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Effect of some abiotic factors on zooplankton productivity in a subtropical pond in Jammu, India

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ABSTRACT

Study of a water body at Jammu was carried out for a period of one year from January 2004 to December 2004 to observe various water quality parameters and zooplankton dynamics. Temperature, Dissolved oxygen, Free Co_2, Carbonates, Bicarbonates, Calcium, Magnesium and Chlorides were estimated on monthly basis. A total of 12 zooplankton species were identified comprising of three major planktonic groups viz. cladocera, rotifera, and copepoda. Moina among cladocera and Brachionus among rotifera were present at high as well as low DO level, therefore revealing their wide tolerance for oxygen variation. Dominance of Copepods during period of high pollution characterized by high temperature, high Free CO_2 and low level of Ca^{++} and Mg^{++} reveals their importance as pollution indicators. Zooplankton population was mainly contributed by cladocerans (46.39%) followed by rotifers (44.12%) and copepods (9.48%).

Keywords: Subtropical pond, zooplankton, abiotic factors, water quality**.**

INTRODUCTION

Water is the basis of existence of all life forms in our biosphere. Of all the planet's renewable resources, water has a unique place. It is essential for sustaining all forms of life, food production, economic development and for general well being. Accelerated urbanization and industrialization has made water bodies susceptible to various threats. Aquatic ecosystem is exposed to local disturbances, Suryanaraynan (1991). According to Laal *et al.* (1986) and Nath (2001), thorough knowledge of physico-chemical conditions prevailing in a water body is important for the assessment of water quality and extent of pollution. Prevailing physicochemical characteristics of water regulates the population dynamic and distribution of the inhabiting zooplanktons. A knowledge of both the organism and its environment is, therefore, very essential and pre-requisite for understanding the various life history parameters of aquatic organisms, Weltch (1952).

Zooplanktons serve as an important link in the food chain of an aquatic environment. They constitute a major portion of diet of fishes and play a very important role in nutrition particularly when developing young fish switches from endogenous to exogenous mode of feeding. Live feeds are additionally superior to compounded ones, because they are readily ingested and digested rapidly do not affect water quality, besides, having essential inherent growth promoting factors, Kinne (1977) and Watanabe *et al.*, (1983).

Apart from serving as important fish food organism, zooplanktons are considered as indicators of water quality. The distribution and abundance of these organisms in polluted and unpolluted water can provide useful information on the health of the water body, Gajbhiye *et al.*, (1981).

It was with this background that present work was undertaken to analyze the physico-chemical parameters, seasonal abundance of

zooplankton and the relationship between the former and latter.

MATERIAL AND METHODS

The study area, Janipur pond lies 10kms west of Jammu (old) city. The pond is spring fed, covers 0.023 Sq. kilometer surface area and has mean depth of 1 meter samples were collected from three study stations raised along the periphery. Station-I (S-I) located along the margin of the road and is void of vegetation. Station-II (S-II) is characterized by dense vegetation and is mainly used by cattles for drinking and bathing. Station-III (S-III) receives water from catchment area.

Temperature was recorded with the help of a thermometermeter graduated up to 100°C. pH of the water was determined by a field pH meter (Hanna instruments Italy). Dissolved oxygen, Free carbon dioxide, Carbonates, Bicarbonates, Calcium, Magnesium and Chlorides were estimated by applying method suggested by Indian standard methods (1973) and APHA (1985). Analysis of zooplankton was carried following Edmondson, (1959) and Needham and Needham (1962).

RESULT S AND DISCUSSION

Monthly variations in various physico-chemical factors are shown in Table-I. Air temperature ranged from minima of 18°C in the month of January to maxima of 39°C in May. Water temperature showed a corresponding variation and fluctuated from a minimum of 17°C in January to a maximum of 34°C in August. The water temperature closely followed air temperature as earlier advocated by Qadri and Yousuf (1980), Raina *et al*. (1982), Singh and Singh (1995), Panday and Lal (1995), Sharma (2001), Shafiq (2004), Sawhney (2004) and Shvetambri (2007). The rise in temperature (Air and Water) is primarily due to increased day length (Summer 14 hours and winter 10 hours) and sharp angle of incidence during summers. pH of the water remained mostly alkaline except for the months of June (6.8) and September (6.1). pH was low, when Free CO_2 and HCO_3 in the water-body were quite high (Table-I) and therefore were major contributing factors towards acidic nature of water during the period of study. Similar observations were made by Lal *et al*. (1986) and Charkraborty *et al*. (1995). A fall in pH was observed in monsoon and was attributed to CO_3^{2-} and increased Free CO_2. This has been supported by Qadri and Yousuf (1980) who maintained that the rain water and associated decaying organic matter inundating into the waterbody are responsible for such a change in pH. Dissolved oxygen of the pond fluctuated from a minima of 3.6 mg/l (August 2004) to a maxima of 15.2 mg/l (November 2004). The rise and fall in temperature was responsible for an increase and decrease in the DO content respectively and also affected the photosynthetic activities of Chlorophyll bearing organisms. The results presented in this study are in accordance with result of earlier workers, Sarwar and Parveen (1995), Joshi and Singh (1997) and Masud *et al*., (2002). Low DO during post monsoon period was probably due to the turbidity and waste material entering into water body along with rainwater. Higher value of DO during winter and low during post monsoon is a well-known characteristics feature of stable aquatic ecosystem as has already been observed by many workers , Lal *et al*., (1986). Monthly variation in Free CO_2 is shown in Table-I. Higher values of Free CO_2 during post monsoon months corroborate with the finding of Laal *et al.* (1986). An increase in Free CO_2 during post monsoon months is broadly attributed to added load of decayed organic matter brought by rainwater. Absence of Free CO_2 during November and December at all the three stations may be being of its uptake by phytoplankton and submerged rooted vegetation. Monthly variation in Carbonate (CO_3^{2-}) and Bicarbonate (HCO^{3-}) are shown in Table -I. Absence of carbonate (CO_3^{2-}) during most of the months may explain the presence of Free carbon dioxide. An inverse relationship between carbonates and Free CO_2 has been advocated by Goldman and Horne (1983), Singh (1995) and Sharma (1999).

The value of bicarbonate increased during summer months and decreased during winter. The rainfall plays a significant role in increasing the concentration of bicarbonate.

Calcium (Ca^{++}) and Magnesium (Mg^{++}) also showed well-marked seasonal variation throughout the investigated period. Higher values of Ca^{++} at station-II might be due to the allochthonous material especially the excretory wastes of cattles, which

Table - 1: Monthly variations in Physico-Chemical Parameters of a Pond of Jammu

Months	Air Temperature(°C)			Water Temperature (°C)			PH		Dissolved Oxygen(mg/l)				Free Carbondioxide(mg/l)		
	SI	SII	SIII	SI	SII	SIII	SI	SII	SIII	SI	SII	SIII	SI	SII	SIII
January 04	24	18	22	20	17	19	7.7	7.7	7.8	8.8	8.8	9.2	2	4	2
February	28	28	28	25	24	25	7.1	7	7.1	5.2	5.6	5.1	2	4	2
March	28	28	28	26	24	24	7.1	7.0	7.1	4.0	4.8	4.1	3	3	4
April	31	31	31	28	27	28	7.0	6.3	6.8	9.2	8.8	10	4	6	4
May	39	38	39	33	31	34	7.1	7.2	7.2	6.8	6.0	6.4	4	5	5
June	33	33	33	30	30	29	6.8	6.7	6.8	9.2	8.8	8.4	12	12	12
July	31	31	31	29	29	29	7.8	7.5	7.8	6.0	5.6	5.6	7.1	7.2	7.1
August	37	32	34	34	28	30	7.2	7.3	7.2	3.6	3.5	3.6	6.2	6.8	6.3
September	30	29	30	27	27	28	6.1	6.2	6.1	4.8	5.2	4.8	18	18	18
October	28	22	26	23	20	24	7.9	7.5	7.5	8.8	9.2	11.2	7.2	7.3	7.1
November	29	23	28	25	19	25	8.8	8.7	8.7	14.0	15.2	12.8	-	-	-
December	28	21	24	25	19	21	7.9	7.9	7.9	8.8	6.0	8.0	-	-	-
Mean	30.5	27.9	29.3	27.0	24.5	26.3	7.3	7.2	7.3	7.43	7.36	7.38	6.55	7.33	6.75
S.D.	3.98	5.70	4.40	3.83	4.6	3.9	0.65	0.66	0.63	2.82	2.92	2.88	4.78	4.29	4.66

account for increased values of Ca^{++}. It was observed that the Ca^{++} levels increased at low temperature mainly due to reduced metabolic rate and reduced evaporation. These observations get support from the finding of Nath (2001) and Kour (2002). Higher values of Mg^{++} at S-II were due to the influx of pollutants from catchment area and faecal matter of cattles visiting the pond. Table-II shows the seasonal variation in chloride content of Janipur pond. The higher level of chloride was recorded during summer and monsoon period (June to October). This higher level was probably due to rainfall leading to direct entry of allochthonous material carrying appreciable amount of faecal and other organic decaying matter from embankments into the pond. Similar trend of increase in chloride level has been reported by Sinha *et al*. (1992), Singh (1995) and Gurumayum *et al*. (2002).

It was observed that zooplankton undergo both qualitative and quantitative seasonal dynamics concomitant with abiotic and biotic changes (Table-III). The zooplankton acquired maxima in the month of January-March when temperature was recorded to be low (24°C) and pH slightly alkaline or neutral (7-7.7). Subsequently a minima in zooplankton population was recorded in the month of May and August onwards (August-September) which was due to high temperature (Atmospheric temperature, 39°C) and turbidity of water. Maximum density of plankton was probably due to cumulative effect of high transparency low temperature and high dissolved oxygen. A similar pattern in zooplankton variation i.e., a minima in summer and maxima in winter has been recorded by a number of workers, Tamot and Bhatnagar (1989); Joshi *et al.*, (1996); Singh (2004) and Sawhney (2004). It has been well recorded that pH of water has an important bearing on plankton production and during the present study, it was observed that pH ranging from 7 to 8.8 was favorable for the growth of plankton. Free CO_2 was recorded to show inverse relationship with plankton production, as during the month of September, due to high value of free CO_2 zooplankton were completely absent-. DO was recorded to be directly proportional to zooplankton production, since the maximum of cladocera (2982/l) was recorded when concentration of DO was highest (9.2 mg/l) during month of January.

Seasonal fluctuation in the zooplankton population was due to dominance of one or more than one constituent zooplankton as a result of their growth in number. The major groups constituting the zooplankton population were rotifers, cladocerans and copepods. The winter season was dominated by a population boom of cladocerans especially *Daphnia* while copepods dominated the summer season.

During the course of present study seven species of rotifers were recorded (Table- III). A peak in rotifer population was recorded during month of March (2583/l), whereas minima was recorded during the month of August (3/l). Rotifer fauna was found to be completely absent in the months of May and September, possibly be due to temperature rising beyond acceptable range (28°C)--. Rotifer fauna was dominated by *Brachionus* sps. and was found to be available at a wide range of temperature (19-30°C) thus exhibiting eurythermal character. On the contrary, the other rotifer species such as *Filinia*, *Polyarthra*, *Testudinella*, *Asplanchna*, *Hexarthra*, *Keratella* were found during a relatively narrower thermal range (17-24°C) thus exhibiting stenothermal behaviour. Similar results have been reported by Malhotra *et al*. (1995).

Dissolved Oxygen in water body has been considered to be an important ecological factor for survival of rotifers, Sharma & Srivastava (1986). During the present investigation DO was recorded to be highest in November when the rotifer sps. such as *Filinia* (376/l), *Brachionus* (33/l), *Polyarthra* (172/l), *Testudinella* (17/l) and *Hexarthra* (5/l) recorded their presence, however, out of these only *Brachionus* sps. exhibited its presence in August when DO level was recorded to be lowest (3.6 mg/l) in the pond. A qualitative peak of rotifer fauna observed during the month of November. This could be attributed to the combined effect of favourable temperature, increased Ca^{++}, Mg^{++} & optimum pH of water. A single quantitative peak was observed during the month of March, when *Brachionus* sps. (1744/l) and *Asplanchna* sps. (802/l) dominated. Maximum number of cladocerans were recorded during the month of January (2993/l) whereas minimum number during the month of August (15/l). No Cladoceran were however found in samples taken in month of March to June and September to

Table -2 : Monthly variations in Physico-Chemical Parameters of a Pond of Jammu

Parameters	Carbonate(CO_3^{2-}) (mg/l)			Bicarbonates(HCO_3) (mg/l)			Calcium (Ca^{++}) (mg/l)			Magnesium(Mg^{++}) (mg/l)			Chloride(Cl^-) (mg/l)		
Months	**SI**	**SII**	**SIII**	**SI**	**SII**	**SIII**	**SI**	**SII**	**SIII**	**SI**	**SII**	**SIII**	**SI**	**SII**	**SIII**
Jan	-	-	-	506.3	524.6	506.3	28.860	43.30	39.29	33.53	28.67	32.07	44.90	45.91	44.90
Feb	-	-	-	402.6	359.9	396.5	41.70	47.31	43.30	21.87	20.41	20.41	45.90	41.91	43.91
Mar	-	-	-	396.5	353.8	390.4	40.1	53.73	40.1	21.87	17.98	21.87	43.91	41.91	47.90
Apr	-	-	-	372.1	433.1	469.7	17.64	18.44	17.64	20.89	18.46	34.02	67.86	61.87	69.86
May	-	-	-	707.6	658.8	683.2	16.84	18.44	16.84	23.32	21.87	21.87	75.84	69.86	73.85
Jun	-	-	-	750.3	744.2	744.2	10.42	13.63	12.03	17.98	12.15	16.52	103.79	141.71	105.78
Jul	-	-	-	738.1	713.7	725.9	19.24	16.84	18.44	10.69	13.12	11.17	99.8	97.80	101.79
Aug	-	-	-	786.9	744.2	762.5	34.48	32.88	33.68	15.06	14.58	14.58	87.82	83.83	85.82
Sept	-	-	-	799.1	805.2	829.6	34.48	32.88	33.68	15.06	14.58	14.58	91.81	93.81	83.83
Oct	-	-	-	699.9	663.8	667.5	41.70	45.71	40.90	22.84	20.89	29.16	87.82	93.81	121.75
Nov	144.0	186.0	156.0	401.2	422.4	409.9	42.50	45.71	52.13	20.41	32.56	27.70	87.82	113.79	109.78
Dec	87.0	156.0	186.0	502.5	507.7	504.9	30.47	27.66	38.49	36.93	47.38	37.90	75.84	79.84	79.84
Mean	115.5	171.0	171.0	586.09	577.6	590.8	29.53	33.04	32.21	21.70	21.88	23.48	76.09	80.50	80.75
S.D.	28.5	15.0	15.0	163.4	155.4	153.4	10.88	13.39	12.23	7.07	9.65	8.24	20.36	29.08	25.02

Table - 3 : Monthly variations in Zooplankton abundance of a pond of Jammu

MonthsGenera Rotifers	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Brachionus	-	3	1744	-	-	10	14	3	-	337	33	130
Filinia	-	108	11	-	-	-	-	-	-	4	376	163
Asplanchna	-	4	802	114	-	-	-	-	-	-	-	54
Keratella	10	-	-	-	-	-	-	-	-	-	3	6
Testudinella	-	-	-	-	-	-	-	-	-	12	17	-
Polyartha	-	-	26	-	-	-	-	-	-	-	172	-
Hexartha	-	-	-	-	-	-	-	-	-	-	5	-
Total	10	115	2583	114	-	10	14	3	-	353	606	353
Cladocerans												
Daphnia	2982	1191	-	-	-	-	14	-	-	-	-	17
Moina	5	4	-	-	-	-	34	15	-	-	32	19
Moinodaphnia	2	5	-	-	-	-	-	-	-	-	-	25
Ceriodaphnia	4	6	-	-	-	-	-	-	-	-	-	20
Total	2993	1206	-	-	-	-	48	15	-	-	32	81
Copepods												
Mesocyclops	-	18	50	120	130	235	298	30	-	5	-	-
Grand Total	3003	1339	2633	234	130	245	360	48	-	358	638	434

October. This complete absence of cladocerans may be attributed to high temperature. Among Cladocerans, *Daphnia* dominated (2982/l). Cladocerans were mostly present during the moderate temperature range (17-20°C) as documented by Saint-Jean (1983) who reported that cooler periods favour the cladoceran dominance. Rotifer production exhibited an inverse correlation with DO and free CO_2. During the present investigation DO was recorded to be highest 15.2 mg/lt in November when *Moina* showed its presence. This species was also present in the month of August (15/l) at lowest DO level, revealing its wide tolerance for oxygen variation. Other cladocerans were more or less absent during the months of low DO level. Maximum qualitative abundance of cladocerans was recorded during the month of December, January and February which was probably due to the combined effect of favourable temperature, high Ca^{++}, Mg^{++} and optimum pH of water. From above discussion it appear that zooplankton population showed two peaks, 1st during January and February which was exclusively due to *Daphnia* species. During this period temperature was low (17 °C and 19°C) and DO was high (8.8 and 9.2 mg/l). February onwards, water temperature observed a gradual increase (19 °C-34°C) and this resulted in sudden disappearance of *Daphnia* and zooplankton fauna was exclusively dominated by rotifers. After March till July, zooplankton fauna was characterized by high free CO_2, low level of Ca^{++} and Mg^{++}, high temperature condition (upto 34°C in May at S-III). Prevalence of copepods as a dominant group during the presently studied period strongly indicates copepods to be better tolerant of temperature as compared to rotifers and cladocerans.

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