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Impact of Floating Gardens on the Water Quality and Cladocera Population in Nigeen Lake

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ABSTRACT

The present paper reports on the impact of floating gardens on the water quality and the population density of Cladocera in Nigeen lake. The water near floating gardens is more enriched with nutrients as is indicated by high level of chloride, phosphorus, nitrogen as well as electrolytic conductivity. Cladocera was dominated by family Chydoridae. Main contributors of cladocera in the lake were *Chydorus sphaericus, Bosmina longirostris, B. coregoni, Diaphanosoma brachyurum, Macrothrix rosea* and *Pleuroxus* sp. The population density of Cladocera was significantly higher in the vicinity of floating gardens which seems to be related with nutrient enrichment vis -a-vis higher density of other biotic communities including bacteria and decaying organic matter which provides food for the cladocera.

Keywords: Floating garden, Water quality, Cladocera population, Nigeen lake.

INTRODUCTION

Nigeen lake, is situated at a distance of about 9 km distançe to the north of Srinagar, at an elevation of 1584 m (ASL), covering an area of 4.5 sq km with the maximum depth 6m. It is connected with Dal Lake at Ashaibagh, Saida kadal. The lake is known for its aquatic sports and has been the focal point of tourist attraction. However it is under great stress due to influence of human settlements along the shore as well within the basin itself. The fresh water area of the lake has got reduced as a result of creation of floating gardens for vegetable cultivation. The unabated encroachment by way of floating gardens has not only squeezed most of the open water to narrow channels but has also led to the deterioration of the water quality. For the vegetable cultivation on the floating gardens not only green manure but even synthetic fertilizers like urea, potash and diammonium phosphate are used. A number of biocides are also applied for the control of different vegetable pests. A significant quantity of these fertilizers and biocides are leached out in the surrounding water and influence the water quality. During 2002 a limnological study of the lake was made. In the present paper an attempt has been made to compare the limnological parameters of the open water zone with those of the area which receives nutrients input directly from the floating gardens.

SAMPLING SITES

Two sampling sites, one in the centre of the lake, designated as site I and the other in the floating gardens area designated as site II, were selected. At site I *Potamogeton crispus*, *P. natans*, *Myriophyllum* spp.,were the dominant macrophytes while, at Site II *Potamogeton natans* *P. crispus*, *Ceratophyllum* spp., *Myriophyllum* spp., *Nelumbo nucifera*, were the main contributors of the vascular plant community.

MATERIAL AND METHODS

Water samples were collected from Jan 2002 to Dec 2002 on a monthly basis at each site using Rutner's sampler. Temperature, transparency, pH, and electrical conductivity were measured in the field. DO samples were fixed at the spot in accordance with Winkler's method. Free CO_2, total alkalinity, chloride were determined by titremetric method (Eaton *et al.*, 1995). Phosphate (Stannous chloride method), nitrate (Salicylate method, Nitrite (buffer color reagent method) and ammonia (Phenate method) were analysed with the help of Systronics 106 Spectophotometer in accordance with Eaton *et al.* (1995), CSIR (1974). Plankton samples were procured by sieving 10 litres of lake water through plankton net having 140 T nylobolt net cloth. The plankton samples were preserved in 4% formaldehyde immediately after collection and sub samples were examined under stereoscopic and compound microscopes. They were identified with the help of standard taxonomic works like Edmondson (1959); Smirnov (1974) Pennak (1978); Michael and Sharma (1988).

RESULTS AND DISCUSSION

Annual mean and range of physico-chemical features of the two sites are presented in Table 1. Only a slight difference was found in air and water temperature ranges of the two sites. Minimum air temperature was recorded in Jan while the maximum was recorded in July. Water temperature was minimum in March, while the maximum during July, showing a direct relation with the atmospheric temperature, the higher water temperature in Jan. and Feb. seems to be related with the heat retention capacity of the water (Spurr, 1975). Secchi transparency at site II was less than at site I. The lesser transparency values at site II are due to the presence of luxirant growth of macrophytes, and hence high quantity of decayed matter. This is substantial by the data on dissolved oxygen that the mean concentration of DO was higher at site I than site II. Low concentration of DO at site II can be related to increased decomposition of organic matter. The pH of the lake water was always alkaline and pH of the two sites did not showed appreciable difference. No significant correlation was observed between water temperature and pH. Mean CO2 also did not showed any appreciable difference between the two zones. A negative correlation was observed between water temperature and free CO2 ($r = -0.49$ at site I and $r = -0.58$ at site II). The alkalinity of water was mainly due to bicarbonates but at site I carbonate ions made their presence from May to June. As soon as pH of water rose 8.5, carbonate made its appearance (Buch, 1930). A weak negative correlation was seen between temperature and total alkalinity ($r = -0.28$ for site I and $r = -0.12$ for site II). The specific conducitivity was high throughout the year with its peak in June and July. High level of conductivity reflected the pollution status as well as trophic level of the lake (Shastree *et al.*, 1991). Conductivity values were significantly higher at site II, thereby depicting the higher electrolytic concentration in the vicinity of the floating gardens. This is also substantiated by the significantly high value of chloride at this site. This is directly related with the olericultural activities going on the floating gardens. This is further substantiated by the data pertaining to phosphorus and nitrogen content at the two sites. Large quantities of synthetic (super phosphates urea and potash) as well as natural fertilizers (including decayed macrophytic mass and animal faecal matter) are being utilized in the floating islands. Leaching of the fertilizers leads to the increase in ther nutrient concenteration in the close vicinity of the floating gardens.

During present investigation 27 species of cladocera were recorded; 25 species were reported from site I and 20 species from site II (Table 2). The cladocera of the lake was represented by six families viz Sididae, Daphnidae, Bosminidae, Moinidae, Macrothricidae, Chydoridae with the highest number of species belonging to Chydoridae at both sites. Most of the species of cladocera were common to both sites but a few, viz, *Pleuroxus trigonellus*, *Illyocryptus* sp. were absent from site I whereas at site II *Camptocercus* sp., *Acropeus harpae*, *Alonella* sp., *Alona* sp. were absent. Dominant forms at site I were *Chydorus sphaericus*, *Bosmina longirostris*, *Graptoleberis testudinaria*, whereas at site II *Diaphanosoma brachyurum*, *B. longirostris*, *Chydorus sphaericus*, *Graptoleberis testudinaria*, *Daphnia longispina*, *Pleuroxus similis* were dominant. *Bosmina longirostris*, *Chydorus sphaericus*, *Graptoleberis testudinaria* were present round the year at both the sites, whereas other sp. were encountered intermittently. Dominance of high population density of these forms particularly at site II may be due to high level of nutrients that prevailed in the lake during major part of the year. Presence of *Acropeus harpae*, *Alonella* sp., *Alona quadrangularis*, *A. rectangula*, *A.affinis*, may be indicative of low polluted nature of the water at site I as compared to site II. It may be concluded that *B. longirostris*, *Chydorus sphaericus*, *Graptoleberis testudinaria*, *Moinadaphnia* sp., *Daphnia longispina, Pleuroxus similis.* are strongly eutrophic species and can tolerate wide fluctuations of abiotic components and also their population density reach to highest peak mostly in spring and autumn.

Table 1. Physico-Chemical Features of Nigeen Lake During 2002

PARAMETER	SITE I			SITE II		
	RANGE	MEAN	S.D.	RANGE	MEAN	S.D.
Air temp (°C)	2.5 - 33.7	17.5	10.1	2.5 - 34.0	17.6	10.1
Water temp.(°C)	4.4 - 23.4	16.3	7.2	4.0 - 25.2	16.4	7.3
Transparency (m)	0.9 - 3.1	1.8	0.5	0.3 - 0.7	0.4	0.1
DO (mg/l)	3.2 - 10.2	5.3	2.7	2.5 - 7.6	2.4	1.4
pH(units)	8.0 - 9.6	8.5	0.5	7.5 - 8.5	8	0.3
Free CO_2	Ab - 10.2	5.8	4	2.0 - 10.7	6.5	3.2
Alkalinity(mg/l)	66.6 - 139	101.1	24.7	64.6 - 196	117.5	42.1
Conductivity(µs/25°C)	257 - 418	349.9	56.1	270 - 770	514.5	184.2
Chloride (mg/l)	11.2 -22.7	21.8	4.2	20.7 -73.3	44.4	20.1
Nitrate nitrogen (µg/l)	33.9 - 513	416.5	54.2	94.7 -393.2	211.7	85.7
Nitrite nitrogen (µg/l)	12 - 103	52.5	22	22 - 98	65	23.2
Ammonical nitrogen (µg/l)	94 - 229	157.2	53.5	320 - 683	471.6	95.7
Orthophosphate (µg/l)	36.4 - 326	146.9	54.2	109.7 - 324	244.9	72.3
Total phosphate(µg/l)	435 - 590	510.2	75.8	436 - 776	607.7	93.7

Ab = ABSENT

Gulati (1972) reported *B. longirostris* survive from oligo to eutrophic conditions. McNaught and Buzzard (1973) also reported that *Bosmina* reflect the increasing eutrophication of the lake. Hakkari (1977) had also reported *B. longirostris, Chydorus sphaericus* prefer eutrophic water. Gannon (1981 a,b) has reported that *Chydorus sphaericus* is an indication of eutrophic conditions and that inshore areas off urban centres were characterized by high concentration of few species of cladocera especially *B. longirostris* . In valley lakes dominance of *Chydorus sphaericus, Graptoleberis testudinaria, Camptocercus* sp., *Alona rectangular* and *A. exigua* has been recorded by Yousuf et al (1983). Balkhi (1983, 1988), Parveen (1988) reported

Table 2. Cladocera Recorded in Nigeen Lake

Family : Sididae

Diaphanosoma brachyurum
Sida crystallina

Family : Daphnidae

Daphnia pulex
D. longispinna
D. similis
Ceriodaphnia reticulata
C. quadriangularis
Moinadaphnia sp.
Simocephalus sp.

Family : Bosminidae

Bosmina longirostris
B. coregoni

Family : Monidae

Moina micrura

Family : Macrothricidae

Macrothrix rosea
Macrothrix sp.
Illyocryptus sp.

Family : Chydoridae

Chydorous sphaericus
Chydorous sp.
Pleuroxus similis
P. trigonellus
Pleuroxus sp.
Graptoleberis testudinaria
Camptocercus sp.
Acropeus harpae
Alonella sp.
Alona quadriangularis
A. rectangula
A. affinis

Chydorus sphaericus show perennial behaviour in meso and eutrophic waters. Subla et al (1984) has also reported *B.longirostris, Chydorus sphaericus* prefer eutrophic water. Nanazato and Yasund (1985) reported *Moina micrura* to be a dominant plankton in highly eutrophic Kasumigaura lake in Japan. Parveen (1988) reported *Moina micrura* only in highly eutrophic Brarinambal basin of Dal lake. Balkhi and Yousuf (1992) has also observed *Alona monocantha, Chydorus sphaericus, B.longirostris, Diaphanosoma brachyurum, Graptoleberis testudinaria, Macrothrix* sp. and *Pleuroxus trigonellis* in mesotrophic and eutrophic lakes. Balkhi and Yousuf (1996) reported a total of forty- four species of cladocera belonging to seven families from the fresh waters of Kashmir. Pandit (1998, 1999) also reported *Bosmina longirostris* and *Chydorus sphaericus* stronghly eutrophic sp. Parveen and Yousuf (1999) reported that *Moina micrura, Daphnia longispina* were mainly restricted to polluted waters of Brarinambal basin whereas *Ceriodaphnia reticulata, Chydorus sphaericus, Bosmina longirostris, Acropeus harpae* generally avoided polluted water.

Overall at site I population density of cladocera fluctuated between 6 ind/l in January to 54 ind/l in April with *Chydorus sphaericus* contributing about 16.9% followed by *Graptoleberis testudunaria*,12.7% while at site II it fluctuated between 17 ind/l in January to 106 ind/l in September with *Chydorus sphaericus* contributing about 16.6% followed by *Graptoleberis testudunaria* (16.2%) and thus while comparing cladocera population of two sites it is observed that at site II major part of the population density was contributed by Chydoridae (60.4%)followed by Daphnidae (20.1%), Bosminidae (15.4 %) Macrothricidae (3.9 %), Sididae (1.3 %) , Moinidae (0.8%), while at site I contribution of Chydoridae (46.7 %) declined and that of Bosminidae (24.6%), Daphnidae (22.2 %) increased (Table 3).

Several Chydorids like *Chydorus sphaericus, Chydorus* sp., *Graptoleberis testudinaria, Pleuroxus similis* were recorded in relatively higher number in floating gardens water area than in the open water area of the lake and thus shows its eutrophic nature.Balkhi and Yousuf (1992) also reported Chydorid dominance in eutrophic water. Eutrophication of floating gardens water are due to the use of various kinds of fertilizers and raw faecal matter at the floating gardens in order to get more productivity from here. These fertilizers are leached into the surroundings water and thus pollute water which in turn affects the biotic components present in the water. The highly monthly and annual average of cladocera population density at site II can be associated with enrichment of nutrients which facilitates the growth of other biotic communities which in turn subsequently give rise to high decomposed matter which provide food for the cladocera. Thus higher population of cladocera has coincidence with acceleration of eutrophication in the lake particularly in vicinity of floating garden area. This is also clearly revealed by positive correlation coefficient (r = 0.4)

Table 3. Yearly % Distribution of Cladocera in Nigeen Lake

SITES	I	II
FAMILY		
SIDIDAE	0.7	1.3
DAPHNIDAE	22.0	20.1
BOSMINIDAE	24.6	15.4
MOINIDAE	0.1	0.8
MACROTHRICIDAE	5.9	3.9
CHYDORIDAE	46.7	60.4

between cladocera and nitrogen and chloride.

From the data collected on the physico-chemical parameters and the cladocera population density it is quite clear that floating gardens are playing an important role in enhancing the nutrient concenteration viz-a-viz eutrophication and change in biotic diversity of the lake. In order to have a check on the further eutrophication we need to check the further growth of floating gardens. There also needs to be control on the use of synthetic fertilizers for allochonthous sources.

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