International Journal of Allied Practice, Research and Review
Website: www.ijaprr.com (ISSN 2350-1294)

Studies on Faunal Diversity of Macrobenthic Invertebrates in Two Different Fresh Water Ecosystems in Rajasthan

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Abstract - The bottom muds of the lakes appear to be similar but are habitats for high biodiversity. Physical, chemical, and biological processes create significant horizontal and vertical heterogeneities in the substrata that provide a physical template for distinct niches. The diversity of benthic fauna acts as sensitive indicators of lake health. The present communication deals with the year round study on diversity and population turnover of macrobenthic invertebrates and their ecological aspects in the two lakes of different climatic regions of Rajasthan namely Kolayat (Bikaner) and Pushkar (Ajmer) from July, 2012 to June, 2013.

Physical-chemical limnology revealed that the Sacred lakes were shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. Besides the larval forms, the adult macrobenthic invertebrates displayed a diversity of 21 and 22 species belonging to Annelida (Class Oligochaeta and Hirudinea), Arthropoda (Class Insecta) and Mollusca (Class Gastropoda) in the lakes of Kolayat and Pushkar respectively. The data on population turnover and periodicity of occurrence is viewed upon to adjudge the sensitivity of species to environmental condition.

Keywords: ***Benthic macro invertebrates, Physical-chemical limnology, Diversity, Population turnover.***

I. INTRODUCTION

The benthic community is complex. It includes a wide range of organisms from bacteria to plants (phytobenthos) and animals (zoobenthos) and from the different levels of the food web. They are generally classified according to their size viz. microbenthos < 0.063 mm, meiobenthos 0.063–1.0 (or 0.5) mm, macrobenthos > 1.0 (or 0.5) mm and, sometimes, megabenthos > 10.0 mm (Tagliapietra and Sigovini, 2010). Macro benthic invertebrates form an integral part of aquatic environment and are of great ecological and economic importance as they maintain various levels of interaction between the community and the environment (Sharma and Chowdhary, 2014). Aquatic macro-invertebrates have been identified as excellent tool for bio-monitoring studies as they respond rapidly to the environmental changes. Some Benthic forms are often considered to be best indicators of organic pollution because of their constant present, relatively long life span, sedentary habits, and different tolerance to stress habitat (Webber et al., 1989) benthic population is an essential part of lake ecosystems, exerting a considerable impact upon their functioning. The diversity of benthic fauna acts as sensitive indicators of lake health. The benthic population consumes organic matter that sinks from

surface production. These benthic invertebrates become food for the other aquatic invertebrates and vertebrates, hence play a critical role in the natural flow of energy and nutrients in the ecosystem more over they play a vital role in purifying water bodies since they are saprophytic but some may be harmful as some gastropods are intermediate hosts of infectious trematodes and other parasites of animals and human beings. Biological monitoring is considered to provide an integrated approach to assess water and overall environmental quality (Hynes, 1960). Additionally, snails are ideal bio-indicators not only for paleoenvironments and water quality (Harman, 1974; Clarke, 1979), but for lotic and lentic aquatic ecosystems as well (Choubisa, 1992). Usually various physicochemical methods are used to detect the effect of pollution on the water quality changes. Such alterations in water quality are also very well reflected in the structure and composition of biotic community as shown by occurrence, diversity and abundance pattern of species (Kumar et al., 2006).

Physico-chemical parameters are directly affecting to diversity of benthic fauna of the water bodies. Anthropogenic pressures, holy rituals and tourism have adverse impact on the water quality of the sacred lakes. Water is the scarcest and the most stressed resource in the Great Indian Desert. The status of water in the state is very critical. Rajasthan with more than 10.5% of the country's geographical area, supporting more than 5.5% of the human population & 18.70% of the livestock has only 1.16% of the total surface water available in the country, yet it has diverge bodies of water, perennial and ephemeral, lotic and lentic. This region receives less than 300 mm of rain in an average year. Temperatures can exceed 48 °C in the summer months and drop below freezing in the winter. Despite ecological stresses the surface water bodies in far and wide stretches of barren lands of the Thar Desert harbour wide range of flora and fauna and thus need to be conserved.

The present communication deals with the year round study on diversity and population turnover of macrobenthic invertebrates and their ecological aspects in the two lakes of different climatic regions of Rajasthan namely Kolayat (Bikaner) and Pushkar (Ajmer) from July, 2012 to June, 2013. The data on population density are viewed upon to adjudge the sensitivity of species to environmental conditions.

II. STUDY AREA

Kolayat (27° 50’ 32” N, 72° 57’ 10” E) lake is situated 51 Km on the south west of Bikaner. Kolayat is situated in the middle of the Thar Desert and is characterized by typical arid conditions. The lake has a catchment area (Agor) 14,900 ha. Pushkar is situated 14kms on the North west of Ajmer. The geographical coordinates are 26°30°0” North 74°33’0” East. The Pushkar lake draws catchment of the Aravalli hills covering an area of 22 Sq. Kilometers. The lake has water surface of 22 hectares. Pushkar experiences semi-arid climatic conditions.

III. MATERIALS AND METHODS

Both water and sediment samples were collected from three study stations.

1. Water was examined for major ecological variables including temperature, pH, electrical conductance, total dissolved solids, dissolved gases (oxygen, carbon dioxide), alkalinity and hardness.

2. A quadrate was used to collect the samples of sandy sediment. The sediment samples were examined for pH, electrical conductance, total dissolved solids and organic matter. Benthic forms were collected by sieving the mud samples. The results are expressed in the No./m^2.

3. The analysis was made following APHA-AWWA-WPCF (1981). For parameters like temperature, pH, electrical conductance and total dissolved solids, respective meters were used.

4. Benthic fauna were identified following Daglish (1952), Borrer & Delong (1957), Baid (1958), Vazirani (1964), Edmondson(1966), Needham & Needham(1978), Tonapi (1980), Mc Cafferty (1981) and Subbarao (1989).

5. Population turnover was calculated as Maximum population / Minimum population recorded.

IV. RESULTS AND DISCUSSIONS

Physical-chemical limnology revealed that the lakes were shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. No much difference was found in the physical-chemical parameters. The average values of important abiotic variables of water were observed as Temperature 26.3-26.18 ºC, Transparency 0.47-0.49 m, pH 7.81 - 7.61, EC 0.39- 0.38 mmho/ cm, DO 9.95- 11.78 mg/l, Free CO_2 35.00 - 24.83 mg/l, TDS 386.66-378.33 mg/l, Hardness 141.5-145.7 mg/l and Total Alkalinity 82.83-60.16 mg/l. Sediment analysis revealed the average values as pH 9.53– 9.48, EC 0.36 - 0.36 mmho/ cm, TDS 360 – 360.83 mg/g and Organic matter 51.71– 45.37 mg/g in the lakes of Kolayat and Pushkar (Table 1).

The benthic fauna displayed a diversity of 22 species belonging to Annelida (Class Oligochaeta and Hirudinea), Arthropoda (Class Insecta) and Mollusca (Class Gastropoda) (Table 2). Annelids were represented by two Olegochaets namely *Aeolosoma hemprichi, Tubifex tubifex* and two Hirudinian *Alboglossiphonia weberi* and *Hirudinaria globosa.* Considerable number of Annelids was recorded only when the water temperature was above the average value (>26^{o}C). The pattern of the population turnover and the periodicity of occurrence were similar in both the lakes yet the average population density was high in Pushkar Lake.

During the present study insects were represented by adult as well as larval forms. The adult insect fauna belonged to two orders namely Coleoptera (beetles) and Hemiptera (bugs). Coleoptera was represented by 3 families namely Dytiscidae (3 species), Hydraenidae (1), Hydrophilidae (3). Hemiptera was also represented by 3 families Corixidae (1), Nepidae (2), Notonectidae (1). Apart from beetles and bugs, orders Diptera (*Chironmus* sp., *Culicoides* sp and *Tabanus* sp.), Ephemeroptera (Mayfly) Odonata (Dragonfly), Plecoptera (Stonefly) and Tricoptera (Caddisfly) were represented only by larval forms.

Hydraticus fabricii was the most abundant species followed by *Tropisternus lateralis* but numerically by *Hydraena quadricoliis* of which the average population density was good but the periodicity of occurrence were 4 and 6 months in the lakes of Kolayat and Pushkar respectively. The only perennial forms were larvae of *Chironomus* sp. and *Culicoides* sp. of order Diptera and Nymphs of Odonata while other species occurred only for 8 to 10 months in the year. *Hydaticus fabricii* presented the widest range of population fluctuation over the period of study as reflected from its greater population turnover followed by *Hydraena quadricollis,* and *Tropisternus lateralis*. However there was a significant difference between the population turnovers of these species in the lakes of two different climates. The rest of the species displayed a lesser population turnover suggesting narrow variation in their count during the period of study.

Over all the macrobenthic fauna was dominated by the gastropods but the composition of this component was different in the two lakes. *Bellamya bengalensis* (30% of the gastropods) dominated the gastropods in the lake of Kolayat followed by *Diagnostoma pulchella* (23%) and *Lymnaea acuminate* (23%) whereas the gastropods in the lake of Pushkar was dominated by *Lymnaea acuminate* (26%) followed by *Bellamya bengalensis* (24%) and *Diagnostoma pulchella* (16%). *Thiara tuberculata* was recorded exclusively in Pushkar. *Gyraulus rotula* displayed maximum population turnover with discontinuous presence in the lake of Kolayat

The greater population turnover of a species suggests the greater sensitivity of it to the available environmental conditions of existence. However, this should be viewed upon with the incorporation of data on the periodicity of occurrence of the individual species. Thus a species may, however be having a poor population turnover, if displays poor periodicity, is obviously highly sensitive to the available environmental conditions during most part of the year. This is important to

note that species in highly stressed condition such as desert (Kolayat) develop locally adapted population as also observed by Singh and Saxena (2002) and Singh et.al. (2006).

More over the persistent dominance of *Chironmus* sp.larvae may be used as pollution indicator in the lakes. Abundance of *Lymnaea acuminate* and regular presence of *Tubifex tubifex* in the lake are it's another indication. The availability and distribution of chironomids on intra lake level have been attributed to be relative to many factors (Bowman, 1976). Chironomus larvae have also been used as pollution indicators by number of workers Gaufin (1957) and Curry (1962). Thus, the abundance of chironomids in the benthic population is due to impact of altered nature of substrate due to organic pollution. The presence of *Tubifex tubifex* and *Lymnaea acuminate* in the lakes also corroborates with the work of Mason (1981) and Sarang & Sharma (2009). However, the physical-chemical parameters were well within the threshold limit in these water bodies.

Table 1.Physical-chemical variables at the lakes of Kolayat (Bikaner) and Pushkar (Ajmer) from July, 2012 to June, 2013 Values are averages of three study stations and are expressed in mg/l in water and mg/g in sediment, except otherwise mentioned.

Variable		**Kolayat Lake, Bikaner**			**Pushkar Lake, Ajmer**		
		Maximum	**Minimum**	**Average**	**Maximum**	**Minimum**	**Average**
Water	Temperature (ºC)	33.5	16.6	26.3	33.7	17.8	26.18
	Transparency (m)	0.5m	0.4m	0.47m	0.5	0.4	0.49
	pH	8.3	7.2	7.81	8.0	7.3	7.61
	EC (mmho/cm)	0.42	0.32	0.39	0.42	0.31	0.38
	DO	14.63	6.91	9.95	19.10	8.53	11.78
	Free CO_2	56.00	2.0	35.00	48.0	2.0	24.83
	TDS	420	320	386.66	420	310	378.33
	Total Alkalinity	120	42	82.83	76	38	60.16
	Hardness	204	90	141.5	184	110	145.7
Sediment	pH	10.8	8.0	9.53	10.2	8.6	9.48
	EC (mmho/cm)	0.48	0.10	0.36	0.44	0.26	0.36
	TDS	480	100	360	440	260	360.83
	Organic matter	69.26	21.72	51.71	69.26	22.27	45.37

Table 2: Diversity and population turnover of macrobenthic invertebrates in the lakes of Kolayat (Bikaner) and Pushkar (Ajmer) from July, 2012 to June, 2013. Values are averages of three study stations and are expressed as No./m^2.

Faunal Species		Kolayat Lake, Bikaner					Pushkar Lake, Ajmer				
		Max. Pop.	Min. Pop.	Average	Pop. Turnover Max. Pop./ Min. Pop.	Periodicity of Occurr.	Max. Pop.	Min. Pop.	Average	Pop. Turnover Max. Pop./ Min. Pop.	Periodic. of Occurr.
ANNELIDA - OLIGOCHAETA											
1	*Aeolosoma hemprichi,*	80	20	25.00	4.00	07	100	20	40.00	5.00	08
2	*Tubifex tubifex*	180	40	90.00	4.50	12	220	40	103.33	5.50	12
	HIRUDINEA										
3	*Alboglossiphonia weberi*	120	20	40.00	6.00	09	120	20	51.66	6.00	10
4	*Hirudinaria globosa*	100	20	35.00	5.00	09	100	20	43.33	5.00	10
ARTHROPODA - INSECTA											
	F- DYTISCIDAE										
5	*Captotomus interrogatus*	180	40	58.33	4.50	06	140	60	60.00	2.33	07
6	*Hydaticus fabricii*	600	40	216.66	15.00	11	560	60	246.66	9.33	11
7	*Laccophilus anticatus*	120	60	51.66	2.00	07	140	60	50.00	2.33	07
	F-HYDRAENIDAE										
8	*Hydraena quadricollis*	680	120	138.33	5.60	04	800	80	180.00	10.00	06
	F- HYDROPHILIDAE										
9	***Berosus indicus***	140	40	50.00	3.50	07	160	60	38.33	2.66	04
10	*Hydrophilus olivaceous*	100	40	36.66	2.50	07	80	40	31.66	2.00	06
11	*Tropisternus lateralis*	160	60	60.00	2.60	08	240	40	78.33	6.00	10
	F- CORIXIDAE										
12	*Corixa lima*	80	40	36.66	2.00	07	100	40	33.33	2.50	06
	F- NEPIDAE										
13	*Laccotrepes maculatus*	80	20	33.33	4.00	08	120	40	41.66	3.00	07
14	*Nepa cineria*	80	40	21.66	2.00	05	80	20	31.66	4.00	08

	F-NOTONECTIDAE										
15	*Notonecta glauca*	100	80	15.00	1.25	02	80	40	13.33	2.00	03
	MOLLUSCA-Gastropoda										
16	*Bellamya bengalensis*	520	240	340.00	2.16	12	540	240	360.00	2.25	12
17	*Diagnostoma pulchella*	360	200	263.34	1.80	12	340	180	241.67	1.88	12
18	*Gabbia orcula*	160	80	106.67	2.00	12	240	80	146.67	3.00	12
19	*Gyraulus rotula*	140	60	66.67	2.30	09	160	40	76.67	4.00	12
20	*Indoplanorbis exustus*	180	60	103.34	3.00	12	180	80	133.34	2.25	12
21	*Lymnaea acuminata*	380	180	248.34	2.11	12	660	220	393.34	3.00	12
22*	*Thiara tuberculata*	00	00	00	00	00	240	80	175.00	3.00	12

*Recorded only in Pushkar. Refer **Maxim.** as Maximum, **Minim.**- Minimum, **Popul.**-Population, **Periodic. as** Periodicity and **Occurr**. as Occurrence

IV.CONCLUSION

This preliminary investigation enabled a comprehensive monthly analysis of the Physical-chemical fluctuations and macrobenthic faunal diversity of the water bodies and the data generated might help in planning better conservation measures and management of these religiously and biologically important perennial . In spite of certain climatic challenges and intermittent availability of species and lesser population density the lake of Kolayat was equally kaleidoscopic to the lake of Pushkar as far as macrobenthic invertebrates are concerned. The diversity index can be used as a measure of water pollution in the lentic ecosystem and when studied in combination with physico-chemical parameters, it provides more realistic assessment of the quality of water.

VI. ACKNOWLEDGEMENT

Authors are thankful to the Principal, Govt. Dungar College, Bikaner and the Head, Department of Zoology, Govt. Dungar College, Bikaner for providing necessary facilities.

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