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Studies on Biodiversity in Relation to Seasonal Variations in Water of River Indus at Ghazi Ghatt, Punjab, Pakistan

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Abstract: The current study was started from March to December 2001 to investigate the seasonal variations in biological parameters and biodiversity in water of River Indus at Ghazi Ghat (D.G. Khan) by analyzing the frequency of occurrence, relative abundance and diversity index of planktonic life. Density and diversity of Planktonic life was used as a measure of water quality. Phytoplankton were abundant as compared to Zooplankton. 125 Phytoplankton genera were recorded. Among these 17 of Cyanophyta, 3 of Cryptophyta, 1 of Pyrrophyta, 10 of Chrysophyta, 5 of Xanthophyta, 18 of Bacillariophyta, 8 of Euglenophyta, 49 of Chlorophyta, 4 of Charophyta, 1 of Rhodophyta, 7 of Macrophyta and one genera of filamentous algae. 44 genera of Zooplankton were observed including 22 of Protozoans, 10 of Rotifers, 6 of Cladocera and 6 of Copepoda.

Key words: Biodiversity, seasonal variations, Ghazi Ghatt, river indus

INTRODUCTION

Biodiversity refers to "variety and variability among living organisms and ecological complexes in which they occur. Biological diversity occur at three different levels, these are:

i) Species diversity which embraces the variety of living organisms on earth.
ii) Genetic diversity which is concerned with variations in genes within a particular species.
iii) Ecosystem variety which is related to the variety of habitat (Ali *et al.,* 2000; Salam *et al.*, 2000a,b).

The quantity and quality of Phytoplankton is a good indicator of water quality. The high relative abundance of Chlorophyta is indicative of productive water. Blue green algae blooms results in a number of problems including off-flavor in fish, toxic substances, shallow chemical and thermal stratification, taste and odor in drinking water, phytoplankton die off and unsightly appearance (Boyd, 1981; Salam and Perveen, 1997).

Phytoplanton is the base of food web which affects the food production (Ward and Whipple, 1959; Boyd, 1981). Diatoms (Bacillariophytes have been used by ecologists to indicate pollution in water body and other variations of ecological conditions e.g. certain genera avoid acid water and very low concentration of Ca^{++} and Mg^{++} for example *Nitzschia, Gyrosigma* and *Epithemia* (Ward and Whipple, 1959; Mason, 1998).

At present time, however, the world is entering an unprecedently rapid cycle of extinction. It is likely that the ultimate for all the species is extinction. New species develop and old die off as conditions on the planet changes. Extinctions are occurring more rapidly because of the high rate and scale of destruction of natural habitats as a result of human disturbance (Salam and Mahmood, 1988).

The main objective here is not to create a new method to the many existing plankton indices, but to test the effectiveness of easily applied practical methods such as differentiating species methods for pollution and preliminary approach to a tropic evaluation of river sites based on indicator species list. In addition numerical analysis of plankton and environmental data identifies the most important regulating environmental variables and probable cause for the observed diatoms distribution patterns. The annual production of scientific work on plankton is immense, the underlying stimuli to research coming from fisheries, water supplies cultivation of aquatic organisms and pollution studies (Munawar *et al.,* 1991; Trivedi, and Gurdeep, 1992; Boyd and Tucker, 1998).

Measurement of Biodiversity in a given area over a period of time can be fair measurement of Anthropogenic effects causing destruction of an ecosystem. Some Antropogenic effects are:

- Eutrophication
- Man made lakes
- Acid rains
- Potable water supplies

- Fish farming
- Pesticides
- Oil spill dispersants
- Detergents
- Heavy metals and radioactive substances
- Warm water effluents (Boney, 1989).

Species of diatom *Stephanodisus* are useful indicators of Eutrophication. An increase in the preparation of acidophilous diatoms can be taken as indicator of acidfication i.e. *Cyctotella* spp. (diatom). Dense surface blooms of blue green algae (*Aphanizomenon*) are regarded as indicator of potential productivity in fish pond. Detergents cause death of Chrysophyceae and Prymnesiophyceae (Boney, 1989).

The present study investigated effect of monthly variation on biological parameters, productivity of phytoplanktons and zooplanktons and to explore biodiversity and its conservation in river Indus.

MATERIALS AND METHODS

Present study was conducted for water (River Indus) at Ghazi Ghatt (D.G. Khan), which is about 80 km away from Multan. The sampling study period was ranged between March to December 2001 for a total of 10 months. The samples were taken in 1 litre plastic bottles. The water samples for plankton study were preserved by using 10 ml of enugol's iodine solution and examined under a compound microscope by using 40 x and 100 x objectives.

The identification of planktons were done up to generic level by using following literature (Ward and Whipple, 1959; Anonymous, 1978, Belcher *et al.*, 1979; Boney, 1989 and Battish, 1992).

Frequency of occurrence % and Relative abundance % of each genera of Phytoplankton and Zooplankton was calculated for each month. Diversity index was calculated by using following formula:

$$\text{Diversity Index (H)} = \frac{S-1}{\ln N} \quad \text{(Boyd, 1981)}$$

Where:
S = The number of genera of Phytoplankton
N = The total number of Phytoplankton
In = Natural logarithm

RESULTS

The monthly distribution of Phytoplankton and Zooplankton is given in Table 1. 125 Phytoplankton were observed. They belong to Cyanophyta (17 genera), Cryptophyta (3 genera), Pyrrophyta (1 genus), Chrysophyta (10 genus) Xanthophyta (5 genera), Bacillariophyta (18 genera), Euglenophyta (8 genera), Chlorophyta (49 genera), Charophyta (4 genera), Rhodophyta (1 genus), Macrophyta (7 genera) and one filamentous algae (1 genus). 44 genera of Zooplankton were observed including Protozoans (22 genera), Rotifers (10 genera), Cladocera (6 genera), Copepoda (6 genera).

Relative abundance: Phytoplankton were abundant as compared to Zooplankton during the study period. Chlorophyta was relatively abundant.

In March among Phytoplankton Chlrophyta was most abundant followed by Cyanophyta, Euglenophyta, Charophyta, Chrysophyta in abundance. Among genera Ulothrix (Chlorophyta) was most abundant. Among Zooplankton Protozoa was most abundant followed by Copepoda, Cladocerans in abundance. Among genera *Difflugia* (Protozoa) was most abundant. In April among Phytoplankton, Chlorophyta was most abundant followed by Cyanophyta, Bacillriophyta, Euglenophyta, Cryptophyta, Chrysophyta in abundance. Among genera *Oedogonium* (Chlorophyta) was most abundant. Among Zooplankton Protozoa was most abundant followed by Rotifera in abundance. Among genera *Difflugia* (Protozoa) was most abundant. In May among Phytoplankton Chlorophyta was most abundant followed by Cyanophyta, Charophyta, Xanthophyta, Cryptophyta in abundance. Among genera *Closterium* (Chlorophyta) was most abundance. Among Zooplankton protozoa was most abundant. Among genera *Lionotus* (Protozoa) was most abundant. In June among Phytoplankton Chlorophyta was most abundant followed by Bacillariophyta, Cyanophyta, Xanthophyta, Euglenophyta, Pyrrophyta, Cryptophyta, Chrysophyta in abundance. Among genera *Oedogonium* (Chlorophyta) was most abundant. Among Zooplankton Protozoa was most abundant followed by Cladocera in abundance. Among genera Tinntinopsis (Protozoa) was most abundant. In July among Phytoplankton Chlorophyta was most abundant followed by Bacillariophyta, Cyanophyta, Chrysophyta, Xanthophyta, Charophyta, Euglenophyta in abundnace. Among genera Fragillaria (Bacillariophyta) was most abundant. Among Zooplankton Protozoa was most abundant followed by Cladocera in abundance. Among genera *Lacrymaria* (Protozoa) was most abundant. In August among Phytoplankton Chlorophyta and Cyanophyta were equally abundant followed by Bacillriophyta, Chrysophyta, Charophyta, Xanthophyta and Pyrrophyta in abundance. Among genera Actinosphaerium (Protozoa) was most abundant. In September among Phytoplankton Chloraphyta was most

Table 1: Monthly distribution of phyla

Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cyanophyta	-	17.29	9.5	15.5	22.4	8.41	18.73	7.6	18.5	12.5
Cryptophyta	-	-	4.3	-	-	-	-	-	-	3.1
Pyrrhophyta	-	-	-	-	-	-	-	-	-	-
Chrysophyta	37.87	-	-	2	13.6	3.2	4.68	-	2.3	6.1
Xanthophyta	15.5	-	-	-	12.34	1.6	3.12	9.75	4.65	-
Bacillariophyta	24.11	19.74	45.3	13.5	1.18	31.6	3.12	23.77	4.65	-
Euglenopyhta	-	-	-	4	0.59	0.56	-	2.17	-	4.6
Cholorophyta	1.72	38.69	29.4	55.4	7.1	32.95	39.02	15.1	20.7	40.3
Charophyta	-	4.12	-	-	-	4.96	1.56	-	2.3	14
Phaeophyta	-	-	-	-	-	0.56	-	-	-	-
Rhodophyta	6.89	-	-	-	-	-	9.37	11.88	-	-
Macrophyta	-	-	-	-	-	0.81	1.56	1.08	-	4.6
Filamentusalgae	-	-	-	0.5	-	-	-	-	-	-
Protozoa	6.88	3.04	8.83	8	4.08	8.48	10.9	13.98	18.4	6.00
Rotifera	1.72	-	0.27	-	2.36	0.56	3.12	3.25	9.2	4.5
Cladocera	-	-	-	-	-	-	-	1.08	-	-
Copepoda	-	-	-	-	1	-	1.56	5.37	-	-
Benthiccrustacean	1.72	0.54	0.81	-	-	-	4.28	-	-	-

Table 2: Monthly relative abundance of phyto and zooplankton

MONTH	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC.
Number of Phytoplankton	142	325	437	449	260	132	123	244	82	49
Number of Zooplankton	23	13	30	11	3	12	21	14	43	8
Total number of Organisms	165	338	467	460	263	144	144	258	125	57
R.A of phytoplankton	86%	96.15%	93.51%	97.6%	98.85%	91.61%	85.41%	94.51%	65.60%	85.96%
R.A of zooplankton	13.90%	3.84%	6.42%	2.44%	1.14%	8.33%	14.56%	5.42%	34.4%	14.03%

Table 3: Density indices of phytoplankton

Sample No.	Date	No. of genera (S)	Total No. of individuals (N)	In N	Diversity Index = S-1/InN
1	18.03.2001	15	142	4.95	2.82
2	21.04.2001	27	325	5.78	4.49
3	21.05.2001	20	437	6.07	3.13
4	15.06.2001	24	449	6.1	3.77
5	20.07.2001	28	260	5.56	4.85
6	21.08.2001	24	132	4.88	4.71
7	21.09.2001	16	123	4.81	3.32
8	26.10.2001	22	244	5.49	3.82
9	28.11.2001	36	82	4.4	7.95
10	26.11.2001	16	49	3.89	4.37

Table 4: Density indices of zooplankton

Sample No.	Date	No. of genera (S)	Total No. of individuals (N)	In N	Diversity index = S-1/InN
1	18.03.2001	8	23	3.13	2.23
2	21.04.2001	4	13	2.56	1.17
3	21.05.2001	5	30	3.4	1.17
4	15.06.2001	4	11	2.39	1.25
5	20.07.2001	3	3	1.09	1.83
6	21.08.2001	5	12	2.48	1.61
7	21.09.2001	7	21	3.04	1.97
8	26.10.2001	7	14	2.63	2.28
9	28.11.2001	10	43	3.76	2.39
10	26.11.2001	6	8	2.07	2.41

abundant followed by Bacillariophyta, Charophyta, Macrophyta, Euglenophyta, Cyanophyta, Xanthophyta, Chrysophyta in abundance. Among genera *Cocconeis* (Bacillariophyta) was most abundant. Among Zooplankton Protozoa was most abundant followed by Rotifera and Copepoda in abundance. Among genera *Lecane* (Rotifera) was most abundant. In October among Phytoplankton Chlorophyta was most abundant followed by Bacillaeophyta, Cyanophyta, Charophyta, Euglenophyta, Xanthophyta, Macrophyta, Pyrophyta, in abundance. Among genera Dictyosphaerium (Chlorophyta) was most abundant. Among Zooplankton protozoa was most abundant followed by Copepoda, Cladocera, and Rotifera in abundance. Among genera

Raphidiophrys (Protozoa) was most abundant. In November among Phytoplankton Chlorophyta was most abundant followed by Macrophyta, Bacillariophyta, Chrysophyta, Cyanophyta, Euglenophyta, Xanthophyta, Rhodophyta, Pyrrophyta in abundance. Among genera *Oocystis* Chlorophyta was most abundant followed by Rotifera in abundance. Among genera *Triploceras* (Rotifera) was most abundant. In December among Phtytoplankton Chlorophyta was most abundant followed by Bacillariophyta, Macrophyta, Euglenophyta, Cyanophyta, Chrysophyta in abundnace. Among genera *Aulosira* (Cyanophyta) was most abundant. Among Zooplankton Protozoa was most abundnat followed by Rotifera. Among genera *Lacrymaria* and *Epistylist* (Protozoa) were most abundant (Table 2).

Diversity index of phytoplanktons ranges from 2.82 to 7.95. It is minimum in March and maximum in November. It shows moderate trend in April, decreasing in May and then increasing from June to August, decreasing in September and then increasing in October and December (Table 3).

Diversity index of zooplanktons ranges from 1.17 to 2.41. It is maximum in December and minimum in April and May. It shows increasing trend in March, then decreasing from April to May, again increasing from June to July then decreasing. It shows increasing trend from September to December (Table 4).

DISCUSSION

Water quality deals with the physical, chemical and biological characteristics in relation to all other hydrological properties (Leonard, 1971). Rivers and lakes are very important part of our natural heritage. They have been widely utilized by mankind over the centuries, to extent that very few, if any are now in natural condition (Lloyd, 1992).

River and lakes are important part of nature and their water quality should be maintained. Industrial revolution has led to the significant changes in river water chemistry. They have been widely used by mankind over centuries, to the extent that very few are now in natural condition (Lloyd, 1992; Mason, 1998).

Diversity indices are good indicators of pollution in aquatic ecosystem (Mason, 1998). In the present study, diversity index of phytoplankton ranged from 2.82 to 7.95 (Table 3). Diversity index greater than 3 indicates clean water. Values in the range of 1-3 are characteristics of moderately polluted conditions and values less than 1 characterize heavily polluted condition (Mason, 1998). Diversity index of phytoplanktons was greater than 3 in all months except March (2.82) which indicate that water is suitable for the growth of phytoplanktons. The diversity index of water river Indus was smaller than 3 due to sampling artifact. The diversity index of zooplanktons ranged from 1.17 to 2.41 (Table 4). Diversity index was less than 3 throughout the study period therefore poor for zooplanktons (Table 4).

Almost all the species that increase their populations, at some time during the year are ever present in the water as small residual populations. Some may form resting stages in the surface sediments and new one may be brought in from time to time on water birds or by wind or floods. There is, then, a great result of varied forms, each best fitted to exploit a particular set of conditions in the water, when its population will increase and each less able to compete in other conditions, when its population will decline the changing water mass throughout the year, in turn selects the species better fitted for particular time and in turn, precipitates their decline. The result is a procession of over tapping, large population against a background of small, declining population (Wilson, 1988; Nielsen, 1995; Moss, 1998).

These results may be either due to sampling artifact or due to seasonal variations. Some species are better adapted in warm conditions and some in cold conditions that is why results shows great variations. An other reason is that in winter water level falls down, due to which O_2 deficiency occur and planktonic life is effected. Otherwise at Ghazi Ghat no sewage problem or any other pollution is reported during study period.

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