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Distribution and Abundance of Macrozoobenthos in Dal Lake of Kashmir Himalaya

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ABSTRACT

The distribution and abundance of macrozoobenthic fauna in relation to several physico-chemical factors was investigated in Dal lake for the period between January 2006 to December 2006. Five sites were selected on the whole, one each from the four basins of the lake and fifth one from the floating gardens, on the basis of morphometric and biological features of the lake. The physico-chemical factors including temperature, pH, alkalinity, carbon dioxide, dissolved oxygen, chlorides and nutrients were studied. The organisms showed seasonal variation in relation to these physico-chemical parameters and all the parameters had a combined effect on the occurrence, periodicity and population of the various contributors of macrobenthic community.

***Keywords*:** Macrozoobenthos, Kashmir Himalaya, morphometric, occurrence, periodicity, population

INTRODUCTION

The valley of Kashmir also referred to be a "paradise on earth" has been known for its scenic beauty. The high–attitude valley of Kashmir is of tectonic origin, lying between 33º 25′ to 34º 50′ N & 74º to 75º E. It abounds in a great array of fresh water bodies like lakes, ponds, rivers, springs, streams etc. In addition to socio-economic, cultural and ecological values it sustains the economy of the state. It is well known for its high altitude lakes like Alipather, Sheshnag, Kounsarnag, Tarsar, Marsar etc. and low land lakes like Dal, Anchar, Manasbal, Wular etc **.**

Dal Lake a world renowned picturesque tourist spot and an inseparable part of Kashmir's glorious heritage and culture is aptly referred to as a cradle of Kashmir civilization, situated in an expanding urban environment and nested within the Srinagar city, in the back drop of Zabarwan range with lush green slopes descending to woodlands and vast orchards adding splendor and magnificent ambience of the lake. Dal Lake, the urban valley lake of fluviatile origin is situated at an altitude of 1886m (ASL) between 34º5´ - 34º6´ N latitude and 74º8´- 74 º 9´ E longitud'es, in the heart of Kashmir Valley on the northeast of the state summer capital Srinagar at the foot of Zabarwan mountains. The total water surface area of the lake is 11.45km^3, of which 4.1km^3 is floating under gardens, 1.51km^3 and 2.25km^3 are land and marsh respectively, whereas the total volume estimated is 9.05×10 m^3 and the ratio between the mean and maximum depth (m) ranges between 0.20 and 0.25 indicating the gentle slope of the lake bed. This open drainage eutrophic lake is multibasined with the Hazratbal, Bod-dal, Gagribal and Nigeen as its four basins, which differ markedly in their area, volume, depth and shorline development indices etc.

The lake has been experiencing significant ecological changes in the form of deterioration of catchment, excessive nutrient loading and encroachment. Huge quantities of nutrients are added to the lake every year in the form of wash off from the adjoining areas of the city, the large population of the residents within the lake and above all from the mushroom growth of houseboats moored in the lake. The immediate visible effect of these on the biology of the lake is seen, in the luxuriant growth of macrovegetation including *Potamogeton natans, Ceratophyllum demersum*, *Polygonum amphibium, Lemna* sp.*, Salvinia natan,* and above all *Azolla* sp.

In aquatic ecosystem aquatic biota is closely dependent on the physical, chemical and biological characteristics of water, each of which acts as a controlling factor A number of hydrobiological studies have been carried out in this lake with respect to water chemistry, sediment chemistry, plankton, vegetation and others, but so far no attempt has been made to relate the benthic fauna found in its sediments with the water chemistry, which forms a very important component of the lake and plays a great role in the sediment-interface metabolism and thereby determine the condition of the substrate and the life-supporting condition thereupon. In aquatic ecosystem every component gets disturbed as a result of racing eutrophication and studying each of these can help us to evaluate the impact of pollution, thereby enabling us to formulate the management strategies to curb this menace**.** It was with this aim that the present investigation on the population abundance and seasonal behaviour of macrozoobenthos under the operative influence of physico-chemical factors was undertaken.

MATERIAL AND METHODS

On the basis of morphometric and biological features, five sampling sites were selected one each from the four basins and the fifth one from amongst the floating gardens. Sediment and water sampling collection was done at all the sites on monthly basis for evaluating macrozoobenthos and physico-chemical characteristics respectively. The detailed analysis of water samples was carried out according to the standard methods developed by Welch (1963), Mackereth (1963), Golterman and Clymo (1969) and APHA (1989).

Sampling of benthos was done with the help of Ekman-Birge dredge of 225 cm^2 sampling area. At each site the sampling was done at three different places, differing in depth and vegetation and then pooled together. Thereafter, the sample was filtered through a sieve of No. 40 (250 meshes cm^{-2}). The organisms retained in the sieve were then preserved in 10% formaldehyde solution before being sorted out, identified, counted and expressed as individuals m^{-2}(Welch 1948).

The sites selected for the collection of data from the lake are as follows:

Site I : Boddal basin

Site II : Gagribal basin.

Site III: Hazratbal basin.

Site IV: Nigeen basin.

Site V : Near Floating Gardens

RESULTS AND DISCUSSION

The macrozoobenthic animals collected belonged to three metazoan phyla viz.Annelida Mollusca and Artropoda. The greater density of the benthic community was recorded mainly amongst annelids and insects both in respect of their taxa and abundance. This was followed in a decreasing order by molluscs and crustaceans. Within these three major groups a total of 30 different species belonging to 5 classes, 9 orders and 13families were recorded.

Annelida were represented by 13 species of which 12 belonged to class Oligochaeta and 1 species to class Hirudinea. Arthropoda were represented by 12 species, 10 belonged to class Insecta and 1 to Crustacea. Mollusca was exclusively represented by gastropods. Of the 5 species recorded, 4 belonged to family Lymneidae and 1 to Planorbidae.The sequence of dominance of these groups at various sites was of the following order:

Annelida>Insecta>Mollusca>Crustacaea at Sites 1, 2 and 4

Mollusca>Annelida>Insecta>Crustacea at Site 3

Annelida>Mollusca>Insecta>Crustacea at Site 5

Table 1. Distribution and abundance (Individuals/m^2) of dominant macrozoobenthos in Dal lake

Speices	Sites	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Limnodrillus hoffmesteri	I	--	--	44	30	15	--	--	--	--	--	--	15
	II	59	207	74	119	15	15	--	--	--	30	44	44
	III	59	30	193	--	--	--	--	--	--	30	45	74
	IV	--	--	44	74	44	--	--	--	59	59	30	44
	V	104	44	89	59	--	--	--	--	--	59	15	15
Tubifex sp.	I	--	--	74	44	--	--	--	--	--	44	--	--
	II	--	133	56	44	33	33	--	--	--	--	22	--
	III	44	33	122	44	22	--	--	--	--	--	44	56
	IV	--	15	44	89	--	--	--	--	30	15	15	59
	V	59	--	74	44	--	--	--	--	--	44	30	30
Aulodrilus sp.	I	--	--	--	59	--	--	--	--	--	--	--	--
	II	--	44	--	44	--	33	--	--	--	30	44	44
	III	--	--	--	--	--	--	--	22	--	--	33	--
	IV	--	--	59	--	--	--	--	--	--	30	--	15
	V	30	45	30	15	--	--	--	--	--	--	--	--
Chaetogaster sp.	I	--	--	--	--	--	--	--	--	--	--	--	--
	II	--	45	--	22	--	--	22	--	--	--	--	33
	III	--	22	67	22	--	--	--	--	--	--	33	--
	IV	--	--	--	--	30	--	--	--	--	--	--	--
	V	--	30	14	30	--	--	--	--	--	--	--	--
Aeolosoma sp.	I	15	30	30	--	--	--	--	--	--	30	--	--
	II	22	189	56	33	--	--	--	--	--	--	33	--
	III	22	--	122	44	--	--	--	--	--	15	--	44
	IV	--	--	59	--	--	--	--	--	--	15	--	30
	V	59	30	59	30	--	--	--	--	--	--	--	--

Speices	Sites	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Branchiura sowerbyii	I	--	--	--	--	15	20	20	–	--	--	--	15
	II	40	30	45	--	15	15	--	–	--	30	44	44
	III	20	10	10	--	--	--	--	–	--	10	45	55
	IV	--	--	10	--	--	--	--	–	--	--	--	11
	V	15	18	--	--	--	--	--	–	--	--	59	15
Nais communis	I	15	--	45	--	--	--	--	–	--	--	--	--
	II	18	89	43	--	--	--	--	–	--	--	--	--
	III	33	27	67	22	--	--	--	–	--	--	--	44
	IV	15	--	30	--	15	--	--	–	--	--	--	--
	V	30	30	30	--	30	--	--	–	--	--	--	--
Dero dorsalis	I	--	--	--	--	--	--	--	–	--	--	--	--
	II	11	89	33	--	--	--	--	–	--	--	--	--
	III	44	33	22	67	22	--	--	–	--	--	--	--
	IV	--	--	--	--	--	--	--	–	--	--	--	--
	V	--	--	--	--	30	--	45	–	--	--	--	--
Dero digitat	I	--	--	--	--	--	–	--	--	--	–	--	--
	II	--	--	--	--	--	–	22	--	--	–	--	--
	III	--	--	--	--	--	–	--	33	--	–	--	--
	IV	--	--	--	--	--	–	--	--	--	–	--	--
	V	--	--	--	--	--	–	--	--	--	–	--	--
Aulophorus sp.	I	--	15	--	30	15	–	--	--	--	–	--	15
	II	--	56	22	15	--	–	--	--	--	–	--	--
	III	--	--	--	--	--	–	11	22	--	–	--	--
	IV	--	--	45	45	--	–	--	--	--	–	--	--
	V	15	30	45	30	30	–	--	--	--	–	--	15
Pristina longiseta	I	--	--	--	--	--	–	--	--	--	–	--	--
	II	--	--	--	--	--	–	--	--	--	–	--	--
	III	22	--	--	--	--	–	--	11	--	–	--	--
	IV	--	--	--	59	30	–	--	--	--	–	--	--
	V	30	15	--	--	--	–	--	15	--	–	--	15

Speices	Sites	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	I	--	--	30	--	--	--	--	--	--	--	--	--
	II	--	--	44	45	--	--	--	--	--	--	33	--
Stylaria sp.	III	--	--	--	--	--	--	--	--	--	--	--	40
	IV	--	--	--	45	--	--	--	--	--	59	--	--
	V	--	--	30	30	30	--	--	--	--	--	--	--
	I	--	--	30	--	--	15	30	--	--	--	--	--
	II	--	--	--	--	--	44	56	12	--	--	--	--
Nepa sp.	III	--	--	--	--	--	08	12	03	--	--	--	--
	IV	--	--	--	--	15	--	45	--	06	--	--	--
	V	--	--	--	--	30	--	45	--	--	--	--	--
	I	--	--	--	--	--	30	15	--	--	--	--	--
	II	--	--	--	--	--	45	67	16	45	--	--	89
Hydrophilus sp	III	--	--	--	--	--	06	12	--	30	08	45	74
	IV	--	--	--	--	--	38	15	--	31	--	30	--
	V	--	--	--	--	30	43	30	--	15	--	--	30
	I	--	--	--	--	--	--	05	10	--	--	--	--
Tendipes	II	--	--	--	--	--	24	30	05	--	--	--	--
	III	--	--	--	--	--	12	22	12	--	--	--	--
tentans	IV	--	--	--	--	--	22	12	--	31	--	--	--
	V	--	--	--	**46**	17	42	11	--	--	--	--	--
	I	--	15	178	--	--	--	15	06	--	--	--	--
Chironomus	II	--	--	--	45	15	30	--	30	--	--	--	--
	III	104	15	30	15	--	--	--	05	--	12	30	54
sp.	IV	--	15	15	155	44	--	--	15	--	30	15	--
	V	256	104	267	89	--	12	--	09	--	118	77	324
	I	--	--	--	--	--	--	15	30	--	--	--	--
	II	--	--	--	--	15	15	20	--	--	--	--	--
Chaborus sp.	III	--	--	--	--	33	21	34	--	--	30	--	--
	IV	--	--	--	--	44	25	11	--	--	11	--	--
	V	--	--	--	--	10	13	22	09	--	--	--	--
	I	--	--	--	--	--	26	40	--	--	--	--	--
Pseudochirono-	II	--	--	--	--	15	15	45	--	--	--	--	--
	III	--	--	--	--	--	33	21	--	--	30	--	--
mus sp.	IV	--	--	--	--	--	21	11	10	42	--	30	44
	V	--	--	--	--	31	11	231	76	--	--	27	--

The benthic fauna collected from the five sites varied with respect to the type of vegetation and the impact from the human settlements as the site 2 was located in the thick growth of macrovegetation and the site 4 was very close to human habitation where the greatest concentration of sewage from the surrounding houseboats was flushed into the lake. It recorded the maximum abundance of organisms as compared to other sites. These organisms were represented by annelids of which *Limnodrillus* sp., *Tubifex* sp., *Branchiura sowerbyii, Aelosoma* sp., *and Stephenosoniana* sp., were most conspicuous and among the insecta *Chironomus* sp., *Pseudochironomus* sp., *Tendipes tentans* and *Chaborus* sp. showed predominance. These may be regarded as direct indicators of organic pollution in fresh waters. Wilham and Dorros (1968) and Adholia *et al*. (1990) reported that oligochaetes particularly *Tubifex* sp. are the common large inhabitants of mud enriched with organic matter. In the present study the oligochaete species richness in Dal lake confirms that the lake is high recipient of organic pollution load. Many workers (Oliver,1971; Brinkhurst & Cook,1974; Saether,1979; Milbrink,1980 and Bazzanti,1983) have also designated *Limnodrillus* and *Tubifex* as indicators of pollution in other studies. The presence of C*hironomus* sp. in Dal lake again confirms its organic rich waters. Similar results have also been obtained by Bay *et al*. (1966), Hilsenshoff (1966), Pandit *et al*. (1985), Kaushik *et al*. (1991) and Pandit (1992). Temperature which is generally regarded as one of the most important factors in the aquatic ecology showed a gradual increase from January onwards and favoured the growth of vegetation in the lake bottom which in turn influenced the increase in benthic population. Though eurythermal, molluscs were more common during summer when the temperature of the water was higher and decomposition processes at the sediment interface did not appear to be negative factor. The annelids, however, appeared to be rather stenothermal and cold water species as they did built up their peak population in the winter months only. Such a mode of occurrence of molluscs and annelids has been reported in several other studies (Kajak, 1956; Hunter, 1956 and Michael, 1968).

The concentration of the dissolved oxygen remained low below saturation level. The maximum values were found towards the colder months of autumn and winter and minimum during the high temperature of summer. There are reports of the lake water being in a super saturation condition earlier (Zutshi and Vass, 1978) but the decreasing trend of saturation is indicative of a definite shift in the trophic status of the lake and greater decomposition at the bottom level in the sediments due to the organic nutrients entering the lake from various sources. Further it may also be due to longer duration of photosynthetic activity during summer, when large amounts of oxygen are released and the high temperature reduces the solubility of the gas in water. The low dissolved oxygen and high temperature of summer months appeared to have a direct influence on the population abundance and species composition of oligochaetes in the lake. The number of these organisms was very low as compared to molluscs and insects (Gizinski, 1974).

The pH, which is responsible for providing the appropriate living conditions for the organisms, remained usually on the alkaline side throughout probably due to high total alkalinity more so when the bicarbonate system prevailed. Such a phenomenon has been reported by Freisner and Fuller (1966). The more highly buffered waters supported more macroinvertebrates. Zischki *et al*. (1983) concluded that low pH values decrease community diversity while increasing the relative abundance of the tolerant species. pH showed irregular fluctuations and the range from 7.0 in summer to 9.43 in winter did not vary greatly with changing season (Table. 2). However, the minimum values were recorded in summer months. The decrease in pH was probably the result of high temperature and thereby decomposition of organic matter increased and increased concentration of carbondioxide.

The chlorides showed a direct relationship with the temperature with maximum concentration being recorded in summer and the minimum towards the colder months. Nakao (1982) observed that the seasonal changes in chlorinity corresponded with the variation in population density of benthos. Such a relationship is also supported by the observations of Kroon *et al*., (1985). Silicates in the lake were greatly affected by the amount of silt brought in the water from exterior as has been reported by Hall *et al.* (1977). This was the case with Hazratbal basin site which receives large quantities of silt through Telbal Nallah. The high values at Nigeen in summer and autumn were probably due to the presence of large number of molluscs. Michael (1968) is of the opinion that availability of lime supplied by decomposing of shells result in high concentration of silicates. However, the low values in winter could be due to low inflow of water and the retreating of snails during winter into deeper parts of the littoral region. It is known that in polluted waters the oligochaetes are present in high percentage of the total benthic fauna (Goodnight and Whitley, 1965; Howmiller and Beeton, 1971). In Dal lake the relative abundance of these worms was rather high and more so at Gagribal basin and floating garden basin and the take has crossed the initial stages of entrophication.

REFERENCES

Adholia, U. N., Chakarwarty, A., Srivastava, V. and Vyas, A. 1990. Community studies on macrozoobenthos with reference to limno-chemistry of Mansarovar reservoir, Bhopal. *J. Natcon*, **2** (2): 139 – 154.

A. P. H. A. 1989. *Standard Methods for the Examination of Water and Waste Water*. 20th Ed. American Public Health Association, American Water Works Association, Water Pollution Control Federation, Washington. D.C.

Bay, E. C., Ingham, A. A. and Anderson, L. D. 1966. Physical factors influencing chironomids infestation of water spreading basins. *Ann. Entomol. Soc. Am.,* **59**: 714- 717

Bazzanti, M. 1983. Composition and diversity of the profundal macrobenthic community in the polluted Nemi (Central Italy), 1979-80. *Oecol. Applic*., **4**(3): 211-220.

Brinkhurst, R.O. and Cook, D.G.1974. Benthic macroinvertebrates in relation to water and sediment chemistry. *Freshwater Biol*. **4** (3): 183 – 191.

Freisner, W. and Fuller. S.L.H (eds.), 1966 *Pollution Ecology of Freshwater Invertebrates*. Academic Press, London.

Gizinski, A.1974. Faunistic typology of northern Poland eutrophic lakes-*UMK Torun,* **1**: 1-75.

Golterman, H.T. and Clymo, R.S. 1969. *Methods for the Physical and Chemical Analysis of Freshwater.* IBP HandbookNo.8. Blackwell Scientific Publications, Oxford, Edinburgh.

Goodnight, C J. and Whitley, L.S.1965.Oligochaetes as indicators of pollution. p. 139-142. In: Proc.*15th Annual Waste Conference,* Purdue University.

Hall, A., Valente, I. and Davies, B.1977. The Zambezi river in Moqambique:The physico-chemical status of the middle and lower Zambezi prior to the closure of Cabora Bassa Dam. *Freshwater Biol.,* **7**:187-206.

Hilsenhoff, W. L. 1966. The biology of *Chironomus plumosus* (Diptera: Chironomidae) in lake Winnebag, Wisconsin. *Ann. Entomol. Soc. Am.* **59**: 465- 472.

Howmiller,R.P.and Beeton,A.M.1971.Biological evaluation of environmental quality, Green Bay, Lake Michigan .*J. Water Poll. Control Fed*., **43**:123-133.

Hunter, W.R. 1956.On the growth of the freshwater limpet, *Ancylus fluviatilis,* Muller.*Proc.Zool.Soc*.London.**123**:623-636.

Kajak, Z.1956. Character of the numerical dynamics of benthic Tendipidae in shallow parts of an old branch cut off from the river Vistula.*Bull.Acad.Polon.Sci.Ser.Sci.Biol.*, **6**:489-493.

Kaushik, S., Sharma, S. and Saksena, D. N. 1991. p. 185-200. In: *Current Trends in Limnology (*Nalin. K. Shashtree, ed.). Narender Publishing House, New Delhi.

Kroon, H.D., Jong, H.D. and Verhoeven, J.T.A. 1985.The macrofauna distribution in brackish inland waters in relation to chlorinity and other factors.*Hydrobiologia*,**127**:265-275.

Mackereth, F.J.H. 1963. *Some Methods of Water Analysis for Limnologists*.Freshwater Biological Association, Scientific Publication No.21, U.K.

Michael, R.G.1968.Studies on the bottom fauna in a tropical freshwater fish pond. *Hydrobiol*., **31**(2):203-230.

Milbrink, G. 1980. Oligochaete communities in pollution biology: The European situation with special reference to lakes in Scandinavia. p. 433-455. In: *Aquatic Oligochaeta Biology*. (Brinkhurst and Cook, eds.), Plenum Press, N. Y. and London,

Nakao, S., 1982. Community structures of the macrobenthos in the shallow waters in northern Japan. *Mem. Foc. Fish*., **28**(2):225-304.

Oliver, D.R., 1971.Life history of the Chironomidae.*Ann.Rev.Ent*., **16**:211-230.

Pandit, A. K., Pandit S. N. and Kaul, V. 1985. Ecological relations between invertebrates and submerged macrophytes in two Himalayan lakes. *Pollution Research*, **4** (2): 53-58.

Pandit A. K. 1992. Ecology of insect community in some typical wetlands of Kashmir Himalaya. p. 271-286. In: *Current Trends in Fish and Fishery Biology and Aquatic Ecology* (A. R. Yousuf, M. K. Raina and M. Y. Qadri, eds.) University of Kashmir, Srinagar, J&K.

Seather,O.A.1979.Chironomid communities as water quality indicators. *Holarctic Ecol*., **21**:65-74.

Taras, M.J.1963.*Water Analysis in Standard Mmethods of Chemical Analysis*. Vol.II, 6th Ed. Nostrand Co.Inc.,N.Y.(ed.F.J.Welcher).

Welch, P.S.1963. *Limnological Methods.* McGraw Hill Book Co. N.Y.

Zischke,J.A.,Arthur,J.W.,Nordlie,K.J.,Hemanntz,R.O.,Starden,D.A.andHenry,T.P.1983. Acidification effects on macroinvertebrates and lathead minnows (*Pimephales promelas*) in outdoor experimental channels.*Wat.Res*.,**17**:47-63.

Zutshi, D.P. and Vass, K.K.1978.Limnological studies of Dal lake: Chemical features.*Ind. J. Ecol*., **5**:90-97.