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RESEARCH ARTICLE

Zooplankton diversity and its relation to various limnological parameters in the Arid region of Bikaner, Rajasthan

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Abstract

Aquatic ecosystems consist of physico-chemical factors and biotic factors. Physico-chemical factors are not alike in all water bodies; they change either due to natural or artificial processes. Zooplanktons are good indicators of the change in water quality because they are strongly affected by environmental conditions and respond quickly to changes in water quality. The present study was carried out for the period of fifteen months from January 2009 to March 2010. The study was carried out at three desert water ponds around Bikaner. The objective of the study was to quantify the relative importance of local environmental conditions and diversity of the principal zooplankton species with in sampling site. Limnological parameters were investigated for temperature, pH, EC, dissolved oxygen, free CO_2, hardness and alkalinity. Among cations (Ca^{++}, Mg^{++}, Na^{+}, K^{+}) and anions (CO_3^{--} , HCO_3^{-}, Cl^{-}, SO_4^{--}, PO_4^{--}, SiO_2^{--}, NO_3^{--}) were observed. They were within tolerable range. Even under harsh and hostile environmental conditions of desert a variety of zooplanktonic faunal species was found which are typically adapted for the given conditions of existence, it constituted total of 63 genera of zooplankton of which Protozoa constituted (20 taxa) followed by Crustacea (14 taxa), Rotifera (12 taxa), Insecta (11 taxa), Oligochaeta (3 taxa), Turbellaria, Hirudinea and Acari (1 taxa each) were recorded in decreasing order.

Introduction

India with her unique geological history, highly diverse physiography, monsoon climate with extremes of temporal and spatial variability, and high biotic diversity is endowed with equally diverse aquatic habitats. Among the six natural life supporting ecosystem types of earth, desert occupy roughly one seventh of the land surface. The state of Rajasthan marks the western territory of the country. The panoramic view of the state is mesmerizing and with its lofty hills of the Aravallis and the golden sand dunes of Great Indian, Thar Desert. In this desert, fewer but varied bodies of water are present in the form of ponds, tanks, reservoirs and a few perennial lakes. Most of the bodies of surface water are shallow and ephemeral.

Desert limnology is best defined in terms of hydrography and limited to regions where no run off reaches the sea, the climes were closed basins occur. It exists only where evaporation substantially exceeds precipitation; this broadens the concept of desert to include a spectrum from semiarid steppes or prairies to the most parched and black lands caps of the World. Desert waters are similar by being high in electrolytes and are quite different from the dilute waters of humid regions. The chemical limnology of arid land deals specially with evaporation, concentration, precipitation of compounds, and relative changes in ionic abundance. A review of desert limnology was published by Cole in (1968) and Bayly and Williams (1973) have summarized further details. Desert lakes are less concentrated than would be expected on the basis of their age and the annual input of salt. Moreover, many of them show different ionic composition from salterns and bitterns. Such discrepancies are explained by two facts first, there are seven or eight mechanisms by which salt can be lost from closed basins, and second, the dilute

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waters that initiate the evaporation series may be strikingly different in ionic mixtures. Details of these methods were reviewed by Hutchinson (1957) and Cole (1968).

Bikaner region represents the extreme arid conditions where in various limnological and hydrobiological investigations have been made over last two decades. Bahura (1989) worked on plankton and periphyton of a temple tank, respectively environmental monitoring of Lake Kolayat was made by Sidhu (1991). The word 'Plankton' coined by Hansen in 1887. Among this, zooplanktons are minute aquatic animals that are weak swimmers and they drift in water columns of ocean, and fresh water bodies. The survival strategies of the zooplankton have been reported in a few studies and examined in some detail (Chatterji and Gopal, 1998). The rotifers constitute a phylum found almost exclusively in fresh water (Wallace and Snell, 1991). Sharan (2006) studied a planktonological study on a village pond in relation to ionic regime of the medium. Saxena (2011) investigated the biodiversity and ecology of some eutrophic temple tanks in the Indian desert with special reference to bioindicators. The present study aimed at evaluating zooplankton community of desert waters with special reference to their limnological findings.

Material and Methods

Study area

For this purpose, three limnocrene desert water ponds namely Kolayat, Gajner and Kodemdesar were chosen for detailed study during 2009-2010. These ponds present with in distance of 55 km from Bikaner city. Different study stations in the ponds were marked and sampling of water and planktons at these stations was made at monthly intervals.

Physico-chemical analysis:

Limnological parameters viz., temperature, pH and EC were recorded by a battery operated digital portable water analyzer kit (Model: Century CK710). Depth of water was measured using a weight tied to a graduated nylon rope. Transparency was recorded with the help of standard Secchi disc of 20cm diameter. DO was estimated by Winkler's titration method. The free CO_2, total alkalinity, calcium, magnesium, chloride and salinity were measured by titrametric method while nitrate, phosphate, silica, sulphate, sodium and potassium were analyzed by spectrophotometric and flamephotometric methods respectively. Standard methods as prescribed by APHA-AWWA-WPCF (1975), Golterman et al. (1978) and Saxena (1989) were followed.

Collection, preservation and identification of Zooplankton:

Zooplanktons were collected by filtering 50L of water through plankton net made of bolting silk (No.25, 0.3 mm mesh). The Samples were transferred to the narrow mouthed bottles of 100ml and preserved with 4% formaldehyde. Systematic identification of zooplankter was made following Edmondson (1966), Michael (1973), and Tonapi (1980).

Result

The data obtained from different hydro chemical parameters are presented in Table 1. In keeping with the thermal trend of hot desert, wide seasonal fluctuations in water temperature were evident. Minimum temperature was noted during January 10^0C which continuously increased, touching the peak 38^0C in June. The pH of the investigated ponds varied between 7 to 9.5 throughout the sampling period. The electrical conductivity of the ponds exhibit a variation within the range of 0.072 to 0.956 (mmhos/cm). The DO in the studied ponds revealed a variation within range of 0.8 to 11.3mg/l.

Free CO_2 was maximum to be 88mg/l while minimum value was 2.4mg/l. Total alkalinity values ranged between 46 to 164mg/l and it shows interrelationship with aquatic life forms. The pond waters depicted the ranged of 51.3 to 139.3mg/l for calcium, 1.48 to 87.23mg/l for magnesium, 0.24 to 53.1mg/l for sodium and 6.9 to 51.9mg/l for potassium.

In general the ionic composition of pond waters revealed the predominance of chloride and calcium over the other ions and therefore the ionic progression was: ($Cl^- > HCO_3^- > SO_4^{--} > CO_3^{--}$ and $Mg^{++} > Ca^{++} > K^+ > Na^+$). Among plant nutrients, the maximum value of nitrates and phosphates was 2.319 mg/l and 0.009 mg/l respectively. This is an important parameter in view of its role in increased productivity rate of ecosystem. The silica content was also with in moderate range from 0.019 to 2.319 mg/l but it fluctuated throughout the year.

Zooplankton Community

Table 2. represented the abundance and distribution of zooplankton is guided by a variety of ecological factors. However limnological parameters are extremely variable from place to place and from time to time. In such conditions it is rather difficult to draw specific conclusions about the individual effects of these parameters on population densities of zooplanktons. But it can be expressed in general that the fluctuating patterns of physico-chemical conditions of water affects the distribution of zooplankton.

This microscopic taxonomical study of zooplankton revealed that sixty three genera which inhabited the water bodies. The Protozoa was found as dominant group, showed twenty genera among three water bodies. Crustaceans were represented by fourteen genera and peak value was noticed in spring followed by winter, lowest numbers were present in summer season. Rotifers showed twelve taxa and also its maximum count noticed in spring season. Insect fauna showed eleven taxa of which seven were the larvae of insects. The abundance of mud, debris and decaying matter of the ponds provide suitable nourishment for the survival and growth of annelids so it is followed by three Oligochaetes and one Hirudinea.

The population was rise to a higher level in the winter as a result of favorable environmental conditions, including temperature, dissolved oxygen and the availability of abundant food in the form of bacteria, nanoplankton and suspended detritus. The summer population of total zooplankton was fall during the monsoon due to a dilution effect. Thus study determined that abundance of zooplankton has been governed by the cumulative effect of physico-chemical and biological variables.

Table 1. Phsico-chemical characteristics of water of Kolayat Pond, Gajner Pond and Kodemdesar Pond. All values are in (mg/l) except otherwise mentioned

S.No	Parameters	Kolayat Pond		Gajner Pond		Kodemdesar Pond	
		Min	Max	Min	Max	Min	Max
1	Water Temp.(^{o}c)	10	36	13	35	16	38
2	Depth (m)	0.6	3.0	1.2	3.0	0.9	2.11
3	Transparency(cm)	10	85	28	175	10	195
4	pH	7	8.5	7.1	9.5	7.2	9.0
5	EC(mmhos)	0.107	0.617	0.072	0.153	0.098	0.956
6	Dissolved oxygen	0.8	8.0	0.9	11.3	2.07	10.15
7	Free CO_2	8.0	82	6.0	12	2.4	88
8	Total Alkalinity	88	164	46	130	50	136
9	Total Hardness	18	220	24	162	39	88
10	Calcium	51.3	139.3	40.97	117	58.02	89.4
11	Magnesium	1.48	31.72	14.12	87.23	20.2	87.2
12	Sodium	10.4	53.1	0.24	23.39	1.19	9.02
13	Potassium	10.21	42.6	6.9	18.9	11.4	51.9
14	Carbonate	Absent		22.17	64.9	9.7	39.3
15	Bicarbonate	56.12	143.2	33.6	152.4	41.2	97.3
16	Nitrate	0.417	2.319	0.019	0.287	0.81	1.823
17	Phosphate	0.0007	0.009	0.0003	0.008	0.0001	0.004
18	Silica	0.9731	4.8103	0.9732	4.0216	0.8413	4.4172
19	Sulphate	23.127	115.19	20.96	92.72	39.04	65.92
20	Chloride	35.4	170.1	62.09	163.07	88.13	136.5
21	Salinity	64.95	312.11	124.13	299.23	153	409.6

Table 2. List of identified Zooplanktons from three desert water bodies.

S.No.	***PROTOZOA***	S.No.	***ROTIFERA***
1	*Coleps hirtus*	1	*Keratella cochlearis*
2	*Ophryoglena flava*	2	*Keratella valga*
3	*Chilodonella cucullulus*	3	*Keratella quadrata*
4	*Paramecium caudatum*	4	*Brachionus calyciflorus*
5	*Paramecium bursaria*	5	*Brachionus havanaensis*
6	*Litonotus fasciola*	6	*Brachionus quadridentata*
7	*Metopus es.*	7	*Brachionus bidentata*
8	*Euplotes plumipes*	8	*Monostyla lorica*
9	*Glaucoma pyriformis*	9	*Lecane lorica*
10	*Dileptus sp.*	10	*Filinia longiseta*
11	*Stentor coeruleus*	11	*Platyias polyacanthus*
12	*Chilodenella uncinata*	12	*Platyias platulus*
13	*Stylonychia pustulata*		***CRUSTACEA***
14	*Euglena sociabilis*	1	*Cyclops scutifer*
15	*Euglena spirogyra*	2	*Cyclocypris cruciata*
16	*Euglena mass*	3	*Cyclocypris sp.*
17	*Amoeba proteus*	4	*Nauplius larva*
18	*Amoeba radiosa*	5	*Stenocypris malcolmsoni*
19	*Chilomonas paramecium*	6	*Cypridopsis acculeata*
20	*Condylostoma patons*	7	*Ceriodaphnia reticulata*
	TURBELLARIA	8	*Alonella diaphana*
1	*Porhynchella minuta*	9	*Eurytemora affinis*
	INSECTA	10	*Diaptomus glicialis*
1	*Dipteran larva*	11	*Mesocyclops leukarti*
2	*Odonata larva*	12	*Bosmina longirostris*
3	*Caddisfly larva*	13	*Daphnia carineta*
4	*Midges larva*	14	*Diaptomus minutes*
5	*Rat tailed maggot larva*		***OLIGOCHAETA***
6	*Dytiscidae larva*	1	*Tubifex*
7	*Chironomus larva*	2	*Berosus*
8	*Mayfly nymphs*	3	*Aeolosoma hemprichi*
9	*Hydrocoptus subvittatus*		***HIRUDINEA***
10	*Orectochilus discifer*	1	*Hemiclapsis marginata marginata*
11	*Plea pallula*		***ACARI***
		1	*Water mites*

Discussion

The areas under study are marked by the scarcity of natural resources of which water is most vulnerable. This vital resource is not only scarce but is also qualitatively inferior in terms of high salinity and alkalinity. Environmental factors and chemical aspects of the water body have major effect on biodiversity of aquatic system. The productivity of any aquatic water body depends on the amount of plankton present in it. During present study different desert water ponds (Kolayat, Gajner and Kodemdesar) were explored to determine the relationships among the principal cations, anions and various other limnological parameters and zooplankton community under following heads.

The fifteen months variation of about 28^0c in water temperature was in tune with the other reports from the region (Saxena, 1982; Mittal,1996). The alkaline nature of waters is a common feature in this arid region (Misra et al.,1978). Sharma (2003) in his review pointed out that desert waters around Bikaner held an EC in the range of 0.057 to 1.850

(mmhos/cm). Variation of oxygen in water depends upon the temperature of water, which influence oxygen solubility. The hardness of waters ranged between 18 to 320mg/l and sometimes maximum value indicating hard water nature of the ponds (Moyle, 1945). The hardness directly seems related to the source of Ca^{++} and Mg^{++} which owes its origin to the lacustrine deposits in valley (Wadia, 1961). High ionic concentration is characteristic of desert water and high rate of evaporation is noted as one of the major factors responsible for it (Cole, 1968). In general the ionic progression of pond waters were very close to the well known trend of ions was reported by Jakher et al. (1990) in closed basin Didwana Lake of Rajasthan. The standard value of nitrate for inland surface water is 0.1 mg/l (NEERI 1988). Schindler et al. (1971) concluded from nutrient studies on small lakes that phosphorus is a limiting factor in inland waters. In Indian desert, Mittal (1996) recorded up to 7.559 mg/l silica in temple tank.

In natural aquatic ecosystems, zooplankton organisms by their heterotrophic activity initially handle and manage the biogenic organic materials of primary and secondary production to a considerable extent. Tonapi (1980) has opined that protozoans occur in all the conceivable habitats, over a wide range of chemical and physical environment. The cladocerans and copepods are widely referred as tolerant species, present in all kinds of waters (Verma and Dalela, 1975). Hutchinson (1967) observed that *Brachionus* species are very common in temperate and tropical waters, which indicates alkaline nature of the water bodies. Insects have the capability to adapt to varied aquatic habitats due to their extraordinary structural organization (Tonapi, 1980). The summer population of total zooplankton falls during the monsoon due to a dilution effect.

Conclusion

From the present observations it was concluded that the three water bodies offers the typical aquatic environment of the desert having varied physical-chemical entities. However the extreme summer temperature in desert led to decline in water column due to evaporative loss and resultant increase in concentration of electrolytes as evident from high EC. Besides, these zooplanktons recorded in the month of May and June was very few in no. due to low food availability in hot desert at that extreme summer temperature. The study was quite useful in further investigation and in improvement of quality and quantity of the zooplankton community. Biodiversity is rightly considered as an index of sound health of habitat and strong base for better evolution.

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