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Benthos Composition and Abundance in Lentic Ecosystems

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Abstract

The Benthic invertebrates such as nymphs of stonefly, mayfly, caddisfly larvae, snails, mussels, crustaceans, rat-tailed maggot, etc., convert and transport nutrients from one part of the water body to another, influencing nutrient cycling. In the present study, phytobenthos comprised of three major groups namely Bacillariophyceae, Chlorophyceae, Myxophyceae, whereas zoobenthos comprised of eleven major groups namely Protozoa, Rotifera Cladocera, Ostracoda, Coleoptera, Diptera, Ephemeroptera, Hemiptera, Trichoptera, Gastropoda and Odonata. The study revealed that zoobenthos were more dominant than phytobenthos. Among zoobenthos, Dipterans were found to be abundant followed by Cladocerans and least were Trichopterans, whereas among phytobenthos Bacillariophyceae was found to be most dominant followed by Chlorophyceae and Myxophyceae. The negative but significant correlation between zoobenthos and phytobenthos in all selected water bodies during study indicated grazing of former on latter proving top down control in these lentic ecosystem.

Keywords: Benthos; Phytobenthos; Zoobenthos; Lentic waterbodies

Introduction

Freshwater ecosystems are considered as one of the most essential natural resources for the survivability and success of all the living organisms including man. The habitat is generally divided into Lentic and Lotic ecosystems. The term lentic refers to standing bodies of water such as lakes, reservoirs, and ponds. These ecosystems generally have three zones – Littoral, Limnetic and Benthic zone. The term Benthos is derived from two Greek words "*Ben*" meaning 'the collection of organisms living in or on the sea or lakes' and "*Thos*" 'the bottom of sea or lakes'. Benthos can be classified on a number of basis i.e., on the basis of size; Macrobenthos, Meiobenthos and Micro benthos; On the Basis of Location; Endobenthos, Epibenthos and Hyperbenthos; On the basis of Type; Zoobenthos includes animals and Phytobenthos which comprises of plants. The Benthic invertebrates such as nymphs of stonefly, mayfly, caddisfly larvae, snails, mussels, crustaceans, rat-tailed maggot, etc., convert and transport nutrients from one part of the water body to another, influencing nutrient cycling. They ingest organic matter such as leaf litter and detritus and in turn serve food for higher aquatic organisms such as fish, forming a basic link between organic matter and higher aquatic animals in food web. They are sensitive to changes in habitat and pollution, especially to organic pollution [1].

Materials and Methods

Sites (Plate 1-4)

The present study was carried out on four fresh water bodies of Aligarh (latitude 27° 30' N and longitude 79° 40' E), namely Shekha Jheel, Nai Basti pond, Laldiggi pond and Chautal pond. Laldiggi, Chautal and Nai Basti ponds having 1 ha area, located in the vicinity of the Aligarh Muslim University campus receive water from domestic discharge and rain water which accumulates during rainy season. These are used by washer men extensively for washing clothes, thus adding detergents and certain chemicals that bring changes in its chemical composition. The Shekha Jheel is a 25 ha lake near the village of Shekha, 17 km east of Aligarh. It is a fresh water perennial water body that came into existence after the formation of the Upper Ganges Canal which flows adjacent to the lake. It is maintained by the Forest Department. Sampling was done fortnightly from 9th March, 2016 to 23rd April, 2016. Samples were collected from selected water bodies between 8 am and 9 am and were analysed for following physicochemical parameters were analysed: Air and water temperatures, dissolved oxygen (DO) and free carbon dioxide (CO_2).

Benthos collection, separation and identification

The bottom mud scrapper with low towline designed and described by Miclhae [2] was used to collect the samples from the waterbodies. For benthos analysis, samples were diluted with tap water to prepare slurry in a bucket and sticks, leaves, debris were removed. Then slurry was divided into ten subsamples. Each subsample was first sieved by B.S. no. 30 (0.5 mm) mesh sieve kept above the sieve B.S. no. 72 (0.2 mm) in order to retain smaller organisms (meio) on the latter. Organisms were kept in separate vials and fixed in 10% formalin solution (4% formaldehyde) and labelled. For qualitative and quantitative analysis 1 mL of fixed sample was taken on glass slide and studied under dissecting microscope. Individuals were identified up to genus level with the help of keys given by Edmondson et al. [3] and Needham and Needham [4] and frequency of each taxon was noted and expressed as individual/m^2 [2-4].

Results and Discussion

Physico-chemical parameters

In all selected water bodies air temperature ranged from a minimum of 26.4°C to a maximum of 38.8°C from 8th March to 23rd April, 2016 whereas water temperature ranged from a minimum of 23.1°C to a maximum of 33.2°C from 8th March to 23rd April, 2016. The surface water temperature of all selected water bodies followed closely the trend of air temperature during study period. Reduction in solar radiation due to shorter day length may explain lower temperature

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during the month of March. Increase in both air and water temperature during the month of April is attributed to the increase in solar radiation comparatively due to longer day length. pH values of all selected water bodies ranged from a minimum of 7.0 to a maximum of 8.0 during month of March, 2016 whereas during the month of April, it ranged from a minimum of 7.5 to a maximum of 8.5. Increased values of pH in all selected waterbodies during the study period could be related to increased level of photosynthesis carried out by phytoplankton and macrophytes, wherein CO_2 is consumed, and hence pH is raised. The decrease in dissolved oxygen and the increase in Carbon dioxide in all the selected water bodies from 8th March to 23rd April, 2016 clearly justify the fact that as temperature increases oxygen holding capacity of water decreases while carbon dioxide increases due to high rate of decomposition. Lower values of carbon dioxide were observed in Nai Basti The decrease in dissolved oxygen and the increase in Carbon dioxide in all the selected water bodies from 8th March to 23rd April,2016 clearly justify the fact that as temperature increases oxygen holding capacity of water decreases while carbon dioxide increases due to high rate of decomposition. Lower values of carbon dioxide were observed in Nai Basti The decrease in dissolved oxygen and the increase in Carbon dioxide in all the selected water bodies from 8th March to 23rd April, 2016 clearly justify the fact that as temperature increases oxygen holding capacity of water decreases while carbon dioxide increases due to high rate of decomposition. Lower values of carbon dioxide were observed in Nai Basti The decrease in dissolved oxygen and the increase in Carbon dioxide in all the selected water bodies from 8th March to 23rd April, 2016 clearly justify the fact that as temperature increases oxygen holding capacity of water decreases while carbon dioxide increases due to high rate of decomposition (Tables 1-4).

Lower values of carbon dioxide were observed in Nai Basti pond during study period (Table 2), might be due to high photosynthesis of phytobenthos and macrophytes.

Benthos

In distribution of benthic flora, light plays a very important role when the water is sufficiently shallow. The studied waterbodies, being shallow light reaches the bottom sediments in plenty and as a result of it, phytobenthos grow in greater abundance. The phytobenthos comprised of three major groups namely Bacillariophyceae, Chlorophyceae and Myxophyceae. The variations in Phytobenthos density in the selected water bodies were recorded from a minimum of 38 No/m² to a maximum of 151 No/m² (Tables 5-7; Figures 1-4) in

Parameters	Temperature (°C)		pH	D.O. (mg/L)	Co_2 (mg/L)
Dates	Air	Water			
9/3/2016	26.4°C	23.1°C	7.5	4.6 mg/L	21.0 mg/L
23-03-2016	29.0°C	27.1°C	8	4.0 mg/L	30.0 mg/L
8/4/2016	33.0°C	30.8°C	8	1.8 mg/L	35.0 mg/L
23-04-2016	34.3°C	31.1°C	8.5	2.0 mg/L	39.0 mg/L

Table 1: Fortnight variations in physicochemical parameters in Lal Diggi pond.

Parameters	Temperature (°C)		pH	D.O. (mg/L)	Co_2 (mg/L)
Dates	Air	Water			
9/3/2016	28.3°C	26.0°C	8	3.0 mg/L	18.0 mg/L
23-03-2016	31.2°C	29.4°C	7.5	2.5 mg/L	16.0 mg/L
8/4/2016	34 .0°C	31.0°C	8.5	1.8 mg/L	20.0 mg/L
23-04-2016	35.9°C	33.2°C	8.5	1.6 mg/L	25.0 mg/L

Table 2: Fortnight variations in physicochemical parameters in Nai Basti pond.

Parameters	Temperature (°C)		pH	D.O. (mg/L)	Co_2 (mg/L)
Dates	Air	Water			
9/3/2016	27 .8°C	23.6°C	7	3.1 mg/L	26 mg/L
23-03-2016	30.8°C	26.9°C	7.5	2.4 mg/L	24 mg/L
8/4/2016	33.0°C	30.2°C	7.5	2.1 mg/L	28 mg/L
23-04-2016	35.0°C	33.1°C	7.5	1.9 mg/L	36 mg/L

Table 3: Fortnight variations in physicochemical parameters in Chautal pond.

Parameters	Temperature (°C)		pH	D.O. (mg/L)	Co_2 (mg/L)
Dates	Air	Water			
8/3/2016	27.0°C	24.0°C	7.5	4.9 mg/L	17.0 mg/L
22-03-2016	28.9°C	25.2°C	7.5	4.0 mg/L	21.0 mg/L
7/4/2016	34.2°C	30.0°C	8.5	3.2 mg/L	19.0 mg/L
20-04-2016	38.8°C	33.0°C	8	2.2 mg/	24.0 mg/L

Table 4: Fortnight variations in physicochemical parameters in Shekha Jheel.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Bacillariophyceae				
Navicula spp.	13	17	25	31
Diatoma spp.	12	17	26	21
Cocconeis spp.	-	-	-	-
Total	25	34	51	52
Chlorophyceae				
Chlorella spp.	16	22	19	26
Ulothrix spp.	-	-	-	-
Clorococcus spp.	-	-	-	-
Oedogonium spp.	-	-	-	-
Tetrapedia spp.	-	-	-	-
Crucigenia spp.	15	20	24	29
Hydrodictyon spp.	5	9	13	11
Total	36	51	56	66
Myxophyceae				
Gomphosphaeria spp.	14	18	23	21
Oscillatoria spp.	10	14	19	12
Nostoc spp.	-	-	-	-
Total	24	32	42	33
Grand total	85	117	149	151

Table 5: Fortnight distribution of phytobenthos (no/m²) in nai basti pond.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Bacillariophyceae				
Navicula spp.	5	8	13	7
Diatoma spp.	-	-	-	-
Cocconeis spp.	11	16	23	29
Total	16	24	36	36
Chlorophyceae				
Chlorella spp.	-	-	-	-
Ulothrix spp.	-	-	-	-
Clorococcus spp.	13	19	11	26
Oedogonium spp.	-	-	-	-
Tetrapedia spp.	10	12	16	21
Crucigenia spp.	-	-	-	-
Hydrodictyon spp.	-	-	-	-
Total	23	31	27	47
Myxophyceae				
Gomphosphaeria spp.	-	-	-	-
Oscillatoria spp.	7	12	9	14
Nostoc spp.	5	8	16	20
Total	12	20	25	34
Grand total	51	75	88	117

Table 6: Fortnight distribution of phytobenthos (no/m²) in chautal pond.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Bacillariophyceae				
Navicula spp.	8	13	18	15
Diatoma spp.	-	-	-	-
Cocconeis spp.	11	16	12	17
Total	19	29	30	32
Chlorophyceae				
Chlorella spp.	-	-	-	-
Ulothrix spp.	5	7	3	9
Clorococcus spp.	-	-	-	-
Oedogonium spp.	-	-	-	-
Tetrapedia spp.	-	-	-	-
Crucigenia spp.	-	-	-	-
Hydrodictyon spp.	-	-	-	-
Total	5	7	3	9
Myxophyceae				
Gomphosphaeria spp.	-	-	-	-
Oscillatoria spp.	6	5	8	11
Nostoc spp.	9	12	19	22
Total	15	17	27	33
Grand total	39	53	60	74

Table 7: Fortnight distribution of phytobenthos (no/m²) in shekha jheel.

Figure 1: Naibasti pond.

Figure 2: Chautal pond.

Nai Basti pond ranged from a minimum of 85 No/m² to a maximum of 151 No/m²;. in Shekha jheel, from a minimum of 39 No/m² to a maximum of 74 No/m². Phyto benthos of Chautal pond; from a minimum of 51 No/m² to a maximum of 117 No/m² and in Lal diggi pond, phyto benthos ranged from a minimum of 38 No/m² to a maximum of 73 No/m² (Tables 5-7). Chlorophyceae formed the most abundant group followed by Baillariophyceae and Myxophyceae in Lal Diggi, Chautal and Nai Basti pond whereas Bacillariophyceae formed most abundant group in the Shekha jheel followed by Myxophyceae and Chlorophyceae (Figure 5a-5d). Chlorophyceae showed a direct relation with the temperature. Kumar et al. [5] reported that higher water temperature and low dissolved oxygen support the growth of Chlorophyceae. Statistically, phytobenthos showed positive significant correlation with Water temperature, Carbon dioxide and pH whereas as negative but significant correlation with zoobenthos, in all the four studied waterbodies. With dissolved oxygen significant positive correlation in shekha jheel only whereas significant negative in rest of the waterbodies (Tables 8-11). Benthic fauna are widespread in their

Figure 3: Laldiggi pond.

Figure 4: Shekha Jheel.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Bacillariophyceae				
Navicula spp.	12	17	27	21
Diatoma spp.	-	-	-	-
Cocconeis spp.	-	-	-	-
Total	12	17	27	21
Chlorophyceae				
Chlorella spp.	-	-	-	-
Ulothrix spp.	-	-	-	-
Clorococcus spp.	-	-		-
Oedogonium spp.	3	2	1	5
Tetrapedia spp.	11	18	15	25
Crucigenia spp.	-	-	-	-
Hydrodictyon spp.	-	-	-	-
Total	14	20	16	30
Myxophyceae				
Gomphosphaeria spp.	-	-	-	-
Oscillatoria spp.	4	6	5	7
Nostoc spp.	8	9	11	15
Total	12	15	16	22
Grand total	38	52	59	73

Table 8: Fortnight distribution of phytobenthos (no/m²) in lal diggi.

Date /Genera	9-03-2016	23-03-2016	8-04-2016	23-04-2016
Coleoptera				
Berosus sp.	-	-	-	-
Total	-	-	-	-
DIPTERA				
Chironomus sp.				
Culex sp.	27	25	21	28
Total	27	25	21	28
Ephemeroptera				
Cynigmula sp.				
Total	-	-	-	-
Hemiptera				
Belostoma sp.	-	-	-	-
Notonecta sp.	5	4	8	3
Ptilostomis sp.	-	-	-	-
Total	5	4	8	3
Odonata				
Libellula sp.	-	-	-	-
Total	-	-	-	-
Trichoptera				
Phryganaea larvae	-	-	-	-
Total	-	-	-	-
Cladocera				
Bosmina sp.	-	-	-	-
Moina sp.	15	23	13	6
Chydorus sp.	14	17	7	4
Daphnia sp.	21	18	12	6
Total	50	58	32	16
Ostracoda				
Cypris sp.	13	9	12	7
Cypridopsis sp.	-	-	-	-
Total	13	9	12	7
Gastropoda				
Amnicola sp.	-	-	-	-
Gyraulus sp.	-	-	-	-
Campeloma sp.	-	-	-	-
Rotifera				
Asplanchna sp.	-	-	-	-
Keratella sp.	-	-	-	-
Protozoa				
Euglena sp.	19	21	7	5
Total	19	21	7	5
Grand total	114	117	80	59

Table 9: Fortnight distribution of zoobenthos (no/m²) in nai basti pond.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Coleoptera				
Berosus spp.	28	16	11	-
Total	28	16	11	-
Diptera				
Chironomus spp.	3	8	18	11
Culex spp.	-	-	-	-
Total	3	8	18	11
Ephemeroptera				
Cynigmula spp.	25	18	9	-
Total	25	18	9	-
Hemiptera				
Belostoma spp.	21	15	8	13
Notonecta spp.	19	12	7	4
Ptilostomis spp.	-	-	-	-
Total	40	27	15	17
Odonata				
Libellula spp.	11	3	8	23
Total	11	3	8	23
Trichoptera				-
Phyrganaea larvae	-	-	-	-
Total				
Cladocera				
Bosmina spp.	-	-	-	-
Moina spp.	-	-	-	-
Chydorus spp.	-	-	-	-
Daphnia spp.	-	-	-	-
Total				
Gastropoda				
Amnicola spp.	9	9	15	18
Gyraulus spp.	4	11	17	22
Campeloma spp.	-	-	2	10
Total	13	20	34	50
Ostracoda				
Cypris spp.	-	-	-	-
Cypridopsis spp.	-	-	-	-
Total				
Rotifera				
Asplanchna spp.	-	-	-	-
Keratella spp.	-	-	-	-
Total				
Protozoa				
Euglena spp.	-	-	-	-
Total				
Grand total	120	92	95	101

Table 10: Fortnight distribution of zoobenthos (no/m²) in shekha jheel.

distribution and can live on all bottom types and thus found even in the soil beneath puddles. The zoobenthos comprised of eleven major groups namely Protozoa, Rotifera, Cladocera, Ostracoda, Coleoptera, Diptera, Ephemeroptera, Hemiptera, Trichoptera, Gastropoda and Odonata (Tables 12-15). Among zoobenthos, Dipterans were found to be abundant followed by Cladocerans and least were Trichopterans. In the present investigation, zoobenthos of Nai Basti pond ranged from a minimum of 59 No/m² to a maximum of 117 No/m²: in Lal Diggi pond, it was ranged from a minimum of 121 No/m² to a maximum of 179 No/m²; in Chautal pond, it was ranged from a minimum of 75 No/m² to a maximum of 128 No/m²: in Shekha jheel, it ranged from a minimum of 92 No/m² to a maximum of 120 No/m² (Tables 8-11) (Figure 6a-6d). During study period it was observed that Nai Basti pond is the most productive in terms of phyto benthos whereas Lal Diggi pond in terms of zoobenthos. During the present investigation Cladocerans were found to be abundant in Nai Basti pond while Dipterans in Chautal pond and Gastropods in Shekha jheel. The abundance of dipterans was represented by Chironomus and Culex. Chironomus can survive in low oxygen condition as well as polluted water body. Therefore, its high number in Chautal pond indicated polluted nature [6]. The availability of maximum number of Gastropods could be correlated to the cumulative effect of alkaline nature of water, high calcium contents and macrophytic vegetation [7]. Trichopterans were found to be the least abundant in all ponds. Kabir et al. [6] reported that these insects are sensitive to pollution. The zoobenthos showed negative but significant correlation with Water temperature and pH in Chautal pond, Shekha jheel and in Lal

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Coleoptera				
Berosus spp.	-	-	-	-
Total				
Diptera				
Chironomus spp.	28	8	22	17
Culex spp.	30	21	19	13
Total	58	29	41	30
Ephemeroptera				
Cynigmula spp.	-	-	-	-
Total				
Hemiptera				
Belostoma spp.	-	-	-	-
Notonecta spp.	-	-	-	-
Ptilostomis spp.	-	-	-	-
Total				
Odonata				
Libellula spp.	-	-	-	-
Total				
Trichoptera				
Phyrganaea larvae	10	7	2	-
Total	10	7	2	-
Cladocera				
Bosmina spp.	26	18	7	3
Moina spp.	20	13	5	1
Chydorus spp.	-	-	-	-
Daphnia spp.	-	-	-	-
Total	46	31	12	4
Gastropoda				
Amnicola spp.	-	-	-	-
Gyraulus spp.	8	15	11	17
Campeloma spp.	-	-	-	-
Total	8	15	11	17
Ostracoda				
Cypris spp.	-	-	-	-
Cypridopsis spp.	18	11	7	2
Total	18	11	7	2
Rotifera				
Asplanchna spp.	6	8	11	15
Keratella spp.	10	14	19	23
Total	16	22	30	38
Protozoa				
Euglena spp.	23	20	27	30
Total	23	20	27	30
Grand total	179	135	130	121

Table 11: Fortnight distribution of zoobenthos (no/m²) in lal diggi pond.

Date/Genera	9/3/2016	23-03-2016	8/4/2016	23-04-2016
Coleoptera				
Berosus spp.	-	-	-	-
Total				
Diptera				
Chironomus spp.	9	17	11	17
Culex spp.	8	13	9	16
Total	17	30	20	33
Ephemeroptera				
Cynigmula spp.	-	-	-	-
Total				
Hemiptera				
Belostoma spp.	-	-	-	-
Notonecta spp.	26	23	10	5
Ptilostomis spp.	-	-	-	-
Total	26	23	10	5
Odonata				
Libellula spp.	-	-	-	-
Total				
Trichoptera				
Phyrganaea larvae	-	-	-	-
Total	-	-	-	-
Cladocera				
Bosmina spp.	-	-	-	-
Moina spp.	-	-	-	-
Chydorus spp.	-	-	-	-
Daphnia spp.	-	-	-	-
Total				
Gastropoda				
Amnicola spp.	43	32	15	6
Gyraulus spp.	-	-	-	-
Campeloma spp.	43	32	15	6
Total				
Ostracoda	20	15	8	-
Cypris spp.	-	-	-	-
Cypridopsis spp.	20	15	8	-
Total				
Rotifera	-	-	-	-
Asplanchna spp.	22	27	23	31
Keratella spp.	-	-	-	-
Total	22	27	23	31
Protozoa				
Euglena spp.	-	-	-	-
Total				
Grand total	128	127	76	75

Table 12: Fortnight distribution of zoobenthos (no/m²) in chautal pond.

Diggi; with CO_2 in Chautal pond and Shekha jheel, whereas in Nai Basti pond zoobenthos showed positive significant correlation with water temperature, pH and CO_2. However, with dissolved oxygen these animals showed positive significant correlation in all water bodies (Tables 10-13). The result of present investigation revealed that zoobenthos were more dominant than phytobenthos (Table 16). The negative but significant correlation between zoobenthos and phytobenthos in all selected water bodies during study indicated grazing of former on latter proving top down control in these lentic ecosystems [8-10].

Conclusion

Present investigation revealed that zoobenthos were more dominant than phytobenthos. Among zoo benthos, Diptera was found to be the abundant group followed by Cladocerans and least was Trichopterans. *Chironomus* which is a representative of Dipterans is the pollution indicator. Trichopterans are sensitive to the pollution, so they are least abundant. Chlorophyceae formed the most abundant group in Lal Diggi, Chautal and Nai Basti pond. Zoobenthos are inversely related to phyto benthos in all the ponds indicating former grazing on latter. The presence of zoo benthos along with phytobenthos in all samples indicated nutrient rich and productive pond bottom thereby proving favourable environment for benthic animals especially fish.

Parameters	Parameters	Correlation (r value)	Significant at p=0.05
Air temperature	Water temperature	0.997	✓
Water temperature	Carbon dioxide	0.819	✓
	Dissolved oxygen	_0.965	✓
	pH	0.787	✓
	Zoo benthos	_0.882	✓
	Phyto benthos	0.987	✓
Carbon dioxide	Phyto benthos	0.849	✓
	Zoo benthos	_0.821	✓
	Dissolved oxygen	_0.646	✓
	pH	0.317	✓
Dissolved oxygen	Zoo benthos	0.92	✓
	Phyto benthos	-0.945	✓
	pH	0.962	✓
pH	Phyto benthos	0.77	✓
	Zoo benthos	_0.780	✓
Zoo benthos	Phyto benthos	_0.984	✓

Table 13: Statistical brief of water quality parameters in chautal pond.

Parameters	Parameters	Correlation (r value)	Significant at p=0.05
Air temperature	Water temperature	0.982	✓
Water temperature	Carbon dioxide	0.982	✓
	Dissolved oxygen	_0.958	✓
	pH	0.87	✓
	Zoo benthos	_0.998	✓
	Phyto benthos	0.932	✓
Carbon dioxide	Phyto benthos	0.98	✓
	Zoo benthos	0.988	✓
	Dissolved oxygen	_0.911	✓
	pH	0.947	✓
Dissolved oxygen	Zoo benthos	0.941	✓
	Phyto benthos	-0.863	✓
	pH	_0.753	✓
pH	Phyto benthos	0.981	✓
	Zoo benthos	_0.888	✓
Zoo benthos	Phyto benthos	_0.940	✓

Table 14: Statistical brief of water quality parameters in laldiggi pond.

Parameters	Parameters	Correlation (r value)	Significant at p=0.05
Air temperature	Water temperature	0.997	✓
Water temperature	Carbon dioxide	0.722	✓
	Dissolved oxygen	_0.975	✓
	pH	0.734	✓
	Zoo benthos	_0.879	✓
	Phyto benthos	0.95	✓
Carbon dioxide	Phyto benthos	0.885	✓
	Zoo benthos	_0.802	✓
	Dissolved oxygen	_0.842	✓
	pH	0.146	✓
Dissolved oxygen	Zoo benthos	0.946	✓
	Phyto benthos	0.996	✓
	pH	_0.643	✓
pH	Phyto benthos	0.585	✓
	Zoo benthos	_0.671	✓
Zoo benthos	Phyto benthos	_0.955	✓

Table 15: Statistical brief of water quality parameters in shekha jheel.

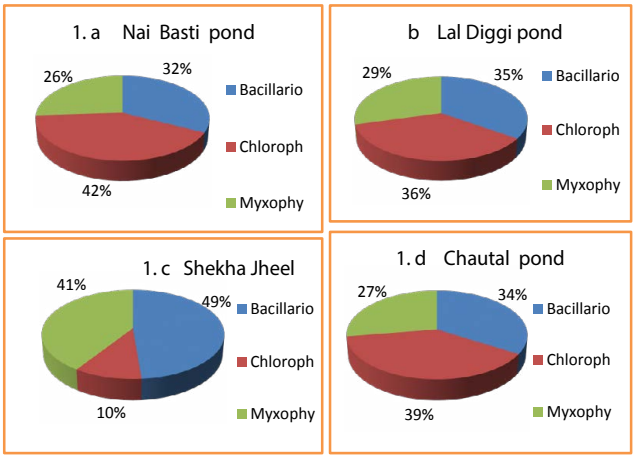

Figure 5a-5d: Percent Composition of different Phytobenthos in the selected waterbodies.

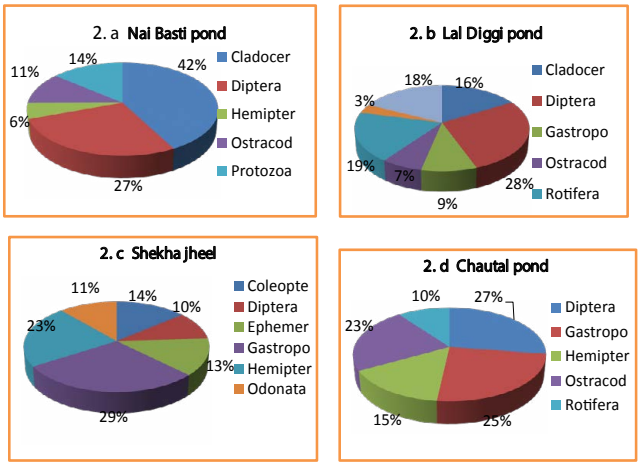

Figure 6a-6d: Percent Composition of different Zoobenthos in the selected waterbodies.

Parameters	Parameters	Correlation (r value)	Significant at p= 0.05
Air temperature	Water temperature	0.991	✓
Water temperature	Carbon dioxide	0.749	✓
	Dissolved oxygen	_0.970	✓
	pH	0.563	✓
	Zoo benthos	0.869	✓
	Phyto benthos	0.96	✓
Carbon dioxide	Phyto benthos	0.671	✓
	Zoo benthos	_0.978	✓
	Dissolved oxygen	_0.773	✓
	pH	0.834	✓
Dissolved oxygen	Zoo benthos	0.886	✓
	Phyto benthos	-0.989	✓
	pH	_0.715	✓
pH	Phyto benthos	0.642	✓
	Zoo benthos	_0.816	✓
Zoo benthos	Phyto benthos	_0.808	✓

Table 16: Statistical brief of water quality parameters in nai basti pond.

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