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The distribution and abundance of epiphytic rotifer populations on submerged macrophytes in Dal Lake, Srinagar

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Abstract

The distribution and abundance of epiphytic rotifer population was studied on five submerged macrophytes in Dal Lake, Srinagar, during 1988-89. Maximum colonization during both the years was registered on *Ceratophyllum demersum* and *Myriophyllum spicatum*. The most dominant species were *Lepadella ovalis* and *Monostyla lunaris*. Coefficients of determination (r^2) between average rotifer population and the selected parameters of water temperature, Secchi transparency and dissolved oxygen were not significant.

Key words: Epiphytic rotifers, submerged macrophytes, population abundances, Dal Lake.

1. Introduction

In recent years, several studies have been reported on the limnology of Dal Lake, Srinagar. Vass and Zutshi[1] investigated morphological and physical features and Zutshi and Vass[2,3] obtained data on water chemistry and biological populations. Information on energy flow and the impact of human activities on the evolution of Dal Lake environment was presented by Vass and Zutshi[4] and Zutshi[5]. However, no data are so far available on the periphyton community of Dal Lake except for preliminary studies done on algal populations[6].

Periphyton is an important heterogenous community of organisms attached to any kind of substratum. It includes filamentous bacteria, rotifers, protozoa and algae. Periphyton are useful as bioindicators of pollution as they are sessile and hence cannot escape pollution effects.

In the present investigation, data on distribution, species composition and community

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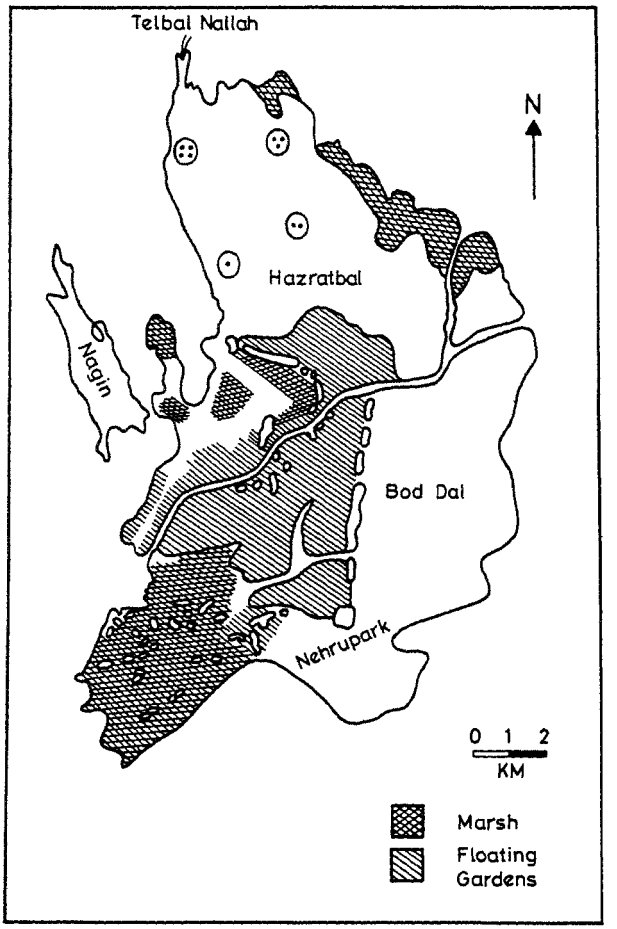

FIG. 1. Map of Dal Lake showing location of the sampling site. ⊙ = 1; ⊙ = 2; ⊙ = 3; ⊙ = 4.

structure of epiphytic rotifer population colonizing five submerged macrophytes in Dal Lake, Srinagar, are presented.

2. Materials and methods

Five submerged macrophytes, *Myriophyllum spicatum* L., *Ceratophyllum demersum* Linn., *Hydrilla verticillata* (L.f.) Royle, *Potamogeton lucens* Linn., and *P. crispus* Linn., were selected for the purpose of present study. These macrophytes were collected from Hazratbal (Fig. 1) which is the largest basin of Dal Lake with a surface area of 240 ha and maximum depth of 3·5 m. The field studies were carried out once every month starting from January, 1988, through December, 1989. The macrophytes were collected from four spots with the help of a grappler and transported to laboratory where these were sorted out and washed to remove debris. About 5 g of plant material was selected randomly from each species and, with the help of a scalpel, the periphyton was carefully removed. The scrapped samples were then preserved in 1% acid Lugol solution in separate plastic tubes for enumeration. Counting was carried out in a one ml Sedgwick Rafter Cell. The entire contents of the cell were counted and the results expressed as the number of individuals on one gram of plant fresh weight (ind./g F.W.). Fresh weight was obtained after plants were pressed between absorbent sheets to remove water until constant weight was registered.

Water samples were collected every month between 10.00 and 12.00 h, near the macrophyte stands. In the field, water temperature was recorded using a standard mercury thermometer. Samples for dissolved oxygen were collected in separate glass-stoppered bottles of 125 ml capacity and were chemically fixed in the field itself using unmodified Winkler's method[7]. Hydrogen ion concentration of water sample was measured using a digital pH meter and electric conductance was determined with the help of a direct-reading conductivity meter (Type 303). Calcium and magnesium were determined titremetrically using Eriochrome Black T as an indicator. Acid molybdate method was used for obtaining total phosphorus content after water samples were digested with 70% perchloric acid. Nitrate–nitrogen was estimated by diphenylamine sulphuric acid method[8].

3. Results and discussion

In the present studies, nearly fifty rotifer species were collected from five natural substrates (Table I). Out of these, only two species, *Lepadella ovalis* and *Monostyla lunaris*, were numerically important. Other species were rare(<1%). According to Pennak[9], planktonic groups in freshwaters at a particular moment are generally composed of one dominant species, one or two species that occur in relatively large numbers and the remaining species forming only a small fraction of the total population. This was the case with the epiphytic rotifer population of Dal Lake. *Lepadella* was the most dominant species and was encountered on all the substrates with maximum population frequency of occurrence registered on *Potamogeton lucens* and the least on *Myriophyllum spicatum* (Table II).

Table I
Distribution of rotifera on aquatic macyophytes in Dal Lake in 1988 (a) and 1989 (b)

Taxa	*Mariophyllum*		*Ceratophyllum*		*P. lucens*		*P. crispus*		*Hydrilla*	
	(a)	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*
Anuraeopsis fissa Gosse		+		+	+	+	+	+		+
Asplanchna sp.	+	+	+	+	+	+	+	+	+	+
Asplanchna priodonta Gosse	+	+								+
Brachionus sp.	+	+	+	+	+	+	+	+		
B. angularis Gosse		+		+		+				
B. calyciflorus Pallas			+	+	+	+	+	+	+	+
B. quadridentatus Hermann	+	+		+					+	+
B. bidentatus Anderson	+	+								
Cephalodella sp.	+	+	+	+	+	+	+	+	+	+
Chromogaster ovalis Bergendal	+	+	+	+	+	+	+	+	+	+
Collotheca sp.		+		+	+	+		+	+	+
Collurella adriatica Ehren	+	+	+	+	+	+	+	+	+	+
C. obtusa Ehren		+		+		+		+		+
Diplois sp.	+	+		+	+	+	+	+	+	+
Euchlanis sp.		+		+						
Gastropus sp.						+				+
Keratella cochlearis Gosse	+	+	+	+	+	+			+	
K. serrulata Ehren	+	+	+	+	+	+	+	+	+	+
K. quadridentata Muller	+	+	+	+	+		+	+	+	+
Lecane luna Muller	+	+	+	+	+	+	+	+	+	+
L. depressa Muller	+	+	+	+	+	+	+	+	+	+
Lepadella ovalis Muller	+	+	+	+	+	+	+	+	+	+
L. patella Muller	+	+	+	+	+	+	+	+	+	+
L. bicornis Muller		+	+	+	+	+	+	+		
Macrochaetus sp.						+				
Manfradium sp.	+	+	+	+	+	+	+	+	+	+
Monommara sp.									+	
Monostyla bulla Gosse	+	+	+	+	+	+	+	+	+	+
M. lunaris Ehren		+	+	+	+	+	+	+		+
M. quadridentata Ehren		+	+	+		+	+	+		+
Mytilina ventralis Ehren	+	+	+	+		+	+	+	+	
Notholca acuminata Ehren	+	+	+	+	+	+	+	+	+	+
N. labis Gosse	+	+								
Pedipartia sp.								+		
Philodina sp.	+	+		+		+	+	+		
Platias sp.						+		+		+
Polyarthra vulgaris Carlin					+		+	+		
Phompholyx sp.							+	+		

(*Contd*)

Table I *(contd)*

Taxa	*Mariophyllum*		*Ceratophyllum*		*P. lucens*		*P. crispus*		*Hydrilla*	
	(a)	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*	*(a)*	*(b)*
Rotaria rotatoria Pallas	+	+	+	+	+	+	+	+		
Scaridium longicaudum Muller	+	+					+	+		
Squatinella sp.	+	+	+	+	+	+	+	+	+	+
Synchaeta sp.						+			+	+
Testudinella patina Herman		+		+		+	+	+	+	+
Trichocerca cylindrica Imhof	+	+	+	+	+	+	+	+		+
T. longiseta Schrank	+	+	+	+	+	+	+	+	+	+
T. similis Wierzejski	+	+	+	+	+	+	+	+	+	+
T. tigris Muller	+	+	+	+		+	+	+	+	+
T. porcellus Gosse		+	+			+				+
T. multicrinis Gosse					+	+		+		
Trichotria sp.	+	+	+	+	+	+	+	+	+	+

Table II
Distribution of *Lepadella ovalis* on macrophytes in 1988

Species	*% occurrence*
Ceratophyllum demersum	12·0
Myriophyllum spicatum	9·7
Potamogeton lucens	18·9
P. crispus	15·5
Hydrilla verticillata	12·8

Table III
Average rotifer density (ind./g F.W.) on macrophyte species in 1988–89

Macrophyte species	*1988*		*1989*		
	Mean n=12	*± S.E.*	*Mean n=12*	*± S.E.*	*t*
Ceratophyllum demersum	200·8	16·5	287·5	22·4	3·10*
Myriophyllum spicatum	188·3	17·4	282·5	25·6	3·04*
Potamogeton lucens	185·0	24·4	264·2	16·5	2·68*
Potamogeton crispus	182·5	20·1	277·5	25·8	3·0*
Hydrilla verticillata	175·8	23·9	261·7	23·9	2·53*

* Significant at 5% level.

Average rotifer population associated with five submerged macrophyte species shows that during 1988 *Ceratophyllum* supported the maximum population and *Hydrilla* the minimum, although the overall values were very close. However, in the subsequent year, mean rotifer population increased significantly in all the cases (Table III).

The possible causes for the increase of the average population during 1989 may be related to more favourable climatic conditions coupled with higher nutrients in the

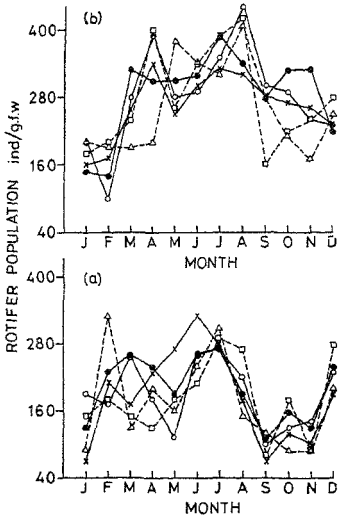

FIG. 2. Seasonal variation in the rotifer population of five macrophyte species (a) 1988 and (b) 1989. o——o Myriophyllum; ●——● Ceratophyllum; x——x *P. lucens*; □——□ *P. crispus*; ▲ - - - ▲ Hydrilla.

lake water. According to Herzig[10], in water bodies of the temperate zone, climatic variability is reflected in the composition of the rotifer community. Long-term data presented by Herzig showed that the species abundance varied markedly from year to year, especially when the lake was disturbed by eutrophication.

Several species of the rotifers showed marked preferences for particular plant substrates, *e.g., Lepadella ovalis, Monostyla bulla, M. lunaris, Collurella adriatica, Asplanchna* sp., and *Lecane luna* were found to colonize all the substrates. *Brachionus calyciflorus* was absent from *Myriophyllum. Keratella cochlearis* was not found on *P. crispus. Brachionus quadridentatus* was present on three macrophytes and absent from both the species of *Potamogeton.* Similarly, *Philodina* sp., and *Lepadella bicornis* colonized four macrophytes except *Hydrilla. Scaridium longicaudum* was only collected from *Myriophyllum* and *P. crispus.* Edmondson[11] reported that different rotifer species tend to select particular plants for attachment, and some species were found only on certain plants. According to Young[12], different plant substrates under identical conditions bear different kinds of epiphytes. The chief difference is that the organisms occur in varying proportions, although some species are completely absent from certain surfaces.

Table IV
Selected physico-chemical data of Hazratbal basin

Parameters	*1988*		*1989*		
	Mean (n=12)	*± S.E.*	*Mean (n=12)*	*± S.E.*	*t*
Temperature (°C)	18·2	1·6	19·4	1·8	0·49
Secchi (cm)	129·4	6·5	132·5	5·9	0·35
Dissolved oxygen (mg/l)	18·5	0·94	13·6	0·47	4·65*
pH	8·7	0·10	8·8	0·05	1·27
Conductivity (μ mhos)	162·0	7·14	194·0	7·49	3·13*
Total alkalinity (mg/l)	102·0	6·1	112·0	6·0	1·12
Ca + Mg (mg/l)	56·6	3·6	61·7	2·8	1·10
Total phosphorus (μg/l)	60·8	3·7	75·5	3·8	2·79*
NO_3–N (μg/l)	179·7	8·7	197·2	9·4	1·35

* Significant at 5% level.

The relationships observed appeared to indicate that the rotifer species responded to morphological differences in the macrophytes. *Lepadella ovalis* and *Monostyla lunaris* were present predominantly on macrophytes with flat convex leaves rather than on dissected leaved species. On the other hand, *Monostyla bulla* was more common on dissected leaved macrophytes than it was on flat-leaved species. Our data support the observations of Downing and Helene[13] who reported that more epiphytic invertebrates were found on the dissected-leaved *Ceratophyllum* and *Myriophyllum* than on the broad-leaved *Potamogeton*.

As shown in Fig. 2, during 1988, the highest rotifer population was recorded in February on *Hydrilla* and in June on *P. lucens*. The minor peak was observed in May. There was rapid decline in the population density during autumn. In 1989, the situation was entirely different. The maximum population was registered on *Myriophyllum* in August. In fact, most of the species showed peak values during this month. A well-pronounced second peak was obtained in April except for *Hydrilla*. The sharp decline in the rotifer population was seen in February. Lund[14] pointed to the fact that sexually dimorphic rotifera usually display pronounced reproductive cycles more or less related to seasonal conditions. Most rotifers of permanent waters are summer forms, that is, the population gradually increases, reaching a maximum at the height of the summer, then gradually declines and disappears, leaving the dormant eggs to initiate a new cycle in the following spring. This type of seasonal behaviour may be due to insufficient quantities of food available during the winter. Pejler[16], however, suggested that temperature along with a set of environmental factors affects the population of rotifera.

In Table IV, data on some important physico-chemical features of lake waters are provided.

Mean values for many parameters are higher in 1989 than in 1988. The calculated

Table V
Coefficient of determination (r^2) between average rotifer density and selected physico-chemical parameters

Parameter	*1988*	*1989*
Temperature	0·11	0·66
Transparency	0·02	0·36
Dissolved oxygen	0·02	0·15

value of t was observed to be significant at 5% level in the case of DO, specific conductance and total phosphorus, with DO being lower in 1989 and specific conductance and total phosphorus being higher.

Coefficient of determination (r^2) was calculated between average rotifer density and some selected physico-chemical parameters such as temperature, Secchi transparency and dissolved oxygen (Table V). During the first year of observation, very little of the variance in rotifer density is explained by these three parameters. However, during the second year, most of the variance in the rotifer population (up to 66%) was due to temperature; transparency was responsible for 36% variation and 15% was related to dissolved oxygen concentrations.

Bray and Curtis[17] index of similarity was applied to find out whether any macrophyte species supported a distinct assemblage of rotifer species. However, no relationship was evident between the rotifer species and the plant substrate. Nogrady[18] also failed to observe any definite substratum–rotifer relationship in the lakes of southern California, USA. According to Elliot[19], in many eutrophic water bodies, hypolimnetic oxygen depletion may restrict rotifer occurrence. Elliot correlated the occurrence and abundance of rotifer community with temperature and oxygen concentration of water, which is not supported in this study. Sand-Jansen[20] states that it is difficult to determine when and how physico-chemical factors regulate the growth of periphyton. Since many physico-chemical parameters affect growth, it is not possible to pinpoint a single regulating factor. The same may hold true for the epiphytic community of Dal Lake.

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