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Diversity and Population Turnover of Insect Fauna in Pushkar Lake in the Aravalli Region of Rajasthan, India

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Abstract

*Anthropogenic pressures, holy rituals and tourism have adverse impact on the water quality of the sacred lakes. Physico-chemical parameters are directly affecting to diversity of insect fauna of the water bodies. The present communication deals with the year round study on of insect fauna and its ecological aspects in the Pushkar lake, Ajmer from April, 2012 to March, 2013. Physical-chemical limnology revealed that the lake was shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. The adult insect fauna displayed a diversity of 18 species belonging to families namely Dytiscidae (4), Helodidae (1), Hydraenidae (1), Hydrophilidae (4), Psephenidae (1), Corixidae (1), Gerriidae (2), Nepidae (2), Notonectidae (1) and Velidae **(1)** besides the larval forms of aquatic and terrestrial insect. The data on population turnover and periodicity of occurrence is viewed upon to adjudge the sensitivity of species to environmental condition.*

Keywords: Aquatic insects, Physical-chemical limnology, Sacred lake, Diversity, Population turnover.

Introduction

The aquatic insects including their larvae are involved in nutrient recycling and form an important vital component of natural food web in aquatic ecosystem. Aquatic macro-invertebrates have been identified as excellent tool for bio monitoring studies as they respond rapidly to the environmental changes. Their abundance, diversity and short life cycle makes them ideal subjects for the assessment of wetland's ecological conditions[1]. Aquatic insects play an important role in the indication of the changes in the quality of water due to pollution or degradation because of their ability to respond quickly to such alterations. Freshwater insects may be used to assess the "health" of a water body.

Physico-chemical parameters are directly affecting to diversity of insect fauna of the water bodies. Anthropogenic pressures, holy rituals and tourism have adverse impact on the water quality of the sacred lakes. Tourism industry is a major contributor to the gross national product of many nations[2]. Pushkar is a famous pilgrimage centre of Rajasthan. In the ancient times the lake had water spread over 71 bighas. However, of late, Pushkar lake is dying due to a variety of reasons[3]. On an average the lake attracts 5000 pilgrims daily. People from all over the country converge here to wash off their sins and immerse the ashes of their dead. The ecosystem process of the lake has been altered and has resulted in loss of biodiversity, eutrophication, siltation and toxic contamination over the years. Lakes are closed ecosystems and hence pollution tends to accumulate in the lake body. High pollution and silting of the lake are causes of serious concern. Congestion of areas in and around the lake have restricted the natural drainage into the lake. Water quality in the lake has been deteriorating continuously primarily due to uncontrolled flow of sewage and waste water and disposal of solid waste in the catchment drains. Regular offerings of flower and bone ash have caused the water quality to deteriorate further[4]. Over the past two decades the water level has been going down continuously. However tube wells are installed near the periphery to maintain the water level and in turn the lake harbour wide range of flora and fauna and thus need to be conserved.

The present study was undertaken on Pushkar lake, Ajmer from April, 2012 to March, 2013. The data on population density are viewed upon to adjudge the sensitivity of insect species to environmental conditions.

Material and Methods

Study Area: 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.

Both water and sediment samples were collected from three study stations. i. The insect fauna from water was collected with suitable nets covering both macroscopic and microscopic forms. A quadrate was used to collect the samples of sandy sediment. Benthic forms were collected by sieving the mud samples. The results are expressed in the No. / m^2 . ii. Population turnover was calculated as Maximum population/ Minimum population recorded. iii. Water was

examined for major ecological variables including temperature, pH, electrical conductance, total dissolved solids, dissolved gases (oxygen, carbon dioxide), alkalinity and hardness. The sediment samples were examined for pH, electrical conductance, total dissolved solids and organic matter. The analysis was made following APHA-AWWA-WPCF[5]. For parameters like temperature, pH, electrical conductance and total dissolved solids, respective meters were used. iv. Insect fauna were identified following Daglish (1952), Borrer and Delong (1957), Edmondson (1966), Needham and Needham (1978), Tonapi (1980) and Mc Cafferty (1981)[6-11].

Results and Discussion

Physical-chemical limnology revealed that the lake was shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. The ranges of important abiotic variables of water were observed as Temperature 17.8 – 32.8ºC, transparency 0.4-0.5m, pH 7.3 - 8.0, EC 0.31- 0.42 mmho/ cm, DO 8.53 - 19.10 mg/l, Free CO_2 2 - 78 mg/l, TDS 320-420 mg/l, Hardness 112 - 184 mg/l and total alkalinity 38 - 104 mg/l. Sediment analysis revealed the ranges of values as pH 8.8 – 10.3, EC 0.26 - 0.43 mmho/ cm, TDS 260 - 430 mg/g and Organic matter 22.27 – 69.26 mg/g (table 1).

Most of the major orders of insects are found in the Indian desert and many of them present interesting adaptations to the desert environment[12]. Insects, the most versatile and tolerant group of invertebrates, are especially important faunal component in desert waters, most of which are ephemeral and offer extremely hostile physical and chemical conditions. In spite of the fact that insects are no lesser important denizens of aquatic environment, no sincere efforts seem to have been made on aquatic insects of the desert region of Rajasthan, except the contributions of Vazirani (1964), Tak and Sewak (1987), Tak (1996), Srivastava and Saxena (2004), Saxena (2008) and Srivastava (2009)[13-18].

During the present study insects were represented by adult as well as larval forms. The adult insect fauna belonged to only two orders namely Coleoptera (beetles) and Hemiptera (bugs). Coleoptera was represented by five families namely Dytiscidae (4Species), Helodidae (1), Hydraenidae (1), Hydrophilidae (4) and Psephenidae (1). Hemiptera was also represented by five families Corixidae (1), Gerriidae (2), Nepidae (2), Notonectidae (1) and Veliidae (1) in the lake. Apart from these orders Diptera (Mosquitoes, Flies, and Midges), Ephemeroptera (Mayfly larva), Odonata (Dragonflies) and Plecoptera (Stoneflies) were represented only by larval forms. The beetles dominated the bugs in the lake except in the months of July and August because of the rise in the population of Water striders due to rains. More over the population of beetles were far below than their average population i.e. 851.66 during these two months. Temperature of the lake water, lower than the average value (25.45^{o}C) supported the population of Coleoptera to flourish. The population of Hemiptera was recorded better with the higher values of temperature than the average one. Numerically *Hydraticus fabricii* was the most abundant species followed by *Hydraena quadricoliis* (Table-2 and figure-1).

The only perennial forms were chironomid larvae 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, Tropisternus lateralis, Dytiscus verticalis, Berosus* Sp. and *Corixa lima. Scirtes nigropunctatus, Limnometra fluviorum* and *Notonecta glauca* exhibited poor population turnover with poor periodicity. The rest of the species displayed a lesser population turnover suggesting narrow variation in their count during the period of study.

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[19]. It is important to note that even when the insect population was less, the number of chironomid larvae was good enough to indicate the pollution in the lake as it can live in highly polluted waters.

Conclusion

The sacred lake of Pushkar was shallow with turbid, alkaline, hard, slightly saline and well oxygenated water. The lake harboured 18 species of Insects (Adult) belonging to two order Coleoptera (beetles) and Hemiptera (bugs) displaying 5 families each besides the larval forms of aquatic and terrestrial insects. The beetles dominated the bugs both in the term of diversity (11:7 species) and population density (79%: 21%) because of their anatomical and physiological features and feeding habits. In order to conserve the Insect and over all faunal diversity of such stressed sacred lakes it is essential to ensure perennially available economically safe water, which could be achieved by judicious water utilization, proper watershed area management and upkeep of water quality. Social rituals can't be redefined but have to be managed.

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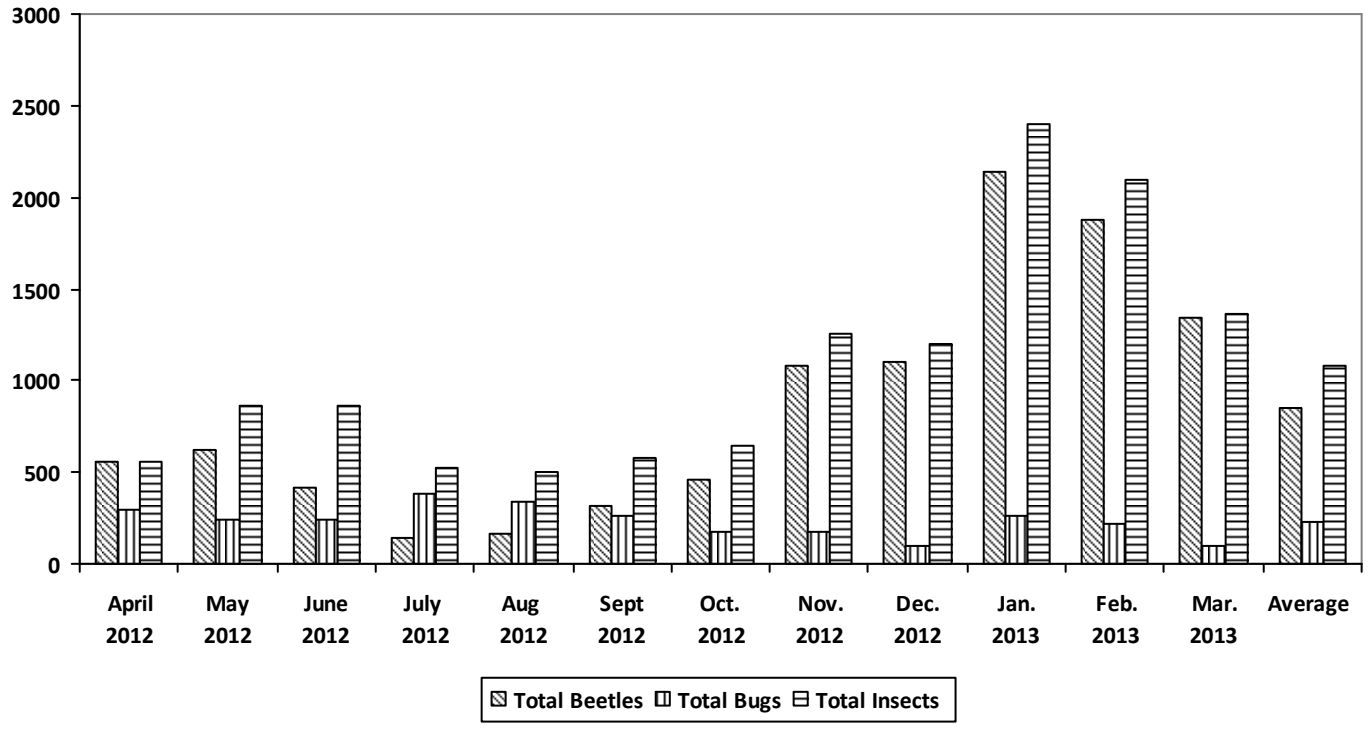

Figure-1
Total insects at the lake of Pushkar Lake, Ajmer during April, 2012 to March, 2013.
Values are averages of three study station and are expressed as No/m^2

Table-1
Physical-chemical variables at Pushkar lake, Ajmer during April, 2012-March, 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		Apr 2012	May 2012	June 2012	July 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Avg.
Water	Temperature (ºC)	26.2	27.2	31.6	32.5	32.3	25.2	24.4	23.2	22.1	17.8	20.4	22.6	25.45
	Transparency (m)	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.48
	pH	7.3	7.6	7.8	8.0	7.6	7.8	7.4	7.6	7.5	7.4	7.3	7.4	7.55
	EC (mmho/cm)	0.37	0.34	0.38	0.36	0.39	0.38	0.34	0.41	0.42	0.36	0.39	0.34	0.37
	DO	17.07	18.69	15.85	11.38	14.63	19.1	9.76	12.6	8.53	8.94	12.6	15.45	13.72
	Free CO_2	78	44	34	36	48	32	12	2	4	38	46	12	38.83
	TDS	370	340	380	360	390	380	340	410	420	360	390	340	373.33
	Hardness	146	172	184	166	162	112	126	136	144	184	158	126	151.33
	Total Alkalinity	52	68	104	76	62	46	38	66	42	76	62	38	60.83
Sediment	pH	9.3	8.9	10.0	9.8	10.2	8.7	9.4	9.2	8.8	9.8	9.3	9.7	9.42
	EC (mmho/cm)	0.39	0.37	0.42	0.34	0.43	0.36	0.38	0.39	0.41	0.34	0.26	0.38	0.37
	TDS	390	370	420	340	430	360	380	390	410	340	260	380	372.5
	Organic matter	54.32	48.88	39.51	64.36	44.54	66.54	22.27	29.87	17.38	22.27	66.81	69.26	45.50

Table-2
Diversity and population density of Insect fauna at Pushkar Lake, Ajmer during April, 2012 – March, 2013
Values are averages of three study stations and are expressed as No./m^2.

Insect species	Apr 2012	May 2012	June 2012	July 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Avg.	Population Turnover Max. Pop./ Min. Pop.	Periodicity of Occurrence
O-COLEOPTERA (Beetle)															
F- DYTISCIDAE (Predaceous Diving Beetle)															
Captotomus enterrogatus	00	00	00	00	00	60	100	80	100	100	140	140	60	2.33	7
Dytiscus verticalis	00	00	40	00	00	00	40	60	100	220	100	80	53.33	5.50	7
Hydaticus fabricii	00	60	80	60	100	80	00	380	560	480	540	480	235	9.33	10
Laccophilus anticatus	80	00	00	00	00	00	60	80	80	100	140	80	51.66	2.33	7
F-HELODIDAE (Marsh Beetle)															
Scirtes nigropunctatus	00	00	00	00	00	00	00	80	60	00	00	00	11.66	1.33	2
F-HYDRAENIDAE (Minute Moss Beetle)															
Hydraena quadricollis	360	240	120	00	00	00	00	00	00	800	580	280	195.33	6.66	6
F- HYDROPHILIDAE (Water Scavenger Beetle)															
***Berosus* sp.**	120	320	180	00	00	60	00	00	00	00	00	00	56.66	5.33	4
***Enochrus* sp.**	00	00	00	00	00	00	60	100	60	60	100	100	40	2.5	6
Hydrophilus olivaceous	00	00	00	80	60	40	00	60	00	00	00	00	20	2.0	4
Tropisternus lateralis	00	00	00	00	00	80	80	60	40	240	180	80	63.33	6.0	7
F- PSEPHENIDAE (Riffle Beetle)															
Eubranax sp.	00	00	00	00	00	00	120	180	100	140	100	100	61.66	1.8	6
Total Beetles	560	620	420	140	160	320	460	1080	1100	2140	1880	1340	851.66	15.28	12
O-HEMIPTERA (Bugs)															
F- CORIXIDAE (Water Boatman)															
Corixa lima	200	80	60	80	60	40	00	60	00	00	00	00	46.33	5.00	7
F- GERRIDAE (Water Striders)															
Gerris marginatus	80	00	80	160	140	100	100	00	00	00	00	80	61.66	2.00	7
Limnometra fluviorum	00	00	00	80	100	80	00	00	00	00	00	00	21.66	1.25	3
F-NOTONECTIDAE (Backswimmers)															
Notonecta glauca	00	00	00	00	00	00	00	00	00	80	40	00	10	2.0	2
F- NEPIDAE (Water Scorpion)															
Laccotrepes maculatus	00	80	60	00	40	00	00	80	40	100	120	00	43.33	3.0	7
Nepa cineria	20	80	00	00	00	00	20	40	60	80	60	20	31.66	4.0	8
F- VELIIDAE (Riffle Bugs)															
Microvelia diluta	00	00	40	60	00	40	60	00	00	00	00	00	18.33	1.5	4
Total Bugs	**300**	**240**	**240**	**380**	**340**	**260**	**180**	**180**	**100**	**260**	**220**	**100**	**233.33**	**3.8**	**12**
Total Insects	**560**	**860**	**860**	**520**	**500**	**580**	**640**	**1260**	**1200**	**2400**	**2100**	**1440**	**1076.33**	**4.80**	**12**

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