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SEASONAL SUCCESSION OF CRUSTACEAN ZOOPLANKTON IN WULAR LAKE OF THE KASHMIR HIMALAYA

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Abstract - The present study was undertaken on Wular Lake, a Ramsar Site in Kashmir Himalaya, to study the seasonal succession of crustacean zooplankton from September 2010 to August 2011. A total of 42 crustacean taxa belonging to Cladocera (23), Copepoda (16) and Ostracoda (3) were identified at five different sampling sites. Among the crustaceans, Cladocera was numerically the most dominant group at sites III, IV and V, followed by Copepoda at sites I and II. On an average basis total crustacean density ranged from 416 ind./l in winter to 1567.6 ind./l in summer. On the basis of Sorensen's similarity index, study sites IV and V showed close similarity (88.13%).

Key words: Succession, Crustacea, density, Wular Lake, Kashmir Himalaya, India

INTRODUCTION

Seasonal succession in aquatic communities is a well-documented phenomenon (Sommer et al., 1986), and there have been many attempts to uncover the forces driving population dynamics among crustaceans in the field. Crustaceans are an important component of zooplankton. They have evolved a high diversity of body forms and habits colonizing every aquatic habitat and are even successful in some edaphic environments (Frey, 1980; Kikuchi, 1991, 1994; Defaye and Heymer, 1996). Cladocera, Copepoda and Ostracoda are the major groups in meiobenthic crustacean assemblages, which can be both numerically abundant and species rich (Giere, 1993). Crustacean succession is largely determined by the interactions and the seasonal cycles of physical-chemical factors (Leibold et al., 2004), and biological factors such as competition and predation (Larson et al., 2009), which vary in different periods of the year (Sommer et al., 1986) and among aquatic ecosystems and scales (Pinel-Alloul and Ghadouani, 2007).

Study area

Wular Lake, the largest freshwater lake on the Indian subcontinent, is a shallow macrophyte dominated rural valley lake, located 34 km northwest of the city of Srinagar in the valley of Kashmir (between 340 16' -340 20' N latitude and 740 33' – 740 44' E longitude). The lake is mono-basined, elliptical in shape and is of fluviatile origin, formed by the meandering of River Jhelum. It lies at an altitude of 1580 m (a.m.s.l.) and its depth is on average 3.6 m, though it reaches 5.8 m at its deepest point. The major inflows to the Wular Lake are River Jhelum and streams like Gurror, Madhumati and Erin. The lake plays a significant role in the hydrographic system of the Kashmir valley by acting as a huge reservoir and it absorbs the high annual flood of River Jhelum. The largest freshwater

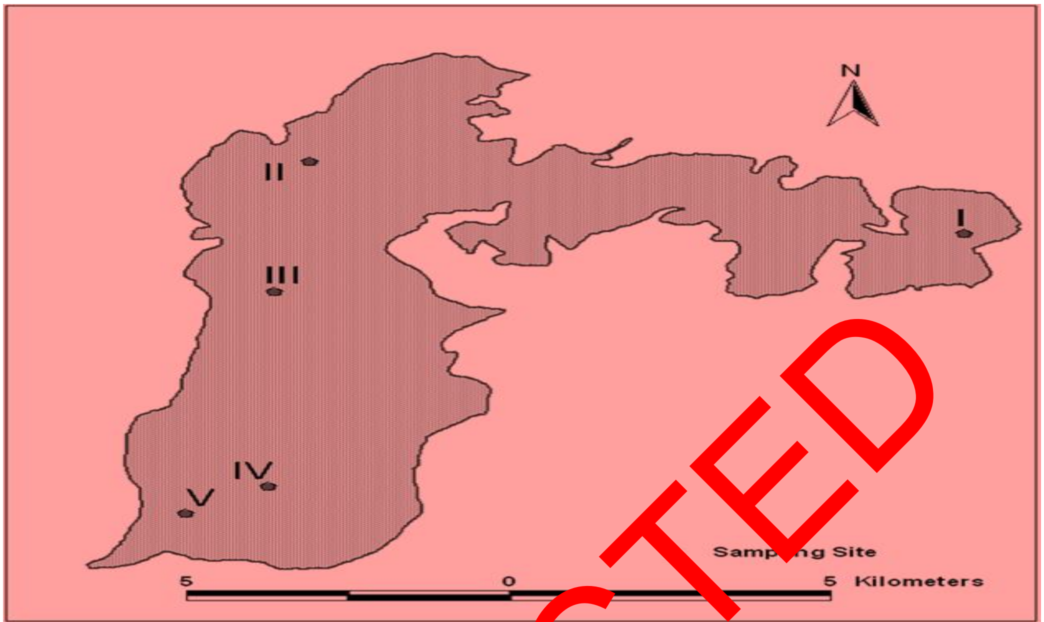

Fig. 1. Five sampling sites in Wular Lake

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shallow lake in 1990 has assumed the status of Ramsar Site, a Wetland of International Importance. Five study sites differing in various characteristics were chosen for the present study (Fig. 1 and Table 1).

Table 1. Location of five study sites in Wular Lake

Sites	Latitude (N)	Longitude (E)
I	34° 21′ 51	74° 39′42
II	34° 24′ 15	74° 32 ′35
III	34° 21′ 29	74° 31′ 48
IV	34° 17′ 13	74° 31′30
V	34° 17′ 16	74° 30′25

MATERIALS AND METHODS

Crustacean samples for qualitative analysis were collected at the indicated study sites on a monthly basis by filtering 100 l of subsurface lake water through a Birge conical crustacean net with a mesh size of 75 µm. The results are presented on a seasonal mean basis. Preservation of the samples was carried out in 4% formalin. Identification of the crustaceans was done with the help of the standard works of Pennak (1978) and Edmondson, (1992). The quantitative analysis was done with the help of Sedgewick Rafter plankton-counting cell and the results were expressed as individual per liter (ind./l.).

RESULTS AND DISCUSSION

The distribution of different taxa of crustaceans at five different sites is given in Table 2. The seasonal variation in their density is summarized in Table 3. In all, 42 species belonging to three different groups, namely Cladocera (23), Copepoda (16) and Ostracoda (3), were recorded during the entire study. Among the study sites, the highest number of crustacean species (40) was registered at site III, followed by 31, 28, 27 and 17 species that were observed at sites IV, V, II and I, respectively. Group-wise distribution of crustacean zooplankton showed discernible differences at different sites. Cladocera thus recorded 22, 16, 15, 11 and 07 species at sites III, V, IV, II and I, respectively, while Copepoda registered 15 at site III, 13 each at sites IV and II, 9 at site V and 8 at site I. Furthermore, Ostracoda was the least represented group, encompassing only 3 species each at sites II,

Table 2. Distribution pattern of crustaceans at five sites in Wular Lake from Sep. 2010 to Aug. 2011.

(A) Cladocera		Site I	Site II	Site III	Site IV	**Site V**
Alona affinis		-	+ + +	+ + +	+ +	+ +
A. costata		-	+	+	-	-
A. guttata		-	-	+	+	+
A. rectangula		+	-	+	+	+
Alonella dentifera		-	+	+ + +	+ +	+
A. exigua		-	-	+ +	+	+ +
Bosmina coregoni		+	-	+	+	+
B. longirostris		+	+	+	+	+
Camptocercus rectirostris		-	-	+	+	+
Ceriodaphnia quadrangula		+	+	+	+	+ +
Chydorus sphaericus		+ + +	+ + +	+ +	+ + +	+ +
C. ovalis		-	-	+	-	-
Daphnia laevis		-	-	+	+ +	+ +
D. magna		-	-	[illegible]	-	-
D. pulex		+ +	+ +	+	+	+
D. retrocurva		-	-	+	-	-
D. rosea		-	+	+	+	-
Diaphanosoma brachyurum		-	[illegible]	[illegible]	-	+
Macrothrix rosea		-	+ +	+ +	+ + +	+ +
Moina affinis		-	+ +	-	-	-
M. brachiata		-	[illegible]	+	-	-
Moinodaphnia sp.		-	-	+	-	+
Sida crystallina		+ +	+	+ +	+	+
Total	23	7	11	22	15	16
(B) Copepoda						
Acanthocyclops bicuspidatus		[illegible]	+	+ +	+	+ +
Bryocamptus minutus		-	+ +	+ +	+ + +	++
Bryocamptus nivalis		+ +	+++	+	+ + +	++
Cyclops bicolor		+ + +	+ +	+ + +	+	+
C.bisetosus		-	+	+	+	-
C. bicuspidatus		-	-	+ + +	-	-
C. panamensis		-	-	.	+	-
C. scutifer		+	+	+	+	+
C.vicinus		+	+	+	+	+
C. latipes		-	+ + +	+ +	+ + +	-
Diaptomus sp.		+	+	+	+ +	+
Diaptomus virginiensis		+ +	+ +	+	+	+
Eucyclops agilis		-	+ + +	+ + +	+	+ ++
Macrocyclops fuscus		+ +	-	+	-	-
Megacyclops viridis		+	+	+	-	-
Paracyclops affinis		-	+	+	+++	-
Total	16	8	13	15	13	9
(C) Ostracoda						
Cypris sp.		-	+	+	+	+
Cyclocypris sp.		+	+	+ +	+ +	+
Eucypris hystrix		+ +	+	+	+	+
Total	3	2	3	3	3	3
Grand total	42	17	27	40	31	28

+ = Present; ++ = fairly present; +++ = abundant; - =absent

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Table 3. Seasonal variations in the mean density values (ind. /l) of crustaceans at five study sites from Sep. 2010 to Aug. 2011.

Group	Autumn	Winter	Spring	Summer
Site I				
Cladocera	152	157	393	309
Copepoda	345	206	260	335
Ostracoda	42	53	50.6	36
Total	539	416	703.6	680
Site II				
Cladocera	385	450	605	476
Copepoda	567.6	428	539	603
Ostracoda	73	72	68	77
Total	1025.6	950	[illegible]	1156
Site III				
Cladocera	721.6	688	966	953
Copepoda	605	433	629	547.6
Ostracoda	62	76.6	47	67
Total	1388.6	1197	1642	1567.6
Site IV				
Cladocera	456	[illegible]	662	573
Copepoda	433.6	[illegible]	569	476.6
Ostracoda	78.6	63	78	51.6
Total	968.2	984	1309	1101.2
Site V				
Cladocera	[illegible]	442	754.6	685
Copepoda	312	315	364	363.6
Ostracoda	77	91	80	60.6
Total	858	848	1198.6	1109.2

Table 4. Sorenson similarity coefficient (%) between different selected sites on the basis of Crustacea.

	Site II	Site III	Site IV	Site V
Site I	54	52.6	58.3	62.2
Site II		74.6	86.2	72.7
Site III			84.5	82.3
Site IV				88.13

III, IV and only 2 species at site I. The most dominant Cladocera taxa reported from the entire lake were *Chydorus sphaericus, Alona affinis, Macrothrix rosea* and *Moinodaphnia* sp. Among Copepoda the dominant species included *Bryocamptus nivalis*, *Cyclops bicolor* and *Eucyclops agilis*, while among Ostracoda *Cyclocypris* sp. and *Eucypris hystrix* were dominant (Table 5). Cladocerans such as *Chydorus ovalis, Daphnia magna, D. retrocurva* and *Moina brachiata* showed restricted appearance at site III, while *Moina* *affinis* was represented at only one biotope (site II). Among the copepods, *Cyclops panamensis* was confined to site IV only.

The data on seasonal variation in crustacean populations suggests that the most favourable period for growth is from May to August, which may be attributed to the increase of phytoplankton population during this period (Pandit, 1980; Qadri and Yousuf, 1980; Balkhi and Yousuf, 1996). It is further believed that the crustacean population at one time is the result of complex variations in numerous factors, the most important among them being the quality and quantity of food, temperature, and the predation pressure by phytophagous species (Onwudinjo and Egborge, 1994; Ovie and Adeniji, 1994). Pennak (1946) maintained that zooplankton annual and seasonal cycles are highly variable in nature from lake to lake and from year to year within the same lake.

During the entire study, the lowest density of crustaceans was registered in the winter months. Herbert and Hann (1986) suggested that differences in the life cycle of the species could explain differences in the dispersion patterns. On the other hand, Soto (1989) demonstrated that the reproductive characteristics of microcrustaceans are of great importance in determining their persistence or extinction in certain environments. The main reason for this is not immediately clear but we believe that predation by fishes may have contributed to the decline in crustacean population (Pandit, 1980; Mwebaza-Ndawula, 1994; Ovie and Ovie, 2002). Solomon et al. (2009) recognized various anthropogenic stressors affecting the abundance and diversity of the crustacean population. At site I, the lowest mean density of crustacean may be attributed mainly to food limitation and fish predation as suggested by the Sommer *et al.* (1986). Saunders *et al.* (1999) suggested that temperature modulates the duration of egg development and this, together with the availability of food, can control the abundance of crustaceans in winter.

Ostracods are very common in most inland waters, where they abound in the benthic and periphytic animal communities. Moreover, some also occur in marine habitats. In the present study, *Cyclocypris* sp., *Cypris* sp. and *Eucypris hystrix* were found to be less in numbers. In general, no regular growth pattern was followed by Ostracoda as the majority of them were found to live at the bottom of the lake. The population dynamics of this group is not clearly known, though some species exhibit distinct seasonal periodicity (Wetzel, 1983).

On the basis of Sorensen's similarity index, the sites that showed close similarity were sites IV and V (88.13%), followed by sites IV and II (86.2%), III and IV (84.5%), III and V (82.[illegible]%) and II and III (74.6%) (Table 4). On the other, the least value for Sorensen's similarity coefficient was observed for sites I and III (52.6%), I and II (54.[illegible]%) and I and IV (58.3%).Thus, it was found that site II was quite different from all the other sites that revealed higher similarities amongst themselves rather than with site I.

A succession pattern where cladocerans dominate during the spring and summer seasons and Copepoda in autumn and summer, as found in the present study, was also supported by Pandit (1980) in Kashmir wetlands, Egborge (1981) in Asejire Lake and Khan and Ejike (1984) in the Lamingo dam. Pandit (1980) and Onwudinjo and Egborge (1994) further attributed low crustacean density during the winter season to low temperature, aside from food availability in the water body. From the study, it can be inferred that the dominance of small-sized Cladocera over the large-bodied crustaceans is a clear sign of accelerated eutrophication.

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