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Species composition and biomass of annelids of Wular Lake, a Ramsar site in Kashmir, India

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During the present investigation of Wular lake in terms of species composition and biomass of annelids, 10 taxa were recorded which belonged to two major classes namely Oligochaeta (7) and Hirudineae (3). The class Oligochaeta included *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, *Branchiura sowerbyii, Nais* sp., *Aelosoma* sp., *Pristina* sp. and an unidentified taxion. Similarly, the class Hirudinaea was comprised by *Erpobdella* sp., *Placobdella* sp. and *Glossiphonia* sp. The seasonal mean value for biomass of annelids fluctuated between 0.31 g/m^2 at site I in winter to 14.92 g/m^2 at site III in summer. The annual mean biomass was highest at site IV (10.82±2.02 g/m^2), followed by site III (10.47±2.07 g/m^2), site II (8.94±1.90 g/m^2), site I (1.85±0.94 g/m^2) and site V (1.71±0.50 g/m^2).

Key words: Biomass, species composition, annelid, Lake and Ramsar site.

INTRODUCTION

In an aquatic ecosystem the life of aquatic biota is closely dependent on the physical, chemical and biological characteristics of water that directly acts as a controlling factor (Yaqoob and Pandit, 2009). Macrozoobenthos is an important constituent of aquatic ecosystem and has functional importance in assessing the trophic status. Thus as the abundance of benthic fauna mainly depends on physical and chemical properties of the substratum, the benthic communities are known to respond to changes in the quality of water or habitat. The benthic macroinvertebrates are associated with bottom or any solid liquid interface, which includes a heterogeneous assemblage of organisms belonging to various phyla like Arthropoda, Annelida, Mollusca and others. The benthos occupies an important position in the lake ecosystem, serving as a link between primary producers, decomposers and higher trophic levels (Pandit, 1980). They also play an important role in the detrital food web which in turn affects the cycling of minerals (Gardner et al., 1981). Macroinvertebrates are used as indicators of pollution as their communities change in response to changes in physicochemical factors and available habitats (Sharma and Chowdhary, 2011). According to Jumppanen (1976) the first signs of eutrophication and pollution in a lake are reflected in the benthic flora and fauna as the suspended waste immediately sink to the bottom to decompose and thus cause a change in the benthic composition and abundance. The lakes and wetlands having soft bottom sediments are characterized by annelids either as the dominant or one of the most abundant group. Of the fresh water annelids,

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Table 1. Geographical coordinates of the five study sites

Sites	Latitude	Longitude	Altitude (m) (a.m.s.l)
Vintage	34° 21' 56.9" N	74° 39' 42.0" E	1583
Ashtung	34° 24' 3.8" N	74° 32' 41.7" E	1580
Watlab	34° 21’ 29.4” N	74° 31’ 48.2” E	1581
Makdomyari	34° 20’ 39. 2” N	74° 34’ 52.2” E	1579
Ningle	34° 17’ 74.31”N	74° 31’ 29.8” E	1578

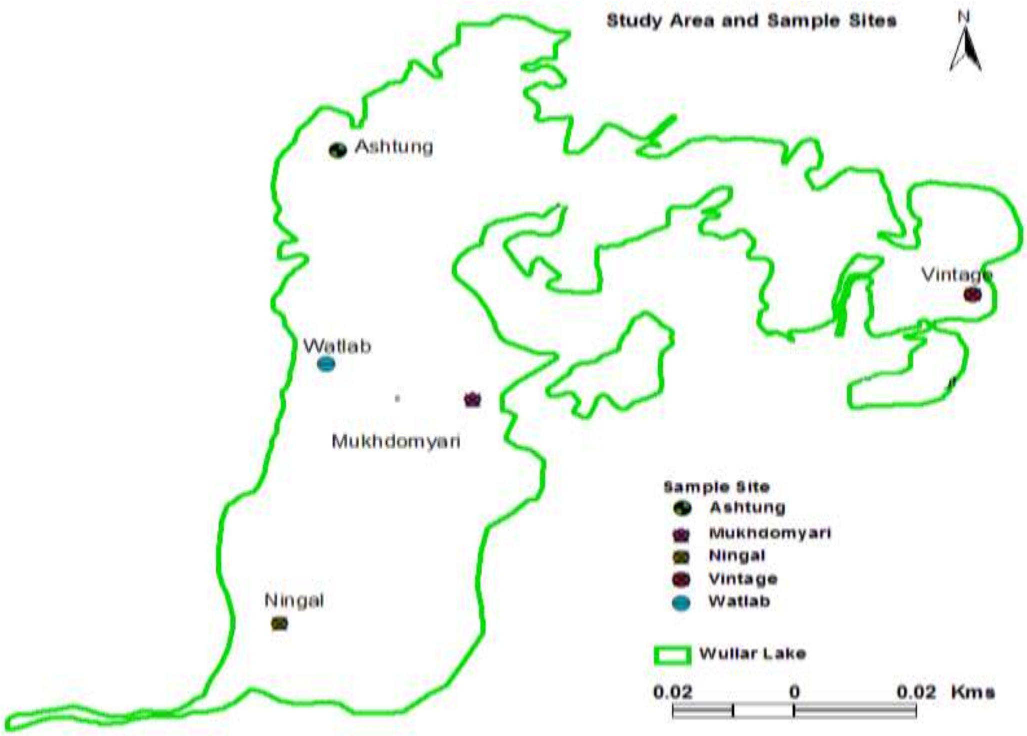

Figure 1. Map showing the study sites of Wular lake.

the oligochaetes display the greatest diversity and have the greatest indicator value. Oligochaetes worms are diverse and occur in a wide spectrum of freshwaters from unproductive to extremely eutrophic lakes and rivers. Leeches are found in warm water of shallow standing sites (Peckarsky et al., 1990) and are generally pollution tolerant. Oligochaeta, especially the Tubificidae family, have been universally applied on bioassessment assays, as bioindicators to reflect the organic pollution (Lin and Yo, 2008). This is because their capacity to increase in number with increasing organic matter, replacing other benthic macroinvertebrates, less tolerant for this condition (Schenkova and Helesic, 2006). It is in the backdrop of paucity of researches on Wular Lake, the largest freshwater body of Indian subcontinent, being recognised as a Ramsar Site, that the present study on community structure and biomass of annelids has been undertaken during 2012.

MATERIALS AND METHODS

Study area and study sites

Wular lake is the largest freshwater lake of Indian subcontinent, located in the flood plains of Jhelum river with an open water area of 24 km^2 (Pandit, 2002). The rural valley lake in the north-west of Kashmir extends from Bandipore to Sopore and is at a distance of about 54 km from Srinagar city and is situated at an altitude of 1,580 m (amsl), lying between 34°16´-34°20´N latitudes and 74°33´-74°44´E longitudes. The lake is mono-basined, elliptical in shape and is of fluviatile origin, formed by the meandering of Jhelum River. Its depth on an average is 3.6 m throughout length, reaching 5.8 m at its deepest point. The major inflows to Wular Lake are Jhelum, Madumati and Erin. The lake plays a significant role in the hydrographic system of Kashmir valley by acting as a large reservoir and by absorbing high annual flood of the Jhelum River. In 1990, this shallow lake was designated as a Ramsar Site, a Wetland of International Importance. For the present investigation, five sampling sites were selected which are described in Table 1 and Figure 1.

Table 2. Species composition of annelids at five sites in Wular lake (+ indicate taxa presence and – indicates taxa absence).

Annelids	Sites				
	Site I	Site II	Site III	Site IV	Site V
Oligochaetea					
Limnodrilus hoffmeisteri	+	+	+	+	+
Tubifex tubifex	+	+	+	+	+
Branchiuria sowerbyii	-	+	+	+	-
Aelosoma sp.	-	+	+	+	-
Nais sp.	-	+	+	+	+
Pristina sp.	-	+	-	+	-
Unidentified taxion	+	-	-	-	-
Total	3	6	5	6	3
Hirudinea					
Erpobdella sp.	+	+	+	+	+
Placobdella sp.	+	+	+	+	+
Glossiphonia sp.	-	+	+	-	-
Total	2	3	3	2	2
Annelids total	5	9	8	8	5

Collection and preservation

The benthic fauna encompassing annelids was collected from all five sites of the lake, with an Ekman Dredge (15 x 15 cm). The sites differered in water depth, vegetation and bottom sediments. The samples were taken in triplicate. The sediment samples collected were sieved carefully in order to remove fine sediments and other extraneous material without damaging the fragile organisms, using sieves of 1mm and 0.5 mm mesh size for checking annelids. The macroscopic organisms were collected with the help of forceps and brushes. The organisms collected were preserved in 70% alcohol for detailed examination.

Identification

Preserved annelids were identified by observing them under a microscope and identification was done with the help of standard taxanomical works of Edmondson (1992), APHA (1998), Pennak (1978), Adoni (1985), Brinkhurst (1971) and Kiemm (1995).

Biomass

Biomass of annelids was determined as fresh weight. The organisms were kept on filter paper for some time until the samples dry and weight became constant. Then organisms were weighed by using electronic balance with the accuracy of 1 mg. The biomass was calculated by using the formula:

$$\text{Biomass (g m}^{-2}\text{)} = \frac{n}{a \times s} \times 10,000$$

Where, n = weight of organisms counted; a = extraction area of dredge; s = number of samples

RESULTS

Species composition

During the present investigation of Wular lake, 10 taxa of annelids were recorded which belonged to two major classes namely Oligochaeta (7) and Hirudinaea (3). The class Oligochaeta included *Limnodrilus hoffmeisteri*, *Tubifex tubifex*, *Branchiura sowerbyii, Nais* sp., *Aelosoma* sp., *Pristina* sp. and an unidentified taxion. Similarly, the class Hirudinea was comprised by *Erpobdella* sp., *Placobdella* sp. and *Glossiphonia* sp. Amongst the 10 species listed, the highest taxa richness was obtained at site II (9), followed by site III (8), site IV (8), and decreasing to the minimum of 3 species each at sites I and V (Table 2). The most common taxa encountered across all the sites were *L. hoffmeisteri*, *T. tubifex*, *Erpobdella* sp. and *Placobdella* sp. The unidentified annelid taxion was found only at site I. Among the two classes, Oligochaeta dominated both qualitatively and quantitatively at each site and was represented by a maximum number of 6 species each at sites II and IV, followed by site III (5), till it reached a minimum number of 3 species each at sites I and V. The class Hirudinea was represented by 3 taxa each at sites II and III and 2 taxa each at sites I, IV and V.

Biomass

The annelid biomass showed a considerable variation between the study sites. Depending upon the species composition biomass of annelids varied seasonally. The seasonal mean value for biomass of annelids fluctuated between a lowest of 0.31 g/m^2 at site I in winter to a highest of 14.92 g/m^2 at site III in summer. However, the annual mean biomass was revealed to be maximum at site IV (10.82±2.02 g/m^2), followed by site III (10.47±2.07 g/m^2), site II (8.94±1.90 g/m^2), site I (1.85±0.94 g/m^2) and decreasing to the lowest ebb (1.71±0.50 g/m^2) at site V.

At site I, the annual mean biomass of Hirudineae was highest (1.18±0.61 g/m^2) as compared to class Oligochaeta

Table 3. Seasonal variation in biomass of annelids (g/m^2) at five different sites of Wular lake.

S/N	Class/ Taxa	Sites	Spring	Summer	Autumn	Winter	Mean
	Oligochaeta						
		Vintage	0.57	0.73	0.28	0.04	0.41
		Ashtung	4.04	4.81	3.51	1.74	3.53
1	*Limnodrilus hoffmeisteri*	Watlab	5.05	6.1	4.02	2.48	4.41
		Makdomyari	4.99	6.18	4.4	2.66	4.56
		Ningle	0.82	0.96	0.55	0.19	0.63
		Vintage	0.03	0.53	0.08	0.03	0.17
		Ashtung	3.99	4.5	3.37	1.72	3.39
2	*Tubifex tubifex*	Watlab	4.89	5.7	4.02	2.39	4.25
		Makdomyari	4.56	5.43	3.99	2.52	4.13
		Ningle	0.67	0.88	0.39	0.09	0.51
		Vintage	0	0	0	0	0
		Ashtung	0.12	0.19	0.11	0	0.11
3	*Branchiuria sowerbyii*	Watlab	0.12	0.19	0.11	0	0.11
		Makdomyari	0.17	0.19	0.11	0	0.12
		Ningle	0	0	0	0	0
		Vintage	0	0	0	0	0
		Ashtung	0.44	0.56	0.35	0.13	0.37
4	*Aelosoma* sp.	Watlab	0.49	0.59	0.37	0.07	0.38
		Makdomyari	0.58	0.61	0.41	0.11	0.43
		Ningle	0	0	0	0	0
		Vintage	0	0	0	0	0
		Ashtung	0.47	0.66	0.34	0.13	0.40
5	*Nais* sp.	Watlab	0.55	0.71	0.35	0.09	0.43
		Makdomyari	0.56	0.71	0.45	0.11	0.46
		Ningle	0.25	0.07	0.06	0	0.09
		Vintage	0	0	0	0	0
		Ashtung	0.05	0.12	0.04	0	0.05
6	*Pristina* sp.	Watlab	0	0	0	0	0
		Makdomyari	0.18	0.23	0.07	0	0.12
		Ningle	0	0	0	0	0
		Vintage	0.26	0	0.08	0	0.09
		Ashtung	0	0	0	0	0
7	Unidentified taxion	Watlab	0	0	0	0	0
		Makdomyari	0	0	0	0	0
		Ningle	0	0	0	0	0
	Total		33.85	40.65	27.46	14.5	29.15
	Hirudinea						
		Vintage	0.77	0.59	0.36	0.18	0.48
		Ashtung	0.58	0.82	0.47	0.11	0.49
8	*Erpobdella* sp.	Watlab	0.51	0.88	0.41	0.12	0.48
		Makdomyari	1.06	0.77	0.53	0.12	0.62
		Ningle	0.35	0.28	0.29	0.06	0.25
9	*Placobdella* sp.	Vintage	2.13	0.47	0.17	0.06	0.71

Table 3. Condt.

S/N	Class/ Taxa	Sites	Spring	Summer	Autumn	Winter	Mean
	Placobdella sp.	Ashtung	0.48	0.53	0.24	0.06	0.33
		Watlab	0.35	0.53	0.29	0.06	0.31
		Makdomyari	0.71	0.54	0.22	0.05	0.38
		Ningle	0.29	0.3	0.17	0.11	0.22
10	*Glossiphonia* sp.	Vintage	0	0	0	0	0
		Ashtung	0.11	0.29	0.59	0	0.25
		Watlab	0.11	0.22	0.05	0	0.10
		Makdomyari	0	0	0	0	0
		Ningle	0	0	0	0	0
Total			7.45	6.22	3.79	0.93	4.62
Grand total			41.3	46.87	31.25	15.43	33.77

(0.67±0.33 g/m^2). Among Oligochaetes, the *L. hoffmeisteri* acquired maximum mean biomass (0.41±0.15 g/m^2) while the unidentified taxion made a minimum mean biomass (0.09±0.06 g/m^2). Among Hirudineae, only *Placobdella* sp. maintained the greatest biomass (0.71±0.48 g/m^2). On a seasonal basis, the oligochaetes registered the maximum biomass during summer (1.26 g/m^2) and the minimum in winter (0.07 g/m^2) whereas the Hirudineae registered the highest biomass in spring (2.90 g/m^2) and the lowest in winter (0.24 g/m^2) (Table 3).

At site II, the annual mean biomass of Oligochaeta was highest (7.86±1.51 g/m^2) as compared to class Hirudinea (1.08±0.39 g/m^2). Further, among Oligochaeta, *L. hoffmeisteri* attained the maximum mean biomass (3.53± 0.65 g/m^2) whereas *Pristina* sp. had the minimum mean biomass (0.05±0.02 g/m^2). On a seasonal basis, the annelids showed maximum biomass in summer (12.48 g/m^2) and lowest in winter (3.89 g/m^2). *Erpobdella* sp. had the highest mean biomass (0.50±0.15 g/m^2) whereas *Glossophonia* sp. had the lowest mean biomass (0.25± 0.13g/m^2) in class Hirudinae (Table 3).

At site III, the annual mean biomass of annelids varied between 9.58±1.76 g/m^2 (Oligochaeta) and 0.89±0.31 g/m^2 (Hirudinea). *L. hoffmeisteri* obtained maximum mean biomass (4.41± 0.77g/m^2) and *B. soewerbyii* registered the minimum mean biomass (0.11±0.04 g/m^2). *Erpobdella* sp. obtained the highest mean biomass (0.48±0.16 g/m^2) and *Glossophonia* sp. the lowest mean biomass (0.10± 0.05g/m^2). On a seasonal basis, the annelids showed a maximum biomass during summer (14.92 g/m^2) and the lowest in winter (5.21 g/m^2) as depicted in Table 3.

At site IV, the mean biomass of *L. hoffmeisteri* was maximum (4.56±0.73 g/m^2), followed by *T. tubifex* (4.13±0.61 g/m^2) while *B. soewerbyii* and *Pristina* sp. registered lower mean biomass (0.12±0.05 g/m^2 for each). *Erpobdella* sp. recorded its greatest biomass (0.62±0.20 g/m^2) while *Placobdella* sp. had its lowest biomass (0.38± 0.15g/m^2). The annual mean biomass of annelids varied between 9.82±1.67 g/m^2 for Oligochaeta and 1.0±0.35 g/m^2 for Hirudinea. In general, on a seasonal basis, the annelids showed maximum biomass (14.66 g/m^2) in summer and minimum (5.57 g/m^2) in winter (Table 3).

At site V, the annelids registered their maximum biomass (2.49 g/m^2) in summer and their minimum (0.45 g/m^2) in winter. The biomass of Oligochaeta was highest (1.24±0.39 g/m^2) than the biomass of Hirudinea (0.47±0.11 g/m^2). Among Oligochaetes, the *L. hoffmeisteri* attained greatest mean biomass (0.63±0.17 g/m^2) while the lowest mean biomass (0.10±0.05 g/m^2) was found for *Nais* sp. *Erpobdella* sp. was the dominant maintained leeches (0.25±0.06 g/m^2) and *Placobdella* sp. was the less abundant one (0.22± 0.05 g/m^2) (Table 3).

DISCUSSION

Assessment of species composition, distribution and biomass of macroinvertebrate community often gives an important clue to the functional status of a water body. Benthic macroinvertebrates are tools that enable rapid bioassessment which is cost effective and quick assessment strategy to determine the health of an ecosystem (Loeb and Spacie, 1994). According to Jumppanen (1996) the first sign of eutrophication and pollution is reflected by the benthic biota, because the pollutants are rapidly deposited into the sediments where they evolve an impact on the benthic organisms. Therefore, it is essential to study the benthic composition to help in the evaluation of the trophic status of the water bodies.

During the present study, 10 taxa of annelids belonging to two major classes namely Oligochaeta (7) and Hirudinea (3) were recorded. Amongst the 10 species listed, the maximum number of species was obtained at site II (9), followed by site III (8), site IV (8), and decreasing to the minimum of 3 species each at sites I and site V. The lowest species richness at site V may be due to the physical heterogeneity of substrate, being reflected in the number of taxa (Marshall and Winterbourn,

1979) as site V is chracterized by sandy sediment with small boulders and diminished macrophytic growth. Conversely the highest richness at sites II, III and IV may be due to the dense macrophytic cover and soft bottom sediments as macrophytes provide suitable habitat for macroinvertebrates. The above finding corroborates the fact that oligochaete community thrives well in soft depositing substrates rather than stony beds (Bhat and Pandit, 2010).

Biomass is a potential renewable source of energy, which is related to the ecological conditions of the habitat. Estimation of biomass is necessary for understanding the trophic dynamics and productivity of an ecosystem (Mir and Yousuf, 2003). During the course of the present study, biomass of annelids fluctuated between 0.31 g/m^2 at site I and 14.92 g/m^2 at site III. This reflected the higher productivity and trophic status of site III and inversely, the relatively lower productivity at site I. Biomass showed a seasonal trend with maximum in spring and summer and minimum in winter. Thus, biomass fluctuated in close relation with density of annelids, which also showed higher value during summer and lower in winter, indicating a positive correlation between the two parameters. Sunder and Subla (1986) and Mortensen and Simonson (1983) also noticed a positive relationship between density and biomass of zoobenthos.

Conclusion

During the present investigation 10 taxa of annelids belonging to two major classes namely Oligochaeta (7) and Hirudinea (3) were recorded. The most common taxa encountered across all the sites included *L. hoffmeisteri*, *T. tubifex*, *Erpobdella* sp. and *Placobdella* sp. However, the unidentified annelid taxion was found only at site I. Among the two classes, Oligochaeta dominated both qualitatively and quantitatively at each site and was represented by a maximum number of taxa at each site. The presence of *L. hoffmeisteri* and *T. tubifex* on an average in great numbers is indicative of organically rich sediments. The class Hirudinea was represented by three taxa each at sites II and III and two taxa each at sites I, IV and V. In general, Oligochaeta comprised 95% of the total annelid community and remaining 5% was made by Hirudinea. During the course of the present study, biomass of annelids fluctuated from the lowest of 0.31g/m^2 at site I to the highest of 14.92 g/m^2 at site III. However, the biomass of oligochaetes fluctuated from 0.67 to 9.82 g/m^2 and the biomass of Hirudinea varied from 0.47 to 1.18 g/m^2, indicating that overall biomass was dominated by oligochaetes and hence reflecting the moderate eutrophication of lake.

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