

Plankton Ecology In Two Ground Water Irrigated Paddy Fields, Indira Nagar, Miran Sahib, Jammu

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Abstract

Plankton ecology, in relation to abiotic characteristics of water, in two ground water irrigated paddy fields, Indira Nagar, Miran Sahib, Jammu, was undertaken during June, 2002 to September, 2002 and has been described. Phytoplankton, qualitatively, has shown the dominance of Bacillariophyceae (7 genera) followed by Cyanophyceae (6 genera) and Chlorophyceae (5 genera). Among zooplankton, there is dominance of Protozoa (19 species) followed by Arthropoda (6 species and 3 larvae), Rotifera (6 species) and Nematoda. Planktonic diversity and density remained low during first observation (preparation of fields). Coefficient of correlation (r) of phytoplankton and zooplankton, with the various water characteristics, is insignificant.

Key Words : *Phytoplanktonic diversity, Paddy field, Correlation coefficient*

Introduction

The area under paddy culture is 1,04,000 ha in Jammu and 1,63,000 ha in Kashmir and quality water (surface and subsurface) is available for irrigation. These seasonal wetlands support a diversified aquatic biota and have not received much scientific attention. Among the earlier workers Goyal *et al.* (1984), Rathor and Mir (1987) and Dutta *et al.* (2002 a,b and 2004) have worked on the plankton ecology of paddy fields. The present work was undertaken to add to the existing knowledge of planktonic ecology from the area and ground water irrigated paddy fields were selected in Indira Nagar.

Topography of the area

Indira Nagar, Miran Sahib, Jammu, the area of present study, is situated at a distance of 10 km from the university campus. The area is plain and is suitable for agriculture. The texture of the soil is soft and loamy. Annually two crops *viz.* wheat during winter and paddy during summer-monsoon are cultivated. Three varieties of paddy *viz.* China, Ratna and local basmati are cultivated in the area. In the field of present study (each of 0.1 hectare size), local basmati is cultivated. Irrigation of these fields is done through underground water.

Materials and Methods

Sampling of Water

Water samples, were collected fortnightly during paddy season *viz.* June-September 2002 in plastic containers and analyzed for abiotic characteristics by standard methods (APHA, 1998).

Sampling and Analysis of Plankton

Plankton were collected by filtering 2 litres of water through a planktonic net (No.25) and analysed in the laboratory (Nair *et al.* 1971; Dutta, 1983; Kudo, 1986 and Ward and Whipple, 1992) and counted by drop count

method. The results are expressed as number per litre (n/l).

Coefficient of correlation (r) of phytoplankton and zooplankton, with various abiotic parameters, is calculated by the formula:

$$\text{Coefficient of correlation (r)} = \frac{\sum xy - \bar{x} \sum y}{\sqrt{(\sum x^2 - \bar{x} \sum x)(\sum y^2 - \bar{y} \sum y)}}$$

Where x and y are the values of either species or physico-chemical parameters and $\bar{x}$ and $\bar{y}$ are their means.

Results & Discussion

Water Characteristics

The results of various physico-chemical characteristics of water are summarized in Table 1. Due to shallowness, water temperature closely followed the air temperature and varied between 25.6°C-33.7°C and 27°C-34°C, respectively. Highest record of air and water temperature is seen during 3rd observation. Due to mixing of hot soil and water during preparation of field, water temperature was higher than air temperature, during first observation. Depth in these paddy fields varied between 2.5-10 cm and recorded its maximum value during 1st observation, when large amount of water is required and is available, before seeding transplantation. Turbidity varied between 21.25-262.6 NTU and remained high during 1st, 2nd and 3rd observation, with maximum record on 2nd observation. Agitation of sediments during seedling transplantation may explain maximum record of turbidity on 2nd observation. pH varied between 7.54-8.66. Its wide variation has correlation with the presence or absence of CO₂ and CO₃²⁻. Direct relationship of pH with CO₃²⁻ may explain the highest record of pH (8.66) during 3rd observation, when CO₃²⁻ was present. Similarly, an inverse relationship of pH with free CO₂ may explain the low record of pH (7.76) during 7th observation, when free CO₂ was highest. An inverse relationship of pH with CO₂ and direct with CO₃²⁻ is already on record (Welch, 1952; Hutchinson, 2004; Reid and Wood, 1976; Goldman and Horne, 1983; Jhingran, 1991 and Wetzel 2000). Dissolved oxygen fluctuated between 1.96-6.53 mg/l. Its highest record on 4th observation coincided with lowest record of free CO₂ and has correlation with high rate of photosynthesis, due to phytoplanktonic increase, indicated by floating algal mats and low shade caused by newly transplanted seedlings and penetration of light upto the bottom. Free CO₂ varied between 5.5-39.92 mg/l and remained high due to irrigation of the field by the ground water. Its highest and lowest record is observed during 7th and 4th observation, respectively. Presence of water in pools and decaying dead organic matter may explain the highest record of CO₂ on 7th observation. Carbonate is seen only once during 3rd observation (13.8 mg/l). Bicarbonate recorded its minimum (101.24 mg/l) record on 4th observation. Maximum record of bicarbonate (416 mg/l) during 1st observation has correlation with mixing of sediments, decayed decomposed vegetation, marls (dead molluscan shells) with water during preparation of field for seedling transplantation. Chloride recorded its highest (36.41 mg/l) and lowest (8.8 mg/l) value during 7th and 1st observation, respectively. Presence of water in pools may explain the highest record of chloride during 7th observation. Calcium, magnesium and total hardness varied between 40.36-65.29 mg/l, 12.37-25.4 mg/l 117.97-167.81 mg/l, respectively. Highest record of calcium, magnesium and total hardness during 7th observation may be explained by presence of water in pools. Sodium varied between 15.75-56 mg/l with its highest and lowest record on 1st and 3rd observation, respectively. Mixing of sediments, cow dung and decayed crop residue during preparation of fields may explain the highest record of sodium during 1st observation. Potassium recorded its

maximum (16.5 mg/l) and minimum (1 mg/l) value during 8th and 2nd observation, respectively. Highest record of potassium during 8th observation may be explained by low consumption of potassium by paddy, at the time of ripening and presence of water in pools.

Planktonic Analysis

Phytoplankton, comprising of 18 genera, has shown the dominance of Bacillariophyceae (7 genera) followed by Cyanophyceae (6 genera) and Chlorophyceae (5 genera). Qualitatively, various phytoplanktonic genera remained irregular. Among the various genera of Bacillariophyceae, *Navicula* and *Fragilaria* are seen seven times, *Cymbella* six times, *Amphora* thrice, *Pinnularia* and *Gomphonema* twice and *Nitzschia* only once. (Table 2). Among the various Cyanophyceae genera, *Oscillatoria* is seen seven times, *Phormidium* six times, *Anabaena* five times, *Nostoc* and *Spirulina* four times and *Microcystis* thrice (Table 2). Various genera of Chlorophyceae also made their irregular presence. *Cosmarium* is observed six times, *Spirogyra* five times, *Chlorella* four times, *Closterium* thrice and *Scenedesmus* only once. An overall analysis has shown minimum and maximum phytoplanktonic diversity during third and second observation, respectively (Table 2). Quantitatively, total phytoplankton varied between nil-2868 n/l. The order of qualitative dominance of different phytoplanktonic group is seen as Bacillariophyceae (nil-2544 n/l) > Cyanophyceae (nil-615 n/l) and Chlorophyceae (nil-140 n/l). Analysis of coefficient of correlation (r) of Bacillariophyceae, Cyanophyceae and Chlorophyceae with various physico-chemical characteristics of water is insignificant (Table 4). This indicates that no single factor is a strong determinant for phytoplanktonic abundance in these paddy fields. A total of 33 zooplanktonic species and 3 larvae, seen in these paddy fields (Table 3), have shown the qualitative dominance of Protozoa (19 spp.) followed by Arthropoda (6 spp. and 3 larvae), Rotifera (7 spp.) and Nematoda. Protozoa, the most dominant group, is represented by *Sarcodina* (17 spp.) and *Ciliata* (2 spp.) only. Qualitatively, *Sarcodina* is seen during all the eight observations. Among its various genera *Diffugia* and *Centropyxis* are observed during all the eight observations, *Arcella* seven times, *Lespuereusia* twice and *Pyxidicula* only once. Among ciliates *Vorticella* is seen thrice and *Paramecium* twice. Total protozoans, quantitatively, varied between 105-988 n/l. Among protozoans, quantitatively, there is dominance of *Sarcodina* (105-988 n/l) and sub-dominance of *Ciliata* (nil-45 n/l). Quantitatively total protozoans recorded trimodal increase. These observed first peak during 2nd observation, second during 4th observation and third during 8th observation (Table 3). Rotifers also made their irregular presence in the planktonic samples collected from these paddy fields. All the rotifers, viz. *Lecane*, *Brachionus*, *Trichocerca*, *Notholca* and *Philodina* are observed only once (Table 3). Quantitatively, total rotifers varied between nil-65 n/l. Analysis of coefficient of correlation of rotifers, with various physico-chemical characteristics, reveals insignificant relationship (Table 5). Arthropods in these paddy fields are represented by two classes, viz. Crustacea and Insecta. Crustacea has shown the presence of three orders viz. Copepoda, Ostracoda and Cladocera. Among copepods, *Mesocyclops*, *Leuckartii* and *M. hyalinus* are observed thrice. *Nauplius* and *Metanauplius* larvae of copepods made their record four times and twice, respectively. Among ostracods, *Cypris* is observed twice and *Potamocypris* only once. *Moina* and *Alona*, only cladocerans seen in these paddy fields, were observed only once (Table 3). Chironomous larva, a dipteran, is seen only twice.

Quantitatively, arthropods varied between 7-174 n/l and recorded increase during 2nd, 4th, 6th and 8th observation.

Water nematodes and unidentified eggs made their appearance twice in these paddy fields (Table 3). Quantitatively, total zooplankton varied between 147-1088 n/l and recorded a trimodal increase. These recorded first peak during 2nd, second during 4th and third during 8th observation. Qualitatively, phytoplankton and zooplankton recorded slight increase on 2nd observation and can be attributed to their transfer along with seedlings. In paddy culture seedlings are grown about a month before their transplantation. There is daily irrigation of these seedlings and is optimum for planktonic growth. Presence of shelled forms of zooplankton during 1st observation has its correlation with resistance of shells to biodegradation and chemical corrosion.

This may explain their dominance in these paddy fields. An increase in zooplanktonic diversity after irrigation of fields has its correlation with hatching of cysts/spores produced by various planktonic forms during drying of fields.

Insignificant results of coefficient of correlation of phytoplankton and zooplankton (Table 4 & 5), with various physico-chemical characteristics of water, indicate that no single factor is a strong determinant for planktonic abundance in these paddy fields of Indira Nagar, Jammu.

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Table-1: Mean Results of Physico-Chemical Parameters of water from Two Paddy Fields, Indira Nagar (Miran Sahib), Jammu (June 2002 to September 2002)

WATER PARAMETERS	OBSERVATION							
	1 29/6/02	2 01/7/02	3 16/7/02	4 27/7/02	5 14/8/02	6 2/9/02	7 16/9/02	8 28/9/02
Air temperature (°C)	30	31	34	31.5	27	31	31	30.2
Water temperature (°C)	31	30	33.7	31.65	25.6	29.6	30.3	29.8
Depth (cm)	10	5.5	4.3	3.7	4.75	2.95	2.5	2.8
Turbidity (N.T.U.)	157.7	262.6	240	21.25	22.3	25.6	26.5	45
T.D.S (ppm)	73	173.65	203.9	91.6	122.6	164.1	176.75	199.1
pH	7.67	7.6	8.66	8.09	7.54	7.67	7.765	7.73
Electrical conductivity (mMho)	0.474	0.347	0.414	0.4	0.380	0.452	0.357	0.385
Salinity (ppt)	0.4	0.3	0.4	0.3	0.25	0.3	0.4	0.4
DO (mg/l)	3.17	5.95	4.82	6.53	4.79	4.2	1.96	4.44
Free CO ₂ (mg/l)	15.8	19.9	-	5.5	13.77	15.29	39.92	18.01
CO ₃ ²⁻	-	-	13.8	-	-	-	-	-
HCO ₃ (mg/l)	416	224.3	119.11	101.24	193.77	217.35	402.46	297.65
Cl ⁻ (mg/l)	8.8	11.3	17.2	14.78	9.75	10.74	36.41	17.87
Ca ⁺⁺ (mg/l)	DNA	43.47	40.36	47.94	43.9	56.61	65.29	64.68
Mg ⁺⁺ (mg/l)	DNA	17.5	17.80	18.26	13.87	23.33	25.4	12.37
Total Hardness (mg/l)	DNA	180.67	145.4	194.77	117.97	150.89	167.81	212.24
Na ⁺ (mg/l)	56	26.75	15.75	24.5	23.25	18.5	31.25	24
K ⁺ (mg/l)	6.5	1	1.25	1.75	1.25	2.25	8.75	16.5

Table-2
Mean Results of Phytoplanktonic Variations (n/l) in Two Paddy Fields,
Indira Nagar (Miran Sahib) Jaamu

PHYTOPLANKTONIC ORGANISMS	OBSERVATIONS							
	1	2	3	4	5	6	7	8
	29/6/02	1/7/02	16/7/02	27/7/02	14/8/02	2/9/02	16/9/02	28/9/02
1. CYANOPHYCEAE								
<i>Nostoc</i> spp.	-	-	23	110	13	-	42	-
<i>Anabena</i> spp.								
<i>Phormidium</i> spp.	-	60	-	180	13	10	30	-
<i>Oscillatoria</i> spp.	-	-	13	10	68	20	23	48
<i>Spirulina</i> spp.	-	40	23	205	42	125	113	168
<i>Microcystis</i> spp.	-	-	-	35	43	23	-	36
	-	120	-	75	-	-	30	-
TOTAL	-	220	58	615	179	238	238	252
II. BACILLARIOPHYCEAE								
<i>Fragillaria</i> spp.	-	155	43	70	25	108	65	24
<i>Navicula</i> spp.	-	1384	39	150	100	135	110	96
<i>Gomphonema</i> spp.	-	32	-	-	-	-	15	-
<i>Cymbella</i> spp.	-	80	8	25	-	20	81	96
<i>Pinnularia</i> spp.	-	896	-	-	-	-	81	-
<i>Nitzschia</i> spp.	-	-	-	-	-	20	-	-
<i>Amphora</i> spp.	-	-	-	20	17	8	-	-
TOTAL	-	2544	90	265	142	291	319	216
III. CHLOROPHYCEAE								
<i>Chlorella</i> spp.	-	64	8	20	-	15	-	-
<i>Closterium</i> spp.	-	-	7	-	25	-	-	24
<i>Cosmarium</i> spp.	-	40	35	45	17	55	23	-
<i>Spirogyra</i> spp.	-	-	13	75	-	68	9	36
<i>Scenedesmus</i> spp.	-	-	-	-	-	-	23	-
TOTAL	-	104	63	140	37	138	55	60
TOTAL PHYTOPLANKTON	-	2868	211	1020	358	667	612	528

(-) Absent

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Table-3 : Mean Result of Phytoplanktonic Variations (n/I) in Two Paddy Fields, Indira Nagar (Miran Sahib, Jammu) (June 2002 to September 2002)

ZOOPLANKTONIC ORGANISMS	OBSERVATION							
	1	2	3	4	5	6	7	8
	29/6/02	1/27/02	16/7/02	27/7/02	14/08/02	02/09/02	16/09/02	28/09/02
PHYLLUM PROTOZOA								
CLASS : SARCODINA								
ORDER : TESTACIDA								
<i>Diffugia tuberculata</i> (Wallich)	110	196	13	100	25	43	23	-
<i>D. pyriformes</i> Perty	33	124	13	5	25	-	8	36
<i>D. corona</i> Wallich	-	48	-	55	13	20	-	-
<i>D. accuminata</i> Ehren	75	112	36	60	-	8	39	72
<i>D. lebes</i> Penard	-	60	-	5	-	-	23	-
<i>D. urceolata</i> Carter	-	20	-	25	-	-	8	-
<i>D. lobostoma</i> Leidy	-	-	8	-	-	-	-	-
TOTAL DIFFLUGIA	218	560	67	250	63	71	101	108
<i>Centropyxis ecoris</i> (Ehren)	33	40	35	125	-	18	45	60
<i>C. spinosa</i> (Cash & Hoppinson)	-	-	-	25	-	-	-	-
<i>C. aculeate</i> (Ehren)	33	208	7	150	17	18	9	84
<i>C. aerophila deflandre</i>	-	-	-	40	-	-	-	-
<i>C. constricta</i> (Ehren)	18	112	8	20	-	-	8	-
TOTAL CENTROPYXIC	84	360	50	360	17	36	62	144
<i>Arcella discoides</i> Ehren	-	-	-	45	-	8	23	36
<i>A. vulgaris ehren</i>	-	20	30	-	25	30	-	-
<i>A. arcelloides</i> Penard	-	32	-	10	-	-	-	24
TOTAL ARCELLA	-	52	30	55	25	38	23	60
<i>Lesquereusia spiralis</i> Ehren	-	16	-	5	-	-	-	-
<i>Pxydicula spp</i>	-	-	-	5	-	-	-	-
TOTAL SARCODINA	302	988	147	675	105	145	186	312
Class : Ciliata								
<i>Paramecium</i> Hill	-	-	-	-	-	23	27	-
<i>Vorticella</i> Linnaeus	-	-	-	-	-	15	18	12
TOTAL CILIATA	-	-	-	-	-	38	45	12
TOTAL PROTOZOA	302	988	147	675	105	183	231	324
PHYLLUM-ROTIFERA								
CLASS : MONOGONONTA								
ORDER : PLOIMA								
<i>Lecane</i> spp.	-	-	-	25	-	-	-	-
<i>Trichocerca</i> spp.	-	-	-	-	9	-	-	-
<i>Notholca Gosse</i>	-	-	-	-	-	-	8	-
<i>Platylas</i> spp.	-	-	-	-	9	-	-	-
<i>Brachionus quadridentata</i> Hermann	-	-	-	-	-	23	-	-
ORDER : BDELLOIDA								
<i>Philodina</i> Ehren	-	-	-	40	-	-	-	-
TOTAL ROTIFERS	-	-	-	65	18	23	8	-
PHYLLUM:ARTHROPODA								
CLASS:CRUSTACEA								
ORDER : COPEPODA								
<i>Mesocyclops leuckartii</i> (claus)	-	-	-	5	-	-	-	24
<i>M. hyalinus</i> (Rehberg)	-	-	-	-	9	-	-	48
<i>Nauplius</i> larva	-	40	7	20	-	-	-	24
<i>Metanauplius</i> larva	-	-	-	-	-	8	-	12
ORDER:OSTROCODA								
<i>Cypris</i> Muller	-	20	-	-	15	-	-	-
<i>Potamocypris</i> Brady	-	40	-	-	-	-	-	-
ORDER:CLADOCERA								
<i>Alona</i> spp.	-	-	-	-	-	-	-	48
<i>Moina</i> Baird	-	-	-	-	-	23	-	-
TOTAL CRUSTACEA	-	100	7	25	24	31	-	156
CLASS : INSECTA								
ORDER:DIPTERA								
<i>Chironomous</i> larva	-	-	-	-	-	-	24	18
TOTAL ARTHROPODS	-	100	7	25	24	31	24	174
Water Nematodes	15	-	-	-	-	-	-	12
Eggs	-	-	-	5	-	-	-	108
TOTAL ZOOPLANKTON	317	1088	154	765	147	237	263	618

Table 4 : co-efficient of correlation (r) between phytoplankton and physico-chemical parameters of water in two paddy fields (Miran Sahib), Jammu

Water Parameters Phytoplankton groups	Water Temp.	Depth	Turbidity	pH	Electrical Conductivity	Salinity	T.D.S.	DO	Free CO_2	CO_3^{2-}	HCO_3^-	Cl ⁻	Ca^{++}	Mg^{++}	Total Hardness	Na^+	K^+
<i>Bacillariophyceae</i>	-0.05	0.04	0.55	-0.28	-0.54	-0.31	0.23	0.40	0.19	-0.22	-0.08	-0.13	-0.28	-0.02	0.22	-0.08	-0.26
<i>Chlorophyceae</i>	0.15	-0.56	-0.16	0.12	-0.14	-0.47	0.15	0.58	-0.20	0.33	-0.61	-0.07	-0.08	0.34	0.32	-0.61	-0.35
<i>Cyanophyceae</i>	-0.07	-0.52	-0.50	0.01	-0.32	-0.41	-0.18	0.52	-0.06	0.37	-0.45	0.13	0.05	0.53	-0.35	-0.06	
Total phytoplankton	-0.08	-0.04	-0.09	0.18	-0.58	-0.40	0.18	0.51	0.15	-0.11	-0.20	0.26	0.30	0.30	0.56	-0.48	-0.04

Table 5 : Co-efficient of correlation (r) between zooplankton and physico-chemical parameters of water in two paddy fields, Indira Nagar, (Miran Sahib), Jammu

	Water parameters																
Zoo-planktonic Groups	Water Temperature	Depth	Turbidity	PH	Electrical Conductivity	Salinity	T.D.S	DO	Free CO ₂	CO ₃ ²⁻	HCO ₃ ⁻	Cl ⁻	Ca ⁺⁺	Mg ⁺⁺	Total Hardness	Na ⁺	K ⁺
Protozoa	0.16	0.12	0.39	-0.14	0.40	-0.25	-0.16	0.6	-0.19	0.08	-0.18	-0.18	-0.24	-0.09	0.56	-0.06	-0.19
Rotifera	-0.06	-0.27	-0.54	0.10	0.05	-0.52	-0.49	0.49	-0.55	0.50	-0.53	-0.09	-0.12	-0.13	0.12	0.23	-0.35
Arthropoda	-0.13	0.08	0.29	-0.19	-0.44	-0.19	0.49	0.22	0.03	-0.33	0.08	0.02	0.41	-0.54	0.69	-0.22	0.63
Nematoda	0.06	0.56	0.04	-0.06	-0.23	0.46	0.55	-0.31	0.03	-0.21	0.60	-0.20	-0.48	-0.82	-0.48	0.70	0.67
TOTAL	0.10	0.09	-0.18	0.46	0.46	-0.19	-0.04	0.60	-0.22	0.02	-0.15	-0.15	-0.09	-0.24	0.71	0.06	0.02
ZOOPLANKTON																	