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Impact of physico-chemical factors on the zooplankton community in Dal Lake, Kashmir

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Abstract
A perusal of the various physico-chemical characteristics of Dal Lake revealed that the physico- chemical factors have a tremendous impact on the abundance, growth, and species composition of zooplankton communities and on the general ecology of the lake. In response to the variations in physico-chemical factors of the lake water, the zooplankton community also revealed differences in abundance and species composition in the different study sites of the lake.

Keywords: zooplankton, Physico-chemical factors, Dal Lake, Kashmir

1. Introduction

The Dal Lake, situated in the North-East of Srinagar at an altitude of 1584m, is a multi basined water body having a large catchment area of about 315 km². The Lake is under intense pressure of tourism, food supply, and waste disposal. Flotilla of house boats, sewage from peripheral habitations, agrochemicals from floating gardens and catchment, enrich the nutrient status of the lake which not only deteriorate its water quality but also the ecology of flora and fauna. Therefore, the present study was undertaken to assess the abundance, species composition and dynamics of zooplankton communities in relation to the operative influence of physicochemical environment. It was this aim that the present investigation was undertaken to assess the relationship and impact of the nutrient status of the lake on the zooplankton community.

2. Material and Methods

The data on various physico-chemical parameters and zooplankton were collected on monthly basis from three sampling stations differing in various environmental variables like depth, vegetation, and human interferences (Fig.1). Site I was chosen close to the inlet of water near Telbal Nallah in the Hazratbal basin. Site II in the central deepest part of the lake virtually free from any pollution and Site III near the floating vegetable gardens in the lake. Sampling from all the study sites was done at least once in a month. Water samples for physico-chemical characteristics were analyzed as per the standard methods given by Golterman and Clymo (1969) [4] and APHA (1998) [1].

For quantitative study of zooplanktk 4 4443333on, ten liters of water were sieved through plankton net having 60 meshes/cm. The contents collected in the plankton tube, attached to lower end of the plankton net were transferred to separate polyethylene tubes and preserved in 4% formalin. Identification of the zooplankton species was done with the help of standard taxonomic works by Edmondson (1959) [3], Koste (1978) [9], Pennak (1978) [11], Smirnov (1974) [12]. Abundance of various zooplankton species was done in accordance with Welch (1948).

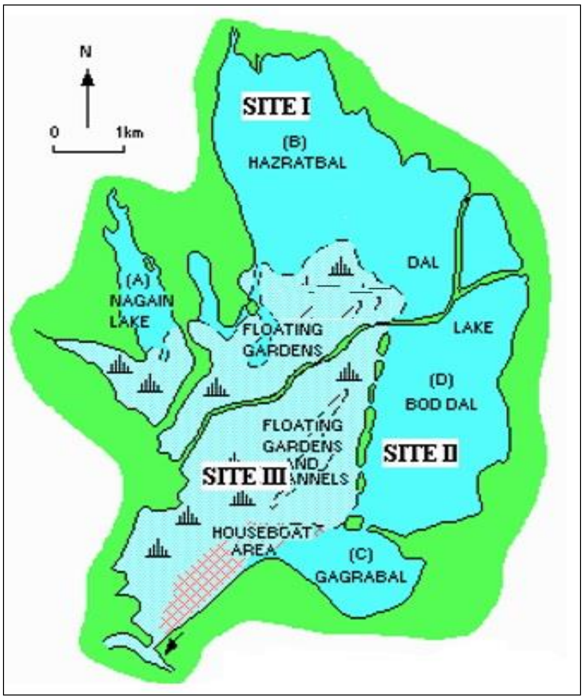

Fig 1: Map of Dal showing study sites

3. Results and Discussion

3.1 Physicochemical features of water

The mean values of various physicochemical features are presented in table 1. The water temperature followed closely the air temperature showing only spatial difference. Transparency was very low near floating gardens. Dissolved oxygen varied from 5.2 mgl^{-1} to 10.2 mgl^{-1}. Low DO content was observed near floating gardens. The study did not show any marked difference in pH values and the water seems to be well buffered. Conductivity values were very high near floating gardens. The concentration of ammonical-N and nitrate-N was high particularly at site-III near floating vegetable gardens. This is attributed to the too much use of nitrogen based fertilizers in the floating gardens and heavy anthropogenic pressure in the catchment area resulting in organic pollution, which in turn adds ammonia by undergoing bacterial decomposition of the organic matter. The nitrate-N and nitrite-N values ranged between 120 µgl^{-1}to 310 µgl^{-1}and 13.5 µgl^{-1} to 20.0 µgl^{-1} respectively. Similarly, total phosphorus concentration ranged from 9.5 µgl^{-1} to 35.5 µgl^{-1}. Higher concentrations of N and P in the lake particularly at site III near floating gardens is attributed to the use of fertilizers and addition of domestic sewage from human habitations around the lake.

Table 1: Average values of physico-chemical parameters recorded in Dal Lake

Parameter	Site I	Site II	Site III
Water temperature (C°)	18.5°c	15.8	19.0
Transparency (m)	2.0	0.98	2.5
Conductivity(µscm^{-1})	150	172	390
Dissolved oxygen (mgl^{-1})	9.1	10.2	7.2
Free Co_2(mgl^{-1})	8.8	7.5	8.0
Alkalinity(mgl^{-1})	80.0	76.1	110.0
Calcium(mgl^{-1})	25.5	15.0	36.5
Chloride(mgl^{-1})	25.0	16.0	27.5
Silicate(mgl^{-1})	2.2	1.2	2.6
Ammonical itrogen(µgl^{-1})	230	225	625
Nitrate nitrogen(µgl^{-1})	201	120	310
Nitrite nitrogen(µgl^{-1})	13.5	15.5	20
Orthophosphorus (µgl^{-1})	32.2	9.5	35.5
Total phosphorus(µgl^{-1})	152	132.5	215
Potassium(mgl^{-1})	5.0	2.0	7.0
Sodium(mgl^{-1})	9.0	7.5	12.0

3.2 Biological features

During the study a total of 62 species of zooplanktons were recorded from Dal lake out of which 41 species belonged to Rotifera, 12 to Cladocera, and 9 to Copepoda. Rotifera was the most dominant group both quantitatively and qualitatively. Branco *et al*. (2002) [2] reported that the abundance of rotifers followed by cladocera as an indication of eutrophication of water bodies. Gliwaiz (1969), Forsynth and McColl (1975) [5], also recorded higher percentage of rotifers and cladocera and a decrease of calanoid copepods in eutrophic lakes. On the whole, sequence of dominance of various groups in the lake was

Rotifera>Cladocera>Copepoda

A comparison of the zooplankton population density, depicted peak values at site III near floating gardens (Table 2) which seems to be related with the majority of pollution tolerant species like *Branchionus calyciflorus, K.cochlearis, K.quadrata, Lepedella patella, Monostylla quadridenta, and Daphnia longispinna*, high population density at site near floating gardens. *Pleuroxus denticulatus, Camptocercus* sp, *Allonella sp, Allonella quadriangularis, A.reactiangular, and A.affinis* were restricted to site 1 in the open waters of the lake. Among branchiondae *Platiyas quadricornis, K.cochlearis, B.quadridentata, B.quadricornis*, were predominant at site III near floating gardens. Ganon (1981) also reported that the species in the genus *Branchionus* are particularly good indicators of eutropy and according to Hutchionson 1969), Branchionus sp are almost entirely limited to alkaline waters. Kumar and Tripathi (2004) reported *Branchionus sp* and *Testudinella sp* as the most abundant rotifers and considered them to be the indicators of eutrophic pollution.

Table 2: Average abundance of Zooplankton species at various sites of Dal Lake

Zooplankton	Site I		Site II		Site III	
(a) Rotifera	S	B	S	B	S	B
1. *Anuraeopsis fissa*	+	+	+	-	4+	3+
2. *Ascomorpha sp.*	+	+	+	-	3+	2+
3. *Ascomorphella sp.*	+	+	+	-	4+	3+
4. *Asplanchna priodonta*	+	+	+	-	4+	3+
5. *Bdelloid sp.*	+	+	-	-	-	-
6. *Brachionus Angularis*	+	+	-	-	3+	3+
7. *B. calyciflorus*	-	+	+	-	4+	3+
8. *B.quadridentate*	+	+	2+	+	3+	3+
9. *B. bidentate*	+	+	+	2+	2+	+
10. *Colurella adriatica*	+	-	-	-	2+	+
11. *Cephalodella sp.*	-	-	+	-	+	-
12. *Conochilus sp.*	-	-	+	-	-	-
13. *Diploid sp.*	-	+	2+	2+	3+	2+
14. *Epiphanius sp.*	-	-	-	2+	2+	+
15. *Euchlanis Dilatata*	-	-	+	-	3+	2+
16. *Gastropus sp.*	+	-	4+	4+	2+	-
17. *Filinia Longiseta*	2+	-	4+	3+	+	-
18. *Hexarthra sp.*	-	-	3+	2+	+	-
19. *Keratella cochlearis*	+	-	+	2+	4+	-
20. *K. volga*	-	-	-	+	-	-
21. *Lantana depressa*	-	2+	+	+	4+	2+
22. *L. melasma*	2+	+	+	-	4+	3+
23. *L.luna*	3+	+	+	+	3+	2+
24. *L. ohiensis*	-	+	-	-	4+	3+
25. *Monostyla bulla*	2+	-	4+	3+	+	-
26. *M.quadridenta*	2+	2+	+	+	4+	3+
27. *M.closteriocerca*	3+	2+	+	-	4+	2+
28. *M.lunaris*	+	-	3+	+	+	2+
29. *Notometa sp.*	+	+	-	+	-	-
30. *Philodina sp.*	+	+	-	-	2+	2+
31. *Plasma sp.*	+	-	2+	+	+	-
32. *Platanias quadridentata*	+	-	4+	2+	+	-
33. *Polyarthra vulgaris*	2+	+	+	2+	2+	3+
34. *Phalaenopsis sp.*	2+	-	+	+	2+	2+
32. *Squatinella Ovalis*	2+	+	-	-	4+	2+
35. *Synchaeta sp.*	+	-	-	-	3+	2+
36. *Trichocerca Longiseta*	3+	2+	+	-	3+	4+
37. *T. cylindrica*	3+	-	4+	2+	3+	2+
38. *T. similis*	2+	-	2+	+	2+	+
39. *T. porcellus*	2+	-	+	+	+	-
40. *Trichotria Tetractis*	+	+	-	+	3+	4+
41. *Testudinella sp.*	+	+	-	2+	3+	3+
(B) Cladocera						
1. *Acroperus hecate*	2+	-	4+	2+	+	-
2. *Allonella affinis*	+	-	3+	2+	-	-
3. *Bosmina longirostris*	+	+	4+	2+	+	-
4. *Camptosaurus sp.*	+	-	3+	2+	-	-
5. *Ceriodaphnia sp.*	+	+	4+	2+	+	-
6. *Chydorus options*	2+	+	3+	2+	+	-
7. *Daphnia longiseta*	2+	+	+	-	3+	2+
8. *D.pulex*	2+	+	+		3+	2+
9. *Macrothrix rosea*	2+	2+	+	+	2+	+
10. *Moina micrura*	2+	+	-	+	4+	2+
11. *Pleuroxus denticulatus*	+	+	4+	+2	-	-
12. *P. similes*	+	2+	+	-	2+	+
(C) Copepoda						
1. *Acanthodiaptomus sp.*	+	-	3+	2+	-	-
2. *Bryocamptus sp.*	3+	+	2+	-	4+	+2
3. *Canthocamptus sp.*	3+	2+	+	-	3+	2+
4. *Cyclops bicuspidatus*	4+	2+	+	-	3+	+
5. *Cyclops sp.*	3+	+	+	+	3+	+
6. *C.scutifer*	4+	+2	2+	+2	4+	+4
7. *C.vicinus*	3+	+	4+	-	2+	+
8. *Eucyclops sp.*	2+	+	2+	+	2+	+
9. *Macrocyclops albidus*	2+	-	2+	-	4+	4+

From the other families *Lapedella ovalis, Monostylla bulla, Filinia longisitta, Philodina sp* were main representatives at site I in the open water area and at site III species *L.petella, L.luna, T.longiseeta, Gastropus, Filinia sp, and Asplanchna priodonata* were main contributors.

Among cladocerans, chydoridae was the most dominant family in the lake with 12 taxa and were dominant at site III near floating gardens and was notably represented by *Chydorus sphericus* and *Graptoleberus testudinaria*. Daphinidae was mainly represented by *Daphinia longispina*, *D.pulex* near floating gardens and *Ceriodaphinia sp* and *D.pulex* in open water areas. *B. longirostris, Macrothrix rosea* were abundant in both areas.

Group *copepoda* was represented by two families' viz. canthocamptidae and cyclopoidae. The former was represented by only one species i.e. *Canthocamptus sp*. Although recorded in both zones, it recorded higher density near the floating gardens. Cyclopoidae was dominated by *Cyclops scutifer* and *Cyclops vicinus.*

The analysis of the results obtained in the present study shows that the alteration in physico-chemical factors exerts considerable influence on the zooplankton abundance and diversity. To assess the interaction between the two, an attempt was made to analyze the data statistically. Rotifers showed negative correlation with DO and transparency (r= -0.3), with total alkalinity (r= -0.4),with nitrogen forms (r= -0.2 for nitrate, r= -0.7 for nitrite, and r= -o.6 for ammonia), while cladocera recorded negative correlation with Co2 (r= -0.3), transparency (r= -0.5), total alkalinity (r= -0.4), ammonia (r= -0.3), chloride(r= -0.5). Copepods showed negative correlation with DO(r= -0.2), Carbon dioxide(r= -0.7), transparency (r= -0.5), total alkalinity (r= -0.5), with nitrogen forms (r= -0.5 for nitrate, r= -o.1 for nitrite, and r= -0.7 for ammonia. Sorenson's similarity index was applied to the data on zooplankton community. The highest similarity was observed between site I and site II and least between site II and site III which seems to be related to the difference in physicochemical features as well as the macrophytic community of the two areas. From the above description it can be concluded that the physico-chemical milieu has a significant impact on the water quality and consequently upon the zooplankton community in the lake.

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