected from each of the substations A, B, C, D, E, and F mixed to have a composite sample. The samples were stored in glass bottles of one-liter capacity, fixed with chloroform and immediately taken to laboratory for analysis. Dissolved gasses, temperature and pH (at the pond site) were determined immediately after collection.

The temperature of the pond water was recorded with the help of electronic thermometer (HI-8564: Hanna) from surface, column and bottom three times a day (6 A.M; 12 P.M and 6.0 P.M) and fortnights average was obtained while air temperature and daily light hours records were obtained from the Department of Agri Meteorology, University of Agriculture, Faisalabad.

The light penetration was determined with the help of Secchi's disc while pH and electrical conductivity of water were determined with a pH meter (Jenco-607) and conductivity meter (MC-1 Mark v) in the Laboratory. The chemical factors viz., dissolved oxygen, carbon dioxide, carbonates, bicarbonates, total alkalinity, calcium, magnesium, total hardness, chlorides, orthophosphates, nitrates, ammonia, total nitrogen, total solids and total dissolved solids were estimated by following Boyd (1981).

Dry weight of planktonic biomass was measured indirectly from the values of total solids and dissolved solids by the following formula as described by Mahboob (1986):

Biomass= Total solids - Total dissolved solids

The data thus obtained were subjected to statistical analysis through computer for the comparison of mean values for various parameters and the significance of interactions were compared by using analysis of variance and Duncan's multiple range tests through two way-classifications (Factorial Experiment) with repeated sampling. Correlation and regression analysis were also performed to find out relationships among various characteristics. M-stat and Micro-stat packages of the computers were used for the analysis.

RESULTS AND DISCUSSION

The seasonal variations in the ecological parameters exert a profound effect on the distribution and population density of both animal and plant species (Odum, 1971). The productivity in terms of planktonic biomass in freshwater bodies is regulated by various physico-chemical factors viz., temperature, transparency, pH, electrical conductivity, total hardness, nitrates, phosphates etc. (Mahboob, 1992; Mahboob & Sheri, 2001).

The overall range of water temperature remained 16-41^{0}C throughout the experimental period. The comparison of means showed significant differences due to months (Table I). Hassan (1998) noted that water temperature of ponds was 2-5^{0}C lower than the air temperature. The difference between air and water temperature in the present was observed less during the months of September and October, possibly due to increase in humidity, which greatly decreased the loss of heat through evaporation. The variation (18-29^{0}C) in water temperature at different times were probably due to surface heating during the day and cooling during night, a phenomenon commonly met within tropical water bodies as reported by Mosely (1983).

The transparency values as interpreted Secchi's disc ranged from 18 to 29 cm. According to Boyd (1981) the apparent color of water is caused by suspended matter, which interferes with light penetration. He further explained that the turbidity and color of water might result from colloidal clay particles, colloidal organic matter originating from the decay of vegetation or from abundance of plankton. The transparency values in April to August remained statistically similar (Table I). Overall these low values of transparency were possibly due to more turbidity of water, which was further confirmed from the higher values of suspended matters. These results were in line with the findings of Mahboob (1992).

The overall pH values showed non-significant differences among all the six stations. The pH values of 8.0 and above were observed during the period from February to September indicated that the photosynthesis activity during these months was greater than the respiratory activity. During December-January and October-November the pH was 7.9 indicating reduced photosynthetic activity. There is a considerable difference of opinion regarding the effect of pH on phytoplankton abundance. Brezonik *et al.* (1984) mentioned that high pH values promote the growth of phytoplankton and result in blooms. On the other hand Mahboob *et al.* (1988a) argued that high pH values of ph during blooming period were the result and not the cause of phytoplankton. The latter explanation seems to be more convincing in the present study.

Slow and restricted flows of stagnation favor the concentration of dissolved salts were to increase the conductance (Prather *et al.,* 1982). The conductivity values confirm the above-explained phenomenon (Table I). Dissolved oxygen of the canal showed that there were significant differences due to months (Table I). During the period from April through August the higher dissolved oxygen contents were probably due to the effect of rain and physical aeration and high blooms of phytoplankton as reported by Mahboob *et al.* (1988b). Low dissolved oxygen contents during December to March were seemed to be the result of combined effect of high salinity of water and of decreased photosynthetic activity. Carbon dioxide remained absent through the experimental period, which could be due to its higher solubility in water.

Carbonates and bicarbonates were strongly correlated with each other as these showed a gradual decrease from April to July, which ultimately resulted in the increase of total alkalinity. These findings were in line with the results of Ghandour *et al.* (1985). The water of this canal like most of the other freshwater bodies was alkaline throughout the year. In this study the total alkalinity and total hardness showed the similar trend of variations with the highest values during the period from April to July. The calcium followed by magnesium, was dominant cations and bicarbonates were the dominant anions (Table I). The concentration of calcium ranged between 34.08 to 47.00 mgL^{-1}. The comparison of means for sodium that march to July, November and December were statically similar (Table I). These results were in line with the findings of

Table I. Comparison of Means values for various Physico-chemical factors in Mangla reservoir at Sukhian, Mirpur

Months	W.T	L.P	pH	E.C	DO_2	CARB.	BICAR.	T.A.	Ca
December	16.00 J	29.00 A	7.90E	0.27B	2.07E	62.97D	196.6BC	257.DE	38.87BC
January	16.50 I	18.00 E	7.87E	1.45A	1.80E	47.25EF	191.3BC	238.G	38.60BC
February	17.50H	16.38 E	8.10C	0.51B	2.05E	47.35EF	189.00C	230.6G	34.30FG
March	20.50G	19.22DE	8.06C	0.22B	1.93E	46.00F	193.4BC	239.5G	35.05DEF
April	23.50F	21.75CD	8.13C	0.19B	2.47D	63.18D	197.9ABC	261.1CD	38.35BC
May	31.00D	21.80CD	8.22B	O.16B	2.50D	71.35BC	199.5ABC	269.2BC	40.77B
June	35.50C	29.05A	8.25B	0.15B	2.77BG	75.25AB	203.1AB	277.5B	33.63EFG
July	41.00A	27.12AB	8.60A	0.20B	3.60A	85.00A	220.00A	310.6A	36.45CDE
August	36.50B	25.87AB	8.22B	0.17B	2.95B	68.38C	198.8ABC	268.4C	35.30G
September	35.50C	24.55BC	8.10C	0.24B	2.68GD	46.82EF	194.6BC	241.5FG	34.08DEF
October	26.50E	24.47BC	7.90D	O.24B	2.55CD	51.62E	198.3ABC	249.9EF	37.77BCD
November	20.50G	23.57BC	7.96D	O.22B	2.53D	49.92EF	191.8BC	241.7FG	47.00A

Months	Mg	T.H	Na	K	Phos.	Nit.	TS	TDS	Bio
December	19.38F	177.9H	15.53CDE	1.75F	0.089AB	1.30H	945.0G	806.0E	139.0EF
January	20.63E	179.1G	19.13BCD	2.79DE	0.072ABC	2.29FG	1043.0BCD	846.3DE	197.0B
February	27.18A	229.7B	27.32A	3..38BCD	0.075ABC	2.38FG	1012.0CDE	869.5CD	142.2DEF
March	24.12D	184.4G	14.49E	1.95F	0.000D	2.97CD	1007.0CDE	825.3DE	181.8BC
April	24.30D	193.1F	13.11E	1.70F	0.037BCD	3.12BC	1010.OCDE	839.2DE	160.7CD
May	25.58CD	204.6DE	14.26E	3.25BCDE	0.040BCD	3.36AB	990.5DEF	824.7DE	182.5BC
June	31.77B	211.3D	15.10DE	4.87A	0.059ABCD	2.76DE	1095.0B	993.0A	102.0F
July	40.00A	247.0A	16..45E	2.92CDE	0.083ABC	3.56A	1058.0BC	916.0BC	142.0DEF
August	3180B	206.0DE	19.67BC	3.90B	0.031BCD	2.14G	1198.0A	948.3AB	249.7A
September	26.90C	194.9F	16.98CDE	5.70A	0.104A	0.46I	1005.0CDE	820.5DE	184.2BC
October	27.08C	203.0E	22.23AB	3.77BC	0.031BCD	2.16G	949.0FG	802.3E	147.2DE
November	27.72C	220.8C	15.22CDE	2.47EF	0.026CD	2.52EF	983.7EF	799.5E	184.2BC

Monthly means with the same letter are statistically similar at $P < 0.05$

Fouzia (1986). The concentration of potassium in this reservoir varied between 1.70 to 5.7 mgL^{-1}. Analysis of variance showed that there were non-significant differences among the six stations for potassium. Sodium and potassium followed the similar trend of variations in this study. Boyd (1984) demonstrated that potassium ions not absorbed by the plants either remain in solution or participate in ion exchange reactions with sediment. The result of this research work was in line with the findings of above worker.

A significant amount of orthophosphates was almost present throughout the experimental period. DMR test revealed that there were significant differences due to months (Table I). The level of orthophosphates varied from time to time, and it was interesting to note that these fluctuations, to significant degrees, do not seem to affect the distribution of phytoplankton species. The maximum amount of nitrates was recorded in July (Table I), which was blooming period of phytoplankton species, especially *Microcystis* (Nazneen, 1980). It shows that, in spite of nitrate being continuously used by the algae there was still in excess amount left in water. This may be due to regeneration of nitrate in water by bacterial species and by nitrogen fixing cynophyta. These results were in accord with the findings of Mahboob *et al.* (1988b). They mentioned significant contribution of nitrates and total nitrogen towards the increase in planktonic biomass. Total solids (TS) and total dissolved solids (TDS) showed similar patterns of seasonal variations. The TS additionally contain also some suspended matters. Both TS and TDS were extremely variable throughout the period of study (Table I).

Productivity in water is measured in many ways. Estimation of this by the dry weight of planktonic biomass has also been popular as reported by Watson and Carpenter (1974) and Mahboob *et al.* (1988). The dry weight of planktonic biomass including the phytoplankton and zooplankton gave a vivid picture of fluctuations in productivity. The dry weight of planktonic biomass ranged from 102 to 249.7 mgL^{-1}. The minimum (102 mgL^{-1}) amount of planktonic was recoded in June immediately after a spell of heavy rain. This was perhaps due to the fact that rains generally disturbed the fauna and flora of freshwater bodies.

Correlation coefficients of physico-chemical parameters with dry weight of planktonic biomass. The correlation coefficients between dry weight of planktonic biomass and various physico-chemical factors of Mangla reservoir at Sukhian water is shown in Table II. The dry weight of planktonic biomass was positively and significantly correlated with water temperature, dissolved oxygen and nitrates. However, Secchi's disc penetration showed negative and significant correlation with biomass. The pH, electrical conductivity showed negative and non-significant relationship. As regards the other chemical variables like carbonates, bicarbonates, total alkalinity, calcium,

Table II. Correlation coefficients of different physico-chemical parameters in Mangla reservoir at Sukhian, Mirpur

	W.T	S.D	pH	E.C	D.O	CO_3	HCO_3	T.A	Ca	Mg	T.H	Na	K	P	Nit	T.S	T.D..S	Bio
W.T		0.527	0.826	-0.508	0.904	0.604	0.770	0.716	-0.353	0.559	0.490	-0.239	0.627	0.118	0.120	0.562	0.604	0.529
S.D			0.238	-0.536	0.620	0.643	0.688	0.668	0.003	0.002	0.001	-0.392	0.251	0.237	-0.199	0.188	0.314	-0.568
PH				-0.511	0.779	0.661	0.701	0.723	0.381	0.743	0.689	-0.290	0.305	0.027	0.486	0.550	0.654	-0.068
E.C					-0.531	-0.432	-0.459	–0.450	0.087	-0.287	-0.294	0.352	-0.115	0.262	-0.103	0.013	-0.109	0.218
D.O						0.694	0.817	0.771	-0.153	0.595	0.619	-0.248	0.415	0.128	0.187	0.467	0.533	-0.636
CO_3							0.886	0.985	-0.083	0.294	0.302	-0.460	0.067	0.094	0.462	0.408	0.616	-0.286
HCO3								0.949	-0.102	0.329	0.334	-0.452	0.161	0.116	0.391	0.310	0.524	-0.329
T.A									-0.113	0.337	0.339	-0.455	0.109	0.093	0.455	0.418	0.621	-0.285
Ca										-0.514	-0.154	-0.428	-0.477	0.158	-0.169	-0.616	-0.658	0.014
Mg											0.926	0.322	0.444	0.072	0.299	0.508	0.630	-0.128
T.H												0.184	0.302	0.010	0.420	0.317	0.437	-0.138
Na													0.314	0.133	-0.322	0.048	-0.018	0.060
K														0.349	-0.406	0.384	0.437	0.014
P															-0.524	- 0.090	0.079	-0.511
Nit.																0.201	0.287	0.688
T.S																	0.873	0.585
T.D.S																		0.183
Bio.																		

magnesium, total hardness, sodium, potassium and orthophosphates with dry weight of planktonic biomass remained non-significant. While the total solids and total dissolved solids showed positive and significant relationships with biomass.

CONCLUSION

The findings of this study showed that water of the Mangla reservoir found to be suitable for drinking and freshwater fish culture purposes.

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