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Original Research Article

Spatial variation of benthos in fresh water and abiotic factors influencing their distribution

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Keywords

Benthos, Fresh water, Correlation, Abiotic factors

A B S T R A C T

The relation of benthos with abiotic factors in a fresh water pond was studied for a period of one year from February, 2009 to, January 2010. A total of Fourty one (41) species of benthos belonging (Cladocera, Rotifera, Oligochaeta, Crustacea, Copepoda, Ostracoda, Diptera, Coleoptera, Tricophtera, Ephemeroptera) were found during the study period. One of the most dominating groups is Rotifrea followed by Diptera, Cladocera, Coleoptera, Ostracoda, Hemiptera, Oligochaeta, Copepoda, Trichoptera and Ephemeroptera. All Benthic macro-invertebrates (Rotifera, Diptera, Cladocera, Coleoptera, Ostracoda, Hemiptera, Oligochaeta, Copepoda, Trichoptera and Ephemeroptera) showed negative and significant correlation with Transparency, water temperature while Temperature showed positive correlation with NO_3-N and Total Solids. All Benthic macro-invertebrates showed negative correlation with Total dissolved Solid (TDS) while Dissolved oxygen and NO_3-N showed positive and significant correlation with Total dissolved Solid (TDS).

Introduction

Benthos is those organisms that live on or inside the deposit at the bottom of a water body (Idowu and Ugwumba, 2005). Hutchinson (1967) defined benthos as an association of species of plants and animals that live in or on the bottom of a body of water. Benthic fauna are especially of great significance for the fisheries that they themselves act as a food of bottom feeding fishes (Walker *et al.*, 1991; Vijaykumar *et al*., 1991) forming an important part of the food chain. Among the invertebrate taxa, benthos is sensitive to pollutants such as metals and organic waste. Mayflies, stone flies and caddis flies are generally intolerant of pollution but some species can survive in good oxygen concentration in moderately polluted water body. Stream macro invertebrates have been used extensively to bio-monitor numerous environmental stresses (Rosenberg and Resh, 1993).

The distribution and abundance of

benthos in a water body are influenced by many abiotic factors of overlying water and sediment and it is difficult to correlate them with a single such parameters. Some important abiotic factors affecting the distribution of benthic fauna are depth of overlying water, temperature, dissolved oxygen, hardness, sediment texture, conductivity, transparency, carbon dioxide, total dissolved solids and organic matter in the sediment as discussed by various workers (McLachalan and McLachalan, 1971; Kurian *et al*., 1975).

Nearly all facets of the life-history of benthos, and consequently their distribution and abundance are influenced by temperature (Wetzel, 2001., Vivas *et al*., 2002; Hieber *et al*., 2005), substrate type and composition (Allan, 1995; Hieber *et al*., 2005), hydraulic conditions (Allan, 1995; Vivas *et al*., 2002) and food availability (Basaguren *et al*., 1996; Gonza´ lez *et al*., 2003) combined and acting in various spatio-temporal scales and gradients (Cortes, 1992; Grac¸a *et al*., 2004; Murphy and Davy- Bowker, 2005). In natural water courses, altitude, slope, channel stability, width, depth, pH, conductivity and salinity vary seasonally and/or over downstream gradients, and their relative importance affecting benthic macroinvertebrates differs (Grac¸a *et al*., 2004).

Their composition, abundance and distribution can be influenced by water quality (Odiete, 1999). They all stated that variations in the distribution of benthic organisms could be as a result of differences in the local environmental conditions. The present study has been carried out to evaluate the variation of benthos in freshwater and abiotic factors influencing their distribution by using standard method, which enables the common man to understand the effect of abiotic factors on benthos distribution.

Materials and Methods

Study Area: Aligarh district is a part of Central Ganga Plain of the state covering an area of 5498 square kilometer. and lies between North latitudes 27°28´ and 28°10´ and East longitudes 77°29´ and 78°36´ with total population of 4,32,37,60 as per 2001 census (density: 786 persons/sq.km.). The district is bounded by river Ganga in the west and the river Yamuna in the east. The entire district falling in Upper Ganga Doab represents flat topography.

The selected study area is a shallow eutrophic freshwater body of water having an irregular shore line with varying depth and area. The basin of the pond is more or less flat which is marshy in nature consisting of dead planktonic organisms, decayed leaves, sand, clay, humus, gravels and broken pieces of bricks etc. The whole shore line of this pond is also surrounded by large number of trees of Neem (*Azadirachta indica)* and Babul *(Acacia arabica*). These tall trees cover the pond in such a way that deprive the shore line area of direct sunlight during early and late hours of the day.

Sediment and Water analysis: Sampling of sediment and water was performed from February, 2009 to January, 2010. At each sampling site sediment sample was collected using Ekman-dredges and water sample in bottle after collection labeled and bring to laboratory. The collected sediment was washed and sieved on a mesh screen of 0.5 mm, sorted, preserved and identified. The benthos was identified using identification keys Edmondson (1959), Pennak (1978) and Tonapi (1980) and density determined per meter square area (ind/m^2). The abiotic factors like

Water temperature, pH-pH, Dissolved-oxygen, Nitrate, Phosphate, Alkalinity, Hardness, Calcium, Magnesium, Transparency, Chloride, Conductivity, Depth, Total dissolved solids, Total suspended solids, Total solids were analysed with the help of method given in Triedy and Goel (1984).

Results and Discussion

A total of Fourty one (41) species of benthic macro-invertebrates fauna belonging (Cladocera, Rotifera, Oligochaeta, Crustacea, Copepoda, Ostracoda, Diptera, Coleoptera, Tricophtera, Ephemeroptera) were found during the study period. One of the most dominating group is Rotifrea followed by Diptera, Cladocera, Coleoptera, Ostracoda, Hemiptera, Oligochaeta, Copepoda, Trichoptera and Ephemeroptera (Table-1).

Abiotic factors play an important role in the ecology of both aquatic and terrestrial environments. These factors control organic production in lakes and rivers by affecting circulation and exchange of essential nutrients (Rawson, 1939). Water quality assessment can be defined as the evaluation of the physical, chemical and biological nature of water in relation to natural quality, human effects and intended uses. The range of maximum and minimum values of abiotic factors and benthos are given in Table 1.

Water temperature varied between 14°C to 34°C. The minimum temperature of 14°C was recorded in January 2010 and maximum temperature 34°C was recorded in July, 2009.

Transparency fluctuated from minimum of 17.50 cm in June, 2009 to a maximum of 45.0 cm in March, 2009.

Dissolved oxygen The value of dissolved oxygen fluctuated from a minimum of 3.6 mg/l in July, 2009 to a maximum of 10.0 mg/l in December, 2009.

TS: showed the minimum value 1526 mg/l in January, 2010 and maximum 2900 mg/l in August, 2009. Statistically total solids recorded a very significant positive correlation with water temperature (r = 0.758) (Table-2), indicating temperature as one of the important factors responsible for concentration of solids.

TSS: showed minimum value 450 mg/l in June, 2009 and maximum 950 in August, 2009 (Table-1) Statistically TSS showed negative correlation with transparency (r =- 0.187) (Table-2).

TDS: showed minimum value 920 mg/l in December, 2009 and maximum 2010 mg/l in September, 2009. It showed positive correlation (r =0.510). TDS showed positive significant correlation with water temperature (r = 0.542) (Table-2). With the increase in temperature the decomposition and mineralization processes increase, releasing nutrient in the water.

Hardness: showed minimum value 124.00 mg/l during January, 2010 and maximum 260.00 mg/l in April, 2009.

Calcium: It fluctuated from a minimum of 36.87 mg/l in December, 2009 to a maximum of 64.12 mg/l in May, 2009. High values of calcium were recorded throughout the study period which might be attributed to continuous input of sewage from surrounding areas and weathering of calcareous materials.

Magnesium: It fluctuated from a

minimum of 19.77 mg/l in October, 2009 to a maximum of 43.51 mg/l in May, 2009.

Chloride: It fluctuated from a minimum of 127.00 mg/l in the month of January, 2010 to a maximum of 624.0 mg/l in the month of June, 2009. Maximum values during summer might be due to higher rate of evaporation and organic pollution of animal origin, whereas lower values during winter could be related to reduction in siltation or allochthonous import of organic matter from catchment area.

Nitrate-nitrogen: It fluctuated from a minimum of 0.054 mg/l in January, 2010 to a maximum of 0.195 mg/l in August, 2009.

Statistically NO_3-N recorded a significant positive correlation with water temperature (r = 0.915), and with TDS (r = 0.528) (Table- 2). Higher values were recorded during Monsoon, which could be related to influx of decaying organic matter along with surface run-off from catchment area. Lower values of NO_3-N during winter could be attributed to reduced rate of decomposition and its utilization by macrophytes.

Phosphate-phosphorus: It ranged from a minimum of 0.419 mg/l in March, 2009 to a maximum of 1.040 mg/l in June, 2009. Higher values of PO_4 - P during summer were found to be due to release of phosphates from decomposition at high temperature and evaporation of water leading to its high concentration, whereas lower values could be attributed to its utilization by macrophytes and algae for their growth, low calcium level and low temperature.

Cladocera formed the third abundant group represented by species of *Daphnia, Bosmina* and *Moina* (Table-4). Its contribution varied from 278 No/m^2 during July, 2009 to 632 No/m^2 in December, 2009 (Table-1). Statistically Cladocera recorded significant negative correlation with water temperature (r = -0.610), whereas it showed significant positive correlation with D.O. (r = 0.698). A negative significant correlation was obtained with T.D.S (r = -0.622) (Table-2, Fig.1).

Ostracoda formed fifth abundant group represented by *Heterocypris, Stenocypris* and *Centrocypris*. Its contribution varied from 142 No/m^2 during June, 2009 to 392 No/m^2 in November, 2009 (Table-1). Statistically Ostracoda recorded negative correlation with water temperature (r = -0.667) and TDS (r = -0.572) (Table-2, fig-1).

Hemiptera formed sixth abundant group represented by *Notonecta, Coroxid, Hebrus, Sigara, Belostoma and Hespercorixa* (Table-3 and 4). Total contribution of Hemiptera ranged from 142 No/m^2 in July, 2009 to 552 No/m^2 in December, 2009 (Table-1). Statistically Hemiptera recorded a significant negative correlation with water temperature (r = -0.712) whereas it showed significant positive correlation with D.O. (r = 0.772) (Table-2, fig-1).

Coleoptera formed fourth abundant group represented by *Hydrophilus, Dysticus, Berosus* and *Haliplus* (Table-3 and 4). The total contribution of Coleoptera to benthic fauna ranged from 86 No/m^2 during July, 2009 to 438 No/m^2 in October, 2009. Statistically Coleoptera recorded a significant negative correlation with water temperature (r = -0.721).

Table.1 Maximum and Minimum values of different abiotic factors and benthos

Column1	Feb'09	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan'10
W.T						34						14
Tran		45			17.5							
D.O						3.6					10	
NO3-N							0.195					0.054
PO4-P		0.419			1.04							
DE					41		169					
TS							2900					1526
TDS								2010			920	
TSS					450		950					
Ch					624							127
Co		803				1789						
Ha			260									124
Ca				64.12							36.87	
Mg				43.51					19.77			
CLADOCERA						278					632	
COPEPODA								154				403
ROTIFERA						723						1282
OSTRACODA					142					392		
OLIGOCHAETA	157										288	
DIPTERA							218				879	
HEMIPTERA						142					552	
COLEOPTERA						86			438			
TRICHOPTERA			4								15	
EPHEMEROPTERA			2									12

Table.2 Correlations between abiotic and biotic parameters and benthos

Parameters	Parameters	Correlation (r value)	Significant at P<0.05
Air Temperature	Water Temperature	0.996	✔
Water Temperature	Transparency	-0.768	✔
	DO	-0.853	✔
	TS	0.758	✔
	Chloride	0.550	✔
	TDS	0.542	✔
	NO_3- N	0.915	✔
	PO_4- P	0.730	✔
	Cladocera	-0.610	✔
	Copepod	-0.675	✔
	Rotifer	-0.769	✔
	Ostracod	-0.667	✔
	Diptera	-0.654	✔
	Oligochaeta	-0.757	✔
	Ephemeroptera	-0.670	✔
Transparency	DO	0.546	✔
TDS	Total alkalinity	0.265	-
	Hardness	0.168	-
	D.O.	0.510	✔
	NO_3 -N	0.528	✔
	Cladocera	-0.622	✔
	Ostracod	-0.572	✔
	Diptera	-0.538	✔
	Copepod	-0.573	✔
	Rotifera	-0.654	✔
	Ostracod	-0.684	✔

Table.3 Monthly distribution and abundance of benthos

Months	CLADOCERA	COPEPODA	ROTIFERA	OSTRACODA	OLIGOCHAETA	DIPTERA	HEMIPTERA	COLEOPTERA	TRICHOPTERA	EPHEMEROPTERA
Feb'09	++	++	+++	++	++	++	++	++	_	-
Mar	++	++	+++	++	++	+++	++	++	_	_
Apr	++	++	+++	++	++	++	++	++	_	_
May	++	++	+++	++	++	+++	++	++	_	_
Jun	++	++	+++	++	++	+++	++	++	_	_
Jul	++	++	+++	++	++	++	++	+	_	_
Aug	++	++	+++	++	++	++	++	++	_	_
Sep	++	++	+++	++	++	++	++	++	_	_
Oct	++	++	+++	++	++	+++	++	++	_	_
Nov	+++	++	+++	++	++	+++	++	++	_	_
Dec	+++	++	+++	++	++	+++	++	++	_	_
Jan'10	++	++	+++	++	++	+++	++	++	_	_

(- present but negligible, + present but less abundant, ++ moderately abundant, highly abundant)

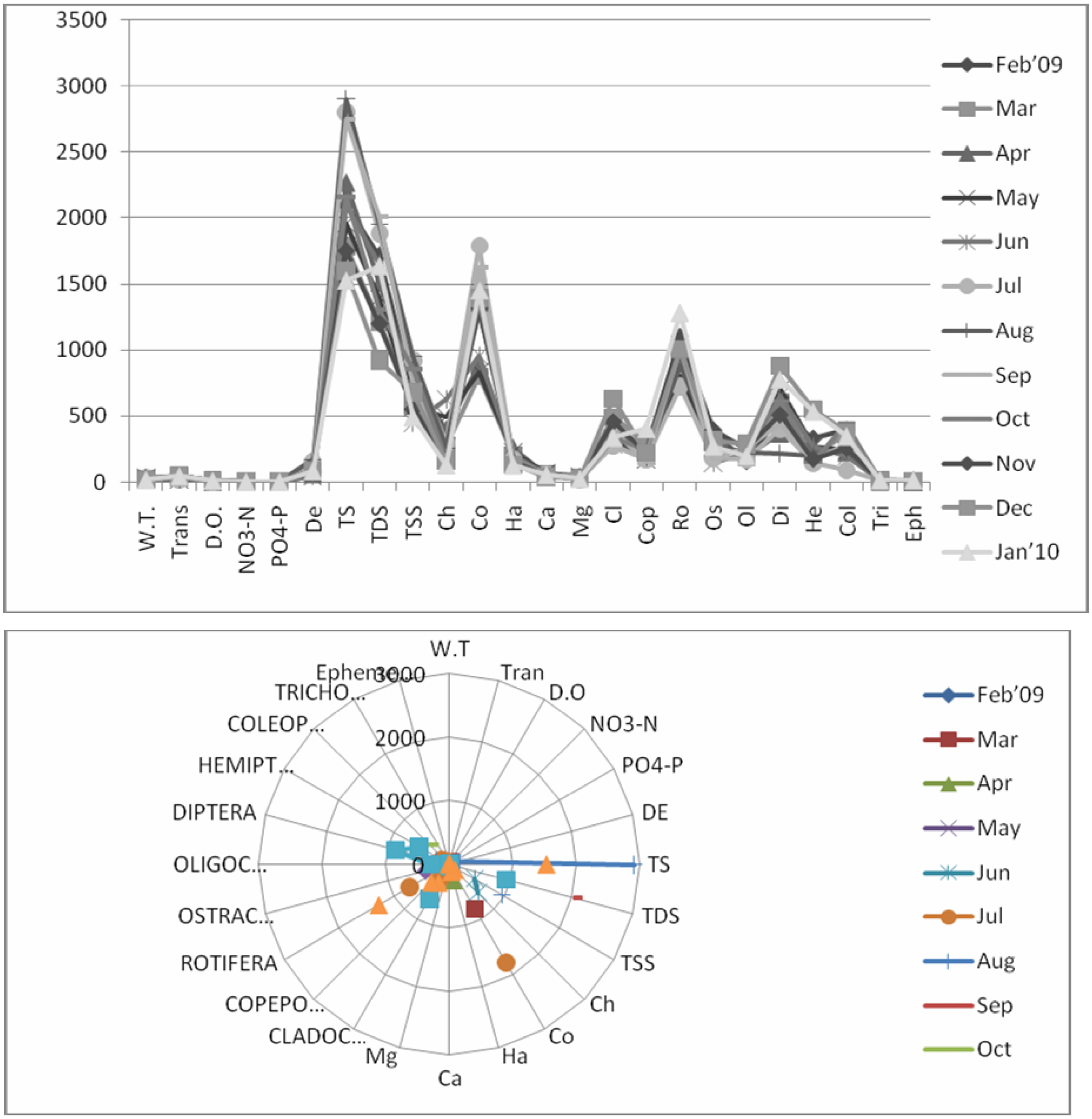

Fig.1 Showing relation benthos abundance and its correlations with abiotic factors during different months

(Abbreviations W.T. -Water temp., Trans-Transparency, D.O.- Dissolved Oxygen, NO3-N PO4-P, De- Depth, TS- Total Solid, TDS- Total Dissolved Solid, TSS- Total Suspended Solid, Ch-choloride, Co- Conductivity, Ha-Hardness, Ca -Calcium, Mg-Magnesium, Cl-Cladocera, Cop-Copepoda, Ro-Rotifera, Os-Ostracoda, Ol-Oligocheta, Di-Diptera, He-Hemiptera, Col-Choleoptera, Tri-Trichoptera,Eph- Ephemeroptera)

Table.4 List of different species

CLADOCERA	COPEPODA	ROTIFERA	OSTRACODA	OLIGOCHAETA	DIPTERA	HEMIPTERA	COLEOPTERA	TRICHOPTERA	EPHEMEROPTERA
Daphnia pulex	*Cyclops viridis*	*Brachionus calyciflors*	*Heterocypris*	*Tubifex*	*Chironomus larva*	*Notonecta insulata*	*Hydrophilus*	*Limnephilus larva*	*Baetis hiemalis nymph*
Bosmina sp.	*Diaptomus sp.*	*B. bidentata*	*Stenocypris sp.*	*Chaetogaster*	*Chironomus pupa*	*Coroxid*	*Dytiscus*	*Phryganaea larva*	*Caenis nymph*
Moina micrura		*B. angularis*	*Centrocypris*	*Nais*	*Helius larva*	*Belostoma*	*Berosus*	*Polycentropus larva*	
		Keratella tropica		*Aelosoma*	*Culex larva*	*Hebrus sp.*	*Haliplus*		
		K. quadrata			*Pentanura*	*Sigara*			
		Asplanchna priodonta				*Hesperocorixa*			
		Filinia longiseta							
		Notholca sp.							
		Hexarthra sp.							

Copepods formed seventh abundant group represented by *Cyclops viridis and Diaptomus* (Table-3 and 4). Total contribution of copepods ranged from 154 No/m^2 during September, 2009 to 403 No/m^2 in January, 2010. Statistically Copepoda recorded significant negative correlation with water temperature (r = -0.675).

Oligochaeta formed eighth abundant group represented by *Tubifex, Chaetogaster, Nais and Aelosma* (Table-3 and 4). The total contribution of Oligochaeta to the density of benthic fauna ranged from 157 No/m^2 during February, 2009 to 288 No/m^2 in December, 2009. Statistically Oligochaeta recorded negative correlation with water temperature (r = -0.187).

Trichoptera formed ninth and second least abundant group represented by *Limnephilus, Phryganaea* and *Polycentropus* (Table-3 and 4). Total contribution of Trichoptera was found negligible and ranged from 4 No/m^2 during April, 2009 to 15 No/m^2 during December, 2009.Statistically Trichoptera recorded a significant positive correlation with dissolved oxygen (r = 0.846) (Table-2, fig-1). Trichopterans showed low frequency in selected fresh water pond. This clearly indicated that they are sensitive to pollution. It can be further concluded that these insects can live in polluted water which can be related to the availability of food and oxygen in these ponds in addition to other factors.

Ephemeroptera formed tenth and least abundant group represented by *Baetis* and *Caenis* (Table-3 and 4). Total contribution of Ephemeroptera was found fractional. It ranged from 2 No/m^2 during March, 2009 to 15 No/m^2 during January, 2010. Statistically Ephemeroptera recorded a significant negative correlation with water temperature (r = -0.670) (Table-2, fig-1). Mayfly larvae were present in selected studied water body. Their presence indicated that these larvae are able to survive in polluted waters provided there is sufficient oxygen (> 2.8 mg/l).

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