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Ecology of plankton in some paddy fields, near Nagri bus stand, Kathua (J&K state)

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Abstract

Physico-chemical characteristics of water and plankton were analysed from four paddy fields, irrigated by a tributary of the river Ravi, near Nagri bus stand, Kathua, J&K, during July, 2005 to September, 2005 have been described. Phytoplankton has shown the presence of Chlorophyceae (14 genera), Bacillariophyceae (9 genera) and Cyanophyceae (6 genera). The order of qualitative dominance of zooplankton is observed as Protozoa (10 genera and 31 species) > Rotifera (8 genera and 9 species) > Arthropoda (8 genera, 8 species and 3 larvae) > Annelida (1 genus and 1 species) and> Nematoda. Planktonic diversity and density remained low during first two observations (preparation of fields and seedlings transplantation). Coefficient of correlation (r) of phytoplankton and zooplankton, with the various parameters of water, is insignificant.

Key words: *Planktonic Ecology, Paddy fields, Nagri bus stand, Kathua.*

Introduction

Paddy fields, which support a diversified aquatic biota, have received the scientific attention of Goyal *et al.* (1984), Rather and Mir (1987), Pandoh (1998) and Dutta *et al.* (2002 a,b; 2004; 2005 and 2006 a,b,c) from J&K state. However, there is no record of any work for seasonal wetlands from Kathua district. The present planktonic study from paddy fields, irrigated by a tributary of the river Ravi, near Nagri bus stand, was undertaken to add to the existing knowledge of biotic characteristics of seasonal wetlands from Jammu region of J&K state.

Topography of the area

Kathua district, of Jammu region,situated at 32°17' to 32°55' North Latitude and 75°70' to 76°16' East Longitude has an area of 2651 Km^2. The District is surrounded by Punjab in the S-E , Himachal Pradesh in N-E, Doda and Udhampur in North and N-W, Jammu in the West and Pakistan in S-W. (Fig. 1). The main drainage of the area is by the river Ravi. The area being plain is suitable for agriculture. The texture of the soil is soft and loamy. Annualy two crops viz. wheat during winter and paddy during summer- monsoon season are cultivated. Three varieties of paddy viz. China, Ratna and local basmati are cultivated in the area. For the present study, four paddy fields (about 1 acre), near Nagri bus stand, were selected. In these fields, local basmati is cultivated. Irrigation of fields in the area is done through a tributary of the river Ravi called as Kathua canal or Kashmir canal.

Materials and methods

Sampling of Water

Water samples, from four selected paddy fields, were collected during preparation of fields for seedlings transplantation, during seedlings transplantation and weekly thereafter, during paddy growing season viz. July to September (2005) in plastic containers and analysed for various abiotic characteristics by standard

methods (Indian Standard Method, 1973; Trivedy *et al.* 1987 and APHA, 1998). Depth was recorded by using a meter rod and temperature by mercury bulb (^{0}C) thermometer.

Sampling and Analysis of Plankton

Planktonic samples from each paddy field were collected by filtering two litres of water through a planktonic net (No. 25) and analysed in the laboratory (Smith, 1950; Nair *et al.* 1971; Kant, 1977; Kant and Anand, 1978; Dutta, 1983; Adoni, 1985; Kudo, 1986; Battish,1992; Edmondson, 1992 and Biswas and Raut, 2000) and counted by drop count method. The results are expressed as number per litre (n/1).

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

$$\text{Coefficient of correlation}(r) = \frac{\sum xy - \overline{X}\sum y}{\sqrt{\left(\sum x^2 - \overline{X}\sum x\right)\left(\sum y^2 - \overline{Y}\sum y\right)}}$$

Where, x = Total no. of phytoplankton or zooplankton species.

y = Total no. of physico-chemical parameters.

$\overline{X}$ = Mean of phytoplankton or zooplankton.

$\overline{Y}$ = Mean of physico-chemical parameters.

Results and discussion

Physico-chemical Parameters of Water

The results of various physico-chemical parameters of water are summarized in Table 1 and depicted in Figs. 2a to 2h. Water temperature (22.17^{0}C, 1st observation and 29.22°C, 4th observation), due to shallowness and lentic conditions, closely followed by the air temperature, and varied between (25°C, 1st observation and 34°C, 4th observation) and is in accordance with the findings of Dutta *et al.* (2004 and 2006 a,b,c). Heavy rains and irrigation of fields with large quantities of water, during preparation of fields, may explain the lowest record of water temperature noticed on 1 st observation. Maximum record of water temperature during 4th observation coincided with the highest observation of air temperature. Depth in these paddy fields varied between 2.87 and 11.92 cm (Table1 ;Fig.2b) and observed its maximum value during 1st observation, when large amount of water is available for field preparation, before seedlings transplantation, and is in agreement with the findings of Dutta *et al.* (2004 and 2006 a,b,c).

pH varied between 6.38 and 8.18. Its wide variation coincided with the presence or absence of free CO_2 and CO_3. Direct relationship of pH with CO_3 may explain highest record of pH (8.18) during 4th observation, when carbonate was present in two fields. Similarly, an inverse relationship of pH with free CO_2 may explain the low record of pH during 2nd observation, with free CO_2 was comparatively high. An inverse relationship of pH with free CO_2 and direct with CO_3 is already on record (Welch, 1952; Reid and Wood,1976; Goldman and Horne, 1983; Jhingran, 1991 and Wetzel, 2000). Dissolved oxygen fluctuated between 2.49mg/l to 7.15 mg/l. Irrigation of fields with large quantities of water and agitation of water during preparation of fields, before seedlings transplantation, may account for rise in DO during 1st observation. Free CO_2 recorded its

highest (17.44 mg/l) and lowest (6.93mg/l) value during 9th and 4th observation, respectively. Presence of water in pools and records of decaying dead organic matter may explain highest record of free CO_2 during 9th observation. Carbonate is seen only once during 4th observation (21.3 mg/l), in two paddy fields. Bicarbonate showed its minimum (67.05 mg/l) record during 12th observation and maximum (151.85 mg/l) during 11th observation. Highest (17.43 mg/l) and lowest (9.19 mg/l) value of chloride is noticed during 10th and 5th observation, respectively. Calcium, magnesium and total hardness varied between 16.80 to 33.22 mg/I, 1.57 to 11.36 mg/I and 65.60 to 130.83 mg/l, respectively. Highest record of calcium, magnesium and total hardness during 9th observation coincided with decomposition of algae and some macrophytes and maximum value of free carbon dioxide during this observation. Chemical oxygen demand showed its lowest (23 mg/l) and highest (105.4 mg/l) record during 11th and 5th observation, respectively.

Sulphate recorded its highest (80.62 mg/l) value during 1st and lowest (9.25 mg/l) during 6th observation. Mixing of sediments, crop residues and dead organic matter (cowdung) during field preparation, before seedlings transplantation, may explain highest record of sulphate during 1st observation. Silicate varied between 0.65' mg/l (7th observation) and 15.4 mg/l (1st observation). Irrigation of fields by large quantities of water and mixing of sediments during field preparation may explain the maximum record of silicate seen during 1st observation. Nitrate showed its highest (2.5 mg/l) value during 10th observation and lowest (0.125 mg/l) during 6th observation. Decomposition of algae and macrophytes in the pools of water in these paddy fields may account for nitrate enrichment during 10th observation.

Maximum (0.292 µMhos/cm) and minimum value (0.090 µMhos/cm) of electrical conductivity is noticed on10th and 7th observation, respectively. Low record of various salts like bicarbonate, chloride, calcium, magnesium and total hardness may explain lowest record of conductivity during 7th observation.

Planktonic Analysis

The results of phytoplanktonic analysis are shown in Table 2 and depicted in Figs. 3a to 3i. Phytoplankton, qualitatively, comprising of 29 genera has shown the dominance of Chlorophyceae (14 genera) followed by Bacillariophyceae (9 genera) and Cyanophyceae (6 genera) and is in accordance to the findings of Dutta *et al.* (2006b) for paddy fields in Maralia Morh, Jammu. Qualitatively, various phytoplanktonic genera showed their irregular presence. Among the various genera of *Chlorophyceae*, *Spirogyra* made its appeareance 10 times; *Chlorococcum* and *Volvox* nine times; *Cosmarium*, *Eudorina* and *Closterium* seven times, each; *Pediastrum* five times; *Lepocynclis* and *Pandorina* four times; *PIeodorina*, *Euastrum*, *Spirotenia* and *Dictyospherium* thrice and *Gonium* twice (Table 2).

Among various genera of Bacillariophyceae, *Navicula* is noticed nine times; *Caloneis* and *Fragillaria* six times; *Gyrosigma*, *Cymbella* and *Mastogloea* five times, each and *Surirella* and *Pinnularia* four times (Table 2).

Various Cyanophycean genera like *Oscillatoria, Nostoc, Spirulina, Anabaena, Microcystis* and *Anacystis* showed their presence nine times, six times, five times, four times, thrice and only once, respectively. (Table 2).

Maximum phytoplanktonic diversity in these paddy fields is seen during 8th observation minimum during 1st and 2nd observation. Quantitatively, total phytoplankton varied between 0 to 1650 n/l and recorded a bimodal increase viz. during 4th and 8th observation. The order of quantitative dominance of various

phytoplanktonic groups is recorded as Chlorophyceae (0 to 751 n/l), Bacillariophyceae (0 to704 n/l) and Cyanophyceae (0 to 481 n/l).

Analysis of coefficient of correlation (r) of total phytoplankton, Chlorophyceae, Bacillariophyceae and Cyanophyceae, with various physico-chemical characteristics of water, has shown mostly insignificant results (Table 4). This indicates that no single factor is a strong determinant for phytoplanktonic abundance in these paddy fields.

A total of 28 genera of zooplankton, seen in these paddy fields (Table3 and Figs 4a to 4m), have shown the qualtitative dominance of Protozoa (10 genera), followed by Rotifera (8 genera), Arthropoda (8 genera), Annelida (1 genus) and Nematoda. Protozoan dominance as seen during the present analysis is in agreement with the findings of Dutta *et al.* (2002 a,b; 2004; 2005 and 2006 a,b and c). Protozoa, the most dominant zooplanktonic group in these paddy fields, is represented by three classes viz. Sarcodina (6 genera and. 24 spp.) Mastigophora (2 genera and 5 spp.) and Ciliata' (2 genera and 2 spp.).

Qualitatively, Sarcodina is seen during all the twelve observations. Among its various genera, *Centropyxis* is observed during all the twelve observations; *Difflugia* and *Arcella* eleven times; *Lesqueresia* seven times; *Nebela* five times and *Cucurbitella* four times (Table 3). Along ciliates, *Chilodonella* and *Paramecium* are seen five and four times, respectively. *Euglena* and *Phacus*, among mastigophores, showed their presence nine and five times, respectively. Protozoans recorded maximum diversity during 8th and minimum during 1st observation.

Total protozoans, quantitatively, varied between 37 to 443 n/l. Among protozoans, the order of quantitative dominance is seen as Sarcodina (37 to 345 n/l) > Mastigophora (0 to 166 n/l) and> Ciliata (0 to 73 n/l). An overall analysis has shown a trimodal increase of Protozoa viz. during 2nd, 5th and 8th observation (Table 3). Resistance of Testacean rhizopods to the environmental' conditions viz. wide fluctuations in water level, drying of fields after paddy harvest and other abiotic characteristics, due to the presence of test/ shell may account for their presence during 1st observation.

Rotifers are noticed during nine times, out of twelve observations, in the planktonic samples collected from these four paddy fields. These showed maximum diversity during 4th and minimum during 10th observation. Among the various genera of class Monogononta, of Rotifera, *Monostyla, Platyias*, *Colurella* and *Brachionus* showed their presence four times, each; *Lecane* and *Philodina*, thrice, each; *Lepadella* twice and *Asplanchna* only once (5th observation) in the planktonic samples collected from four paddy fields in Kathua District. Rotifers, quantitatively, varied between 0 to 102 n/l and showed maximum diversity during 4th and minimum during 10th observation. These recorded a trimodal increase viz. during 4th, 7th and 12th observation, respectively. Arthropods in these paddy fields have shown the presence of two classes viz. Crustacea and Insecta. Crustaceans are represented by three orders viz. Copepoda, Cladocera and Ostracoda. Among copepods, *Mesocyclops hyalinus* and *Cyclops* are seen only twice. *Nauplius* and *Metanauplius larva* of Copepoda are noticed eight and five times, respectively. An overall Copepod analysis has shown their eight times presence. Among *Cladocerans*, *Ceriodaphnia* recorded its five times presence; *Alonella*, *Daphnia* and *Moina* twice, each, and *Alona* only once. An overall Cladoceran analysis has shown their six times presence. Ostracoda, another order of class Crustacea, is represented by genus *Cypris* and is seen during four observations only. An overall analysis of Crustaceans (Table 3), belonging to Phylum Arthropoda, has shown their nine times presence. Class Insecta, of Arthropoda, is qualitatively represented by *Chironomous* larva and is noticed presence thrice.

An observation of the Table 3 reveals nine times presence of arthropods in the planktonic samples collected from four paddy fields of Kathua district. Maximum and minimum diversity of arthropods is noticed on 10th and 12th observation, respectively.

Quantitatively, arthropods varied between 0 to 218 n/l (Table 3).These recorded a trimodal increase viz, during 5th, 7th and 10th observation. Annelida, represented by *Nais* spp. is seen only once (12th observation) during the present study. Water nematodes and eggs showed their four times presence in the present study area.

Total zooplankton recorded maximum, qualitative diversity during 8th and minimum during 1st observation.Total zooplankton quantitatively, varied between 37 to 684 n/l and observed a trimodal increase. Zooplanktonic first rise is seen during 2nd, 2nd during 5th and 3rd during 8th observation. Maximum and minimum quantitative count of zooplankton is seen during 8th and 1st observation, respectively. An overall study has indicated mostly insignificant correlation(r) of protozoans, rotifers, arthropods, nematodes and total zooplankton with various physico-chemical parameters of water (Table 5).

Insignificant results of coefficient of correlation of phytoplankton and zooplankton (Tables 4 and 5), with various physicochemical parameters of water, indicate that any of the physicochemical water parameter alone does not appear to be a strong determinant factor for the planktonic abundance in these four paddy fields of Kathua District, J & K. A similar type of conclusion has been drawn by Dutta *et al.* (2002 a, b; 2004; 2005 and 2006 a, b and c). Present analysis has indicated that the range of various physico-chemical parameters of water viz. temperature, depth, pH, free CO_2, bicarbonate, chloride, calcium, magnesium, total hardness, COD, silicate, sulphate, nitrate and electrical conductivity, in four paddy fields, near Nagri bus stand, Kathua, J & K, are within the optimum limits for fish culture. Biotic analysis has shown that there is sufficient planktonic food in these paddy fields that can be utilized by the fish. However, for the exploitation of these paddy - fields for aquaculture practices, depth above 15 cm has to, be maintained during the paddy growing period through regular irrigation. Fish larvae of some fishes, however, can be reared in these shallow paddy fields through regular irrigation. These may be released in these fields during seedlings transplantation and allowed to grow before drying of fields for harvesting. Young fishes, after collection, may be transferred into stocking ponds for their further growth. Some fishes like common carps, through depth management, are known to reach marketable size during this paddy growing period of three months (Nath and Dey, 1990).

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References

Adoni, A.D., 1985. Workbook on limnology. Pratibha publishers.

A.P.H.A., 1998. Standard methods for the examination of water and wastewater: 20th *Amer. Publ. Hlth. Assoc. Inc.*, Newyork.

Battish, S.K., 1992. Fresh water zooplankton;of India. Oxford and IBH Publishing CO. Pvt. Ltd., New Delhi,

Bombay.. Calcutta: 323.

Biswas, A. & Raut, S.K., 2000. Bioindicators for freshwater mussel, Lamellidens margin a lis (Lamarck) farming. Proceedings of National Seminar on Environmental Biology April 03-05, 1998. Edited by: A.K. Aditya and P.Haldar. ***Daya Publishing house***, Delhi: 38-53.

Dutta, S.P.S., 1983. On some fresh water Rhizopoda from Jammu Part-I. Jammu Univ. ***Review*** (Sciences) 1 : 91-94.

Dutta, S.P.S., Dogra, K. and Tak, A., 2002a. Qualitative and quantitative study of plankton in some paddy fields, Maralia Morh, Jammu (J&K). National Seminar on Environmental Pollution and Fishery Management. August 8-10, 2002. Organised by: School of Studies on zool ogy. Vikram University, Ujjain (M.P.) India. (Abstract No. 28).

Dutta, S.P.S., Khajuria, M., Dogra, P. and Singh, A., 2005. Ecology of zooplankton in some ground water irrigated paddy fields, Indira Nagar, Miran Sahib, Jammu. 1 5t Jammu and Kashmir State Science Congress. Feb. 7-9, 2005, University of Jammu, Jammu (Abstract No. 165).

Dutta, S.P.S., Khajuria, M., Dogra, P. and Singh, A., 2006c. Plankton ecology in two ground water irrigated paddy fields, Indira Nagar, Miran Sahib, Jammu. Env. Con. J., 7(1-2): 1-9.

Dutta, S.P.S., Kiran , K., Sharma A., Khatoon, N. and MIR, A.M., 2002b . Ecology of Plankton in some paddy fields, Miran Sahib, Jammu. (J&K). National Seminar on Recent Trends in life sciences August 26-28, 2002. Organized by: Centre of Research for Development. The University of Kashmir, Srinagar : 32 (Abstract no. 27).

Dutta, S.P.S., Kour, S. and Khajuria, V., 2006a. Plankton ecology of a paddy field, at Maralia Morh, Miran Sahib, Jammu, (communicated).

Dutta, S.P.S., Kour, S. and Sharma, V., 2006b. Quqlitative and quantitative analysis of plankton in some paddy fields at Maralia. Morh, Miran Sahib, Jammu, 2nd J&K Science Congress (2006) organized by Univ. of Kashmir, in collaboration with J&K State DST and DST GOI : 262 (Abstract no. 45).

Dutta, S.P.S., Mir, A.M., Kiran, K., Sharma, A., Khatoon, N. and Sala thia, D., 2004. Ecology of Plankton in some paddy fields of Miran Sahib, Jammu, (J&K). ***Aquacult.*** 5 (1) : 1-10.

Edmondson, W.T., 1992. Freshwater Biology. Iind Ed. Published by International Books and Periodicals Supply service 24 B/5, Deshbandu Gupta Road, karol Bagh, New Delhi 110005: 1248.

Goldman, C.R. and Horne, A.J. (1983). Limnology. Mc. Graw Hill, International Book Company, New Delhi.

Goyal, S.K. , Sharma, B.M. and Gupta, R.S., 1984. Algal flora of rice field soils of J&K state. ***Phykos*** , 23 (1&2) : 57-64 .

Indian Standard Methods, 1973. Indian standard methods for sampling and test (Physical and Chemical) for water used in industry. Manak Bhawan, 9, New Delhi.

Jhingran, V. G., 1991. Fish and Fisheries of India. Hindustan Publishing Co. New Delhi.

Kant, S., 1977. Notes on the diatoms of Jammu;1. The University Review, 6 : 6-13.

Kant, S. and Anand, V.K. (1978). New records for *Scendesmus species* from Jammu (J&K). ***Phykos***, 17 (1-2).: 81-85.

Kudo, R.R., 1986. Protozoology, Published by Books and Periodicals Corporation (India) : 1174 pp.

Nair, K.N. , Das, A.K. and Mukherjee, B.N., 1971. On some freshwater Rhizopoda and Helizoa (protozoa) from Calcutta and its environs. Part I . ***Res. Zool. Surv.,*** India, 65 (1-4) : 1-16.

Nath, P. & Dey, S.C., 1990. Fish and Fisheries of North-East India. Volume on Arunachal Pradesh Published by A. K. Choudhary, Barrackpore, West Bengal, India.

Nickolsky, G.V., 1962. The ecology of fishes. Academic Press. london and New York.

Rather, M.D. & MIR, A.M. 1987. Non-symbiotic nitrogen fixation by some BGA from paddy soil of Kashmir. ***Phykos,*** 26 : 63-66.

Reid, G.K. & WOOD, R.D., 1976. Ecology of Inland waters and estuaries. D.Van Northland Company. New Northland Company. New York: 485 PP.

Smith, G.M., 1950. The fresh water algae of United states, 2nd Edition. Mc. Graw Hill Book Co., New York: 799.

Trivedy, R.K., Goel, P.K. and Trisal, C.L., 1987. Practical methods in *Ecology and Environmental Sciences*, Published by Environmental Publication, Post Box-60, Karad - 415110, India.

Welch, P.S., 1952. Limnology. Mc. Graw Hill Book Co. Inc. New York: 539 .

Wetzel, R.G., 2000. Limnology: lake and river ecosystem, 3rd Edition. Academic Press: 1-841.

Table 1:- Mean observations of various physico-chemical characteristics of water, in four paddy fields, near Nagri bus stand, Kathua.

(6th July 2005 to 26th Sep. 2005)

	1	2	3	4	5	6	7	8	9	10	11	12
WATER PARAMETERS	**06.07.05**	**08.07.05**	**18.07.05**	**25.07.05**	**02.08.05**	**09.08.05**	**17.08.05**	**22.08.05**	**29.08.05**	**12.09.05**	**19.09.05**	**26.09.05**
Air temperature(°c)	25	28	30	34	31	29.5	27	28	29	30	30.5	29.5
Water temperature(°c)	22.17	26.55	28.2	29.22	28.75	27.42	26	23.5	25.97	25.95	25.72	25.47
Depth (cm.)	11.92	7.9	6	7.72	4.97	4.85	4.86	5.9	4.67	2.87	3.42	3.95
pH	6.69	6.38	7.71	8.18	7.43	7.39	7.69	7.99	7.67	7.66	8.06	7.52
DO(mg/l)	7.15	4.37	4.95	3.74	6.16	3.26	5.63	6.34	6.3	2.73	2.49	6.67
Free CO_2(mg/l)	11.98	7.27	12.47	4.56	16.2	6.93	12.65	9.08	17.44	14.84	11.01	8.46
CO_3^-(mg/l)	-	-	-	21.3	-	-	-	-	-	-	-	-
HCO_3^-(mg/l)	133.3	106.09	84.16	117.08	104.78	107.9	93.4	131.93	99.5	142.56	151.85	67.05
Cl^-(mg/l)	16.63	12.45	8.85	9.33	9.19	12.15	11.74	11.84	11.87	17.43	15.63	13.5
Ca^{++}(mg/l)	22.43	17.65	25.66	23.76	27.5	31.23	23.36	24.97	33.22	30.5	28.1	16.8
Mg^{++}(mg/l)	5.57	5.35	6.97	4.83	1.57	5.79	5.87	9.93	11.36	8.69	10.96	6.8
Total hardness(mg/l)	74.77	65.6	92.67	79.12	75.01	101.57	69.27	103.14	130.83	107.88	115.12	69.53
COD (mg/l)	73.73	64.24	74.52	39.8	105.4	30.94	101.66	47.52	50.83	80.77	28.92	23
SO_4^-(mg/l)	80.62	27.12	14.92	23.5	14.87	9.25	8.44	14.4	39.3	14.62	10.85	14.82
SiO_3^-(mg/l)	15.4	9.82	3.82	1.21	6.12	0.94	0.65	7.43	1.56	2.5	4.02	1.62
NO_3^-(mg/l)	0.79	1.5	0.125	1.125	2.04	0.57	1.57	0.405	0.725	2.5	0.85	1.89
Electrical conductivity(mMho/cm.)	0.104	0.203	0.131	0.152	0.129	0.122	0.09	0.158	0.189	0.292	0.256	0.146

Table 2:- Mean phytoplanktonic variations (n/l), in four paddy fields, near Nagri bus stand, Kathua.

(6th July 2005 to 26th Sep.2005)

Observations / Phytoplankton	1	2	3	4	5	6	7	8	9	10	11	12
	06.07.05	08.07.05	18.07.05	25.07.05	02.08.05	09.08.05	17.08.05	22.08.05	29.08.05	12.09.05	19.09.05	26.09.05
CHLOROPHYCEAE												
Gonium Muller	-	-	-	-	18	27	-	-	-	-	-	-
Volvox Linnaeus	-	-	-	93	27	56	56	37	75	93	18	9
Pleodorina Shaw	-	-	-	-	-	-	-	-	19	18	-	18
Pandorina Bory	-	-	-	9	-	-	37	-	9	10	-	-
Eudorina Ehren	-	-	-	9	6	-	19	9	9	18	-	22
Lepocynclis Perty	-	-	-	-	17	-	-	-	9	28	-	31
Clorococcum Fries	-	-	-	9	15	38	46	44	76	29	18	21
Dictyospherium pulchellum Wood	-	-	-	-	-	18	-	-	-	10	9	-
Closterium leibleini Kutzing	-	-	-	27	-	9	9	65	15	-	55	9
Spirotenia anglica Brebisson	-	-	-	9	-	46	19	-	-	-	-	-
Euastrum gemmatum Ehren	-	-	-	-	-	18	-	-	9	19	-	-
Pediastrum Meyer	-	-	-	-	-	-	-	9	19	19	19	4
Cosmarium Corda	-	-	-	119	67	-	36	37	28	-	53	38
C.pachydermum West	-	-	-	-	-	-	19	9	-	-	-	-
C.pseudobroomei Wolle	-	-	-	-	15	-	-	-	-	-	-	-
C.monomazum Lundell	-	-	-	18	9	-	-	18	-	-	18	-
C.granatum Brebisson	-	-	-	-	18	-	-	9	-	-	-	-
Total *Cosmarium*	-	-	-	**137**	**109**	-	**55**	**73**	**28**	-	71	**38**
Spirogyra Link	-	-	18	458	9	129	94	219	268	104	27	19
Zygote	-	-	-	-	-	9	9	9	-	-	-	-
Total Cholorophyceae	-	-	**18**	**751**	**201**	**350**	**344**	**465**	**530**	**348**	**217**	**171**
BACILLARIOPHYCEAE												
Caloneis Bory	-	-	-	-	9	-	9	-	9	10	19	9
Gyrosigma (Grun.)	-	-	-	-	8	-	47	36	28	9	-	-
Cymbella (Hemp. & Ehren)	-	-	-	28	-	-	28	18	-	10	-	13
Fragillaria Desmazieres	-	-	-	-	38	9	18	54	9	9	-	-
Surirella Turpin	-	-	-	-	17	-	-	28	19	10	-	-

Observations / Phytoplankton	1	2	3	4	5	6	7	8	9	10	11	12
	06.07.05	08.07.05	18.07.05	25.07.05	02.08.05	09.08.05	17.08.05	22.08.05	29.08.05	12.09.05	19.09.05	26.09.05
Navicula Kutz	-	-	-	74	159	111	84	531	233	114	63	49
Nitzschia Nitzsch	-	-	-	-	-	18	-	-	9	18	-	-
Pinnularia Ehren	-	-	-	9	-	-	-	-	19	-	9	9
Mastogloea Thwaites	-	-	-	-	-	9	37	37	-	19	9	-
Total Bacillariophyceae	-	-	-	111	231	147	223	704	326	199	100	80
CYANOPHYCEAE												
Oscillatoria Vaucher	-	-	-	18	34	18	102	436	187	116	73	4
Spirulina Turpin	-	-	-	28	-	27	28	-	-	29	-	13
Anabaena Bory	-	-	-	-	9	18	-	-	-	47	-	22
Microcystis Kutzing	-	-	-	-	6	-	-	-	28	-	-	4
Anacystis Meneghini	-	-	-	-	-	-	9	-	-	-	-	-
Nostoc Vaucher	-	-	-	18	-	54	-	45	9	-	28	9
Total Cyanophyceae	-	-	-	64	49	117	139	481	224	192	101	52
TOTAL PHYTOPLANKTON	-	-	18	926	481	614	706	1650	1080	739	418	303

Table 3:- Mean zooplanktonic variations (n/l), in four paddy fields, near Nagri bus stand, Kathua.
(6th July 2005 to 26th Sep. 2005)

Observations / Zooplankton	1	2	3	4	5	6	7	8	9	10	11	12
	06.07.05	08.07.05	18.07.05	25.07.05	02.08.05	09.08.05	17.08.05	22.08.05	29.08.05	12.09.05	19.09.05	26.09.05
PHYLUM-PROTOZOA												
CLASS-SARCODINA												
SUBCLASS-RHIZOPODA												
Order-Testacida												
Difflugia lebes Penard	-	38	9	55	94	37	65	129	66	66	63	63
D.urceolata Carter	-	-	-	-	-	-	-	-	-	10	-	-
D.pyriformis Perty	-	-	9	18	-	28	-	-	28	29	-	-
D.tuberculata Wallich	-	-	-	-	9	9	-	-	-	19	-	-
D.rubescens Penard	-	-	-	-	9	27	-	-	9	9	-	-
D.acuminata Ehren.	-	-	-	-	18	-	9	-	9	-	-	9
D.corona Wallich	-	-	-	9	-	-	9	-	18	-	-	-
D.oblonga Ehren.	-	-	9	-	-	-	46	27	28	10	9	8
D.lobostoma Leidy	-	-	-	-	-	-	-	-	-	-	9	9
Total *Difflugia*	**-**	**38**	**27**	**82**	**130**	**101**	**129**	**156**	**158**	**133**	**91**	**89**
Centropyxis aculeata (Ehren.)	-	-	-	-	27	-	-	-	19	18	-	-
C.arcelloides Penard	-	-	-	18	-	-	18	9	-	-	-	-
C.constricta (Ehren.)	-	9	-	-	9	18	19	19	9	-	9	8
C.ecornis (Ehren.)	9	-	9	9	32	-	-	18	18	-	-	8
C.aerophila Deflandu	-	-	-	-	-	27	-	-	19	9	9	8
C.stellata Wailes	-	-	-	-	-	-	-	-	-	9	-	9
Total *Centropyxis*	**-**	**9**	**9**	**27**	**68**	**45**	**37**	**46**	**65**	**36**	**18**	**33**
Arcella discoides Ehren.	-	-	-	-	-	9	18	37	19	9	9	21
A.vulgaris Ehren.	28	9	9	-	37	9	18	56	38	37	18	-
A.polypora Penard	-	9	-	-	-	19	-	-	-	-	10	9
A.dentata Ehren.	-	-	-	-	-	-	9	-	-	-	9	4
A.megastoma Penard	-	-	-	-	-	9	-	-	9	-	9	-
Total *Arcella*	28	18	9	-	37	46	45	93	66	46	55	34
Cucurbitella Penard	-	-	9	-	-	9	-	-	9	10	-	-
Lesquaresia modesta Rhumbler	-	-	-	-	35	18	19	9	19	-	9	8
L.spiralis Ehren.	-	-	-	-	-	9	9	-	28	-	-	4

Observations / Zooplankton	1	2	3	4	5	6	7	8	9	10	11	12
	06.07.05	08.07.05	18.07.05	25.07.05	02.08.05	09.08.05	17.08.05	22.08.05	29.08.05	12.09.05	19.09.05	26.09.05
Total *Lesuqueresia*	-	-	-	-	35	27	28	9	47	-	9	12
Nebela Leidy	-	-	-	-	15	-	19	32	-	-	19	37
TOTAL-SARCODINA	37	65	54	109	285	228	258	336	345	225	192	205
CLASS-CILIATA												
Chilodonella (Ehren.)	-	-	-	-	-	-	19	19	-	9	9	9
Paramecium Ehren.	-	-	-	66	-	-	-	54	-	-	19	9
TOTAL CILIATA	-	-	-	66	-	-	19	73	-	9	28	18
CLASS-MASTIGOPHORA												
Order-Euglenoidida												
Euglena acus (Ehren.)	-	-	-	-	9	19	129	-	9	37	9	-
E.gracilis Klebs	-	-	-	9	-	-	-	18	9	-	-	8
E.viridis Ehren.	-	-	-	46	30	36	28	38	47	9	63	-
E.spirogyra (Ehren.)	-	-	-	-	-	9	-	9	-	-	-	-
Total *Euglena*	-	-	-	55	39	64	157	65	65	46	72	8
Phacus Dujardin	-	-	-	9	-	-	9	18	-	29	-	8
TOTAL MASTIGOPHORA	-	-	-	64	39	64	166	83	65	75	72	16
TOTAL PROTOZOA	37	65	54	239	324	292	443	492	410	309	292	239
PHYLUM-ROTIFERA												
CLASS-MONOGONONTA												
Order-Ploima												
Lecane luna Muller	-	-	-	-	-	-	28	18	-	-	-	31
Lepadella ovalis Muller	-	-	-	-	18	-	-	-	9	-	-	-
Monostyla bulla Ehren	-	-	-	9	-	9	-	18	-	-	9	-
Platyias platulus Harring	-	-	-	66	-	9	9	-	-	-	9	-
Colurella Bory	-	-	-	-	9	9	-	-	19	-	-	9
Brachionus quadridentata Pallas	-	-	-	9	9	-	-	-	-	10	-	-
B.bidentata Pallas	-	-	-	9	-	-	28	-	-	-	-	-
Total *Brachionus*	-	-	-	18	9	-	28	-	-	10	-	-
Asplanchna priodonta Gosse	-	-	-	-	-	-	-	19	19	9	27	18
Total Ploima	-	-	-	93	36	27	65	55	47	19	45	58
Order-Bdelloida												
Philodina roseola Ehren.	-	-	-	9	-	18	-	-	-	-	9	-

TOTAL ROTIFERA	-	-	-	102	36	45	65	55	47	19	54	58
Observations / Zooplankton	1	2	3	4	5	6	7	8	9	10	11	12
	06.07.05	08.07.05	18.07.05	25.07.05	02.08.05	09.08.05	17.08.05	22.08.05	29.08.05	12.09.05	19.09.05	26.09.05
PHYLUM-ARTHROPODA												
CLASS-CRUSTACEA												
Order-Copepoda												
Cyclops Muller	-	-	-	-	-	-	19	-	-	9	-	-
Mesocyclops hyalinus Rehberg	-	-	-	-	-	-	-	-	37	19	-	-
Nauplius larva	-	-	-	9	16	-	18	27	27	133	45	8
Metanauplius larva	-	-	-	9	15	-	-	-	9	29	-	9
Total Copepoda	-	-	-	18	31	-	37	27	73	190	45	17
Order-Cladocera												
Alona Sars	-	-	-	-	-	-	-	-	-	-	9	-
Alonella Sars	-	-	-	-	-	29	-	-	-	-	18	-
Moina Baird	-	-	-	9	26	-	-	-	-	-	-	-
Ceriodaphnia Dana	-	-	-	9	7	9	9	-	-	-	9	-
Daphnia Claus	-	-	-	9	-	-	-	-	-	9	-	-
Total Cladocera	-	-	-	27	33	38	9	-	-	9	36	-
Order-Ostracoda												
Cypris Muller	-	-	-	-	-	-	9	9	-	19	18	-
Total Crustacea	-	-	-	45	64	38	55	36	73	218	99	17
CLASS-INSECTA												
Order-Diptera												
Chironomous larva Meigen	-	-	-	-	-	-	9	-	19	-	-	18
TOTAL ARTHROPODA	-	-	-	45	64	38	64	36	92	218	99	35
PHYLUM-ANNELIDA												
CLASS-OLIGOCHAETA												
Nais Muller	-	-	-	-	-	-	-	-	-	-	-	9
PHYLUM-NEMATODA	-	-	-	-	-	9	-	92	47	-	19	-
Eggs	-	-	-	-	-	-	28	9	-	19	18	-
TOTAL ZOOPLANKTON	37	65	54	386	424	384	600	684	596	565	482	341

Table No.:- 4 Co-efficient of correlation (r) between phytoplankton and physico-chemical parameters of water in four paddy fields, near Nagri bus stand, Kathua.

Water paramters → / Phyto-planktonic Groups ↓	Water Temperature	Depth	pH	DO	Free CO_2	HCO_3^-	Cl^-	Ca^{++}	Mg^{++}	Total Hardness	COD	SO_4^{--}	SiO_3^{--}	NO_3^-	Electrical Conductivity
Chlorophyceae	0.017	0.46	0.492	-0.08	-0.3	0.304	-0.075	0.181	0.11	0.172	-0.22	0.506	-0.25	-0.04	0.056
Bacillariophyceae	-0.59	0.24	0.191	0.456	0.16	0.215	-0.164	0.129	0.33	0.283	0.142	0.14	0.66	-0.41	-0.086
Cyanophyceae	-0.73	0.1	0.281	0.245	0.08	0.35	0.109	0.191	0.33	0.453	-0.02	0.119	0.52	-0.46	0.125
TOTAL PHYTOPLANKTON	**-0.5**	**0.26**	**0.387**	**0.205**	**-0.1**	**0.406**	0.048	**0.205**	**0.35**	**0.327**	**-0.1**	**0.337**	**0.26**	**-0.15**	**0.081**

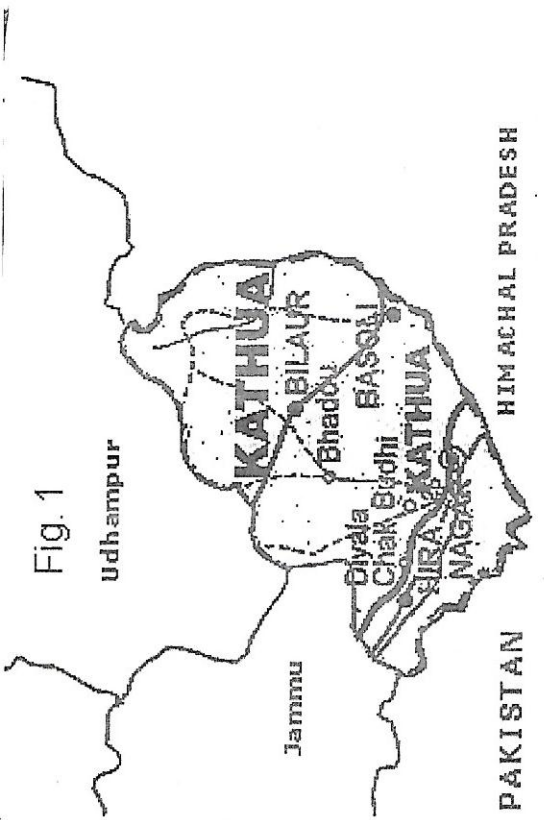
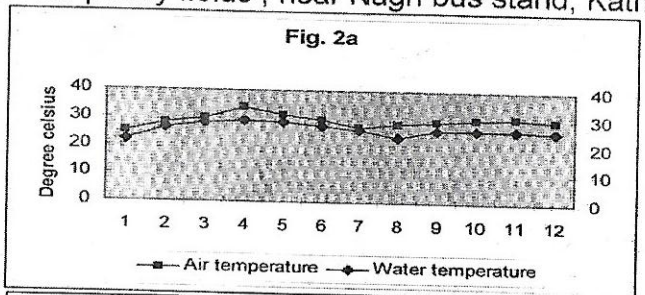
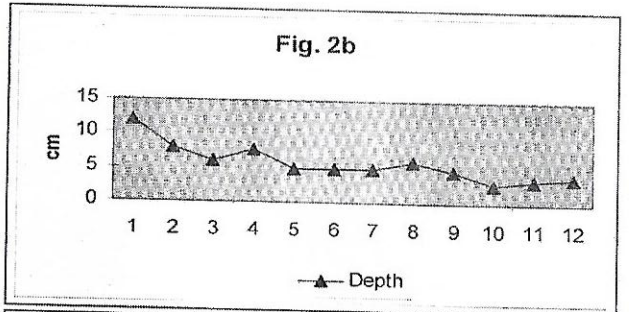
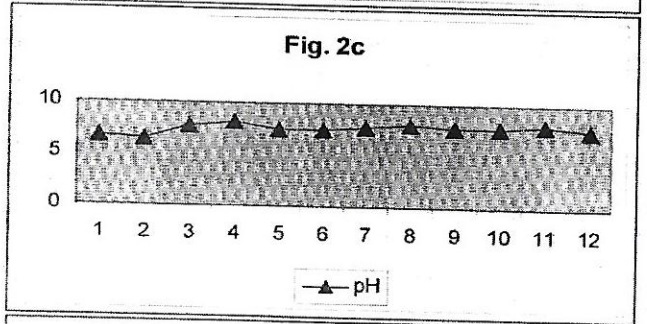

Udhampur
KATHUA
BILAUR
Bhadoli
BASOLI
Diyala
Chak Bidhi
KATHUA
JIRA
NAGAR
Jammu
HIMACHAL PRADESH
PAKISTAN

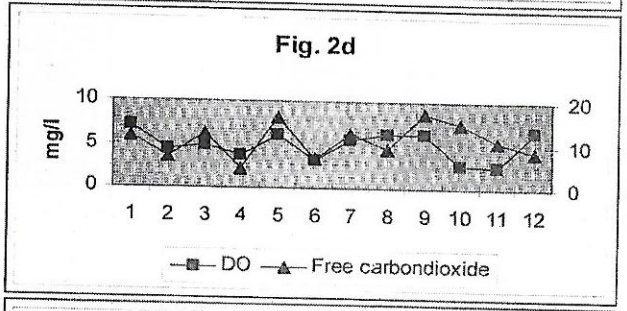
Fig. 1

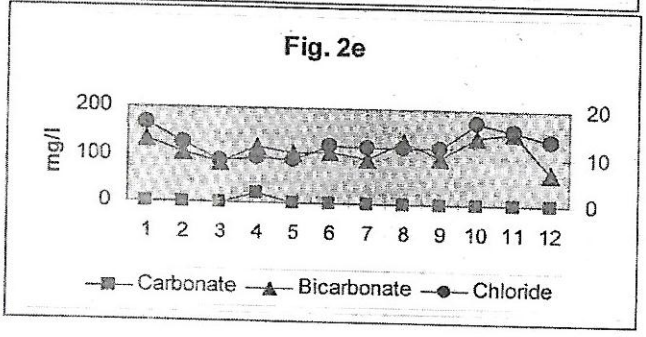
Figs. 2a to 2h showing mean graphical variations in various physico- chemical paramters of water, in four paddy fields , near Nagri bus stand, Kathua.

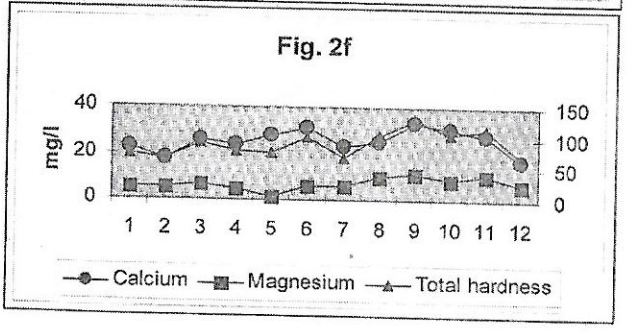












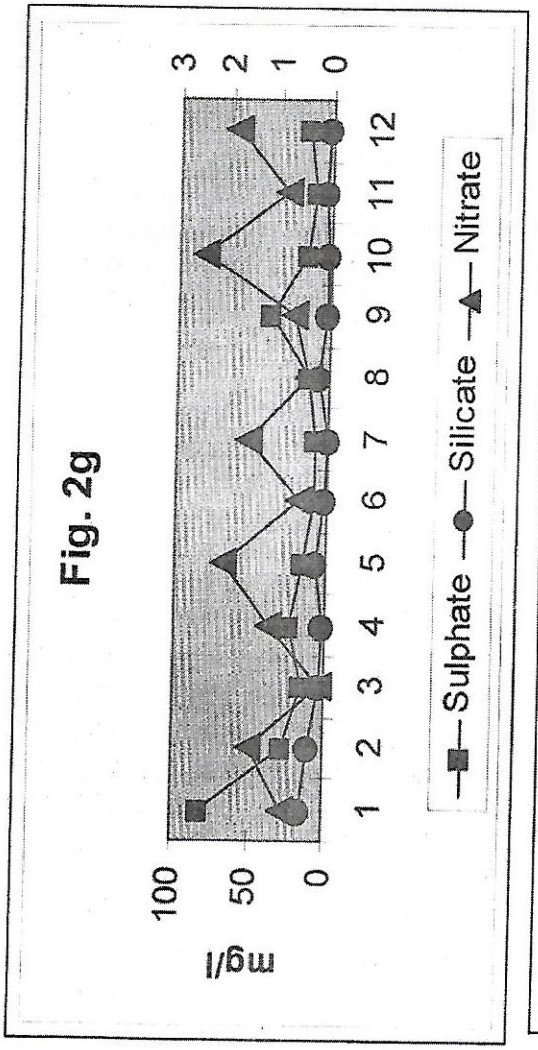


Fig. 2g
mg/l
100
50
0
3
2
1
0
1 2 3 4 5 6 7 8 9 10 11 12
Sulphate
Silicate
Nitrate

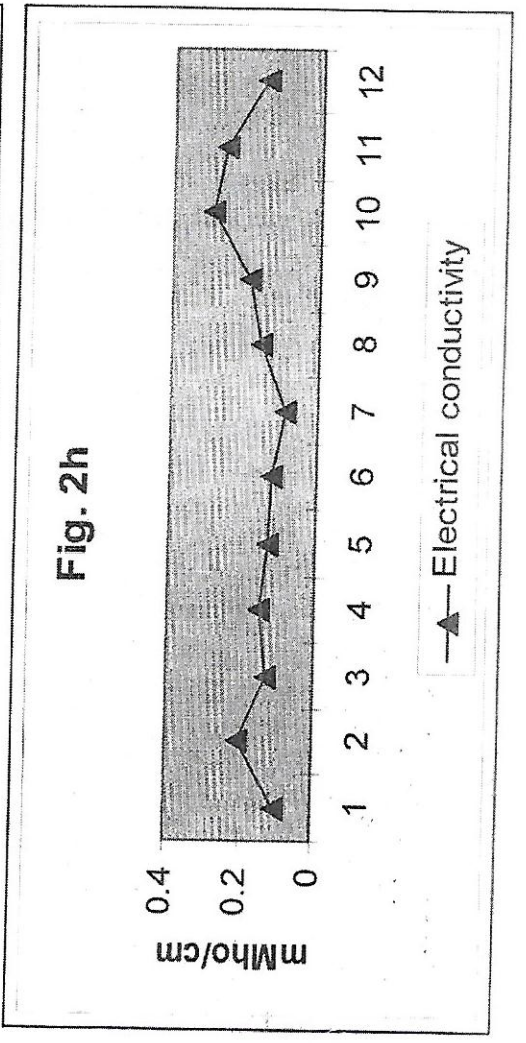
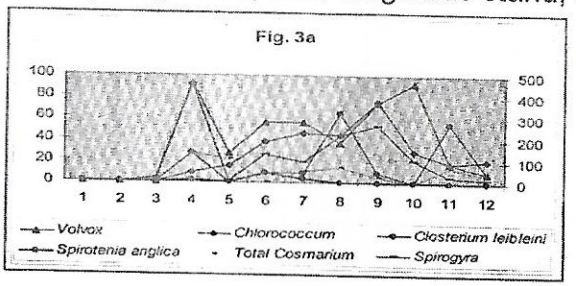
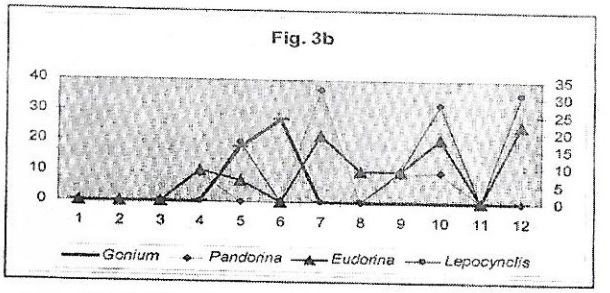
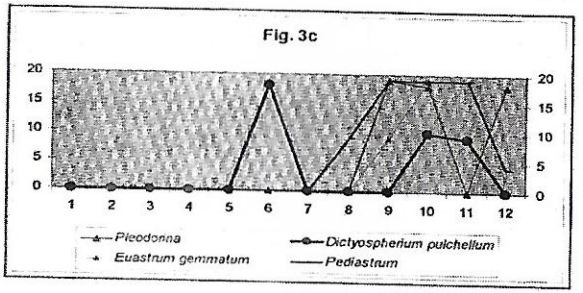


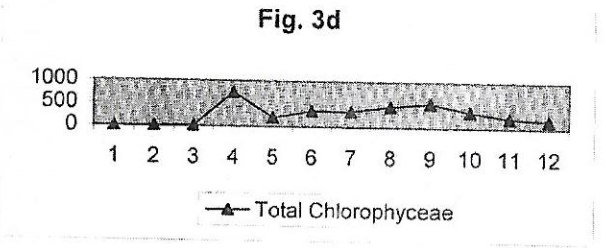
Fig. 2h
mMho/cm
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12
Electrical conductivity

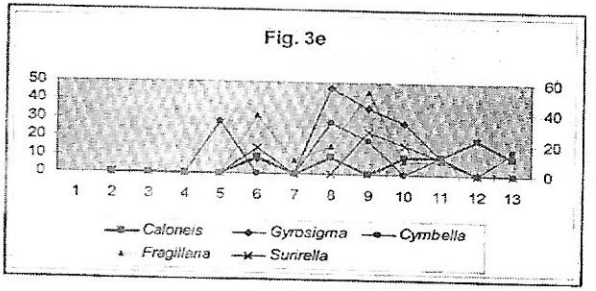
Figs. 3a to 3i and 4m showing mean graphical variations of various phytoplanktonic genera in four paddy fields, near Nagri bus stand, Kathua.

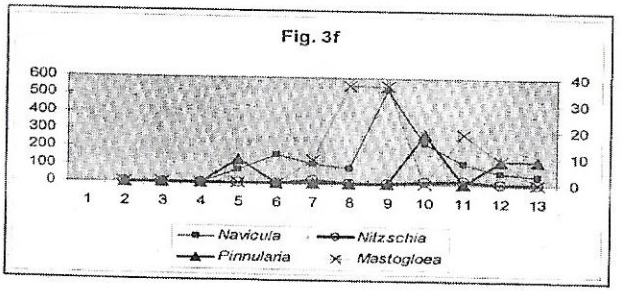












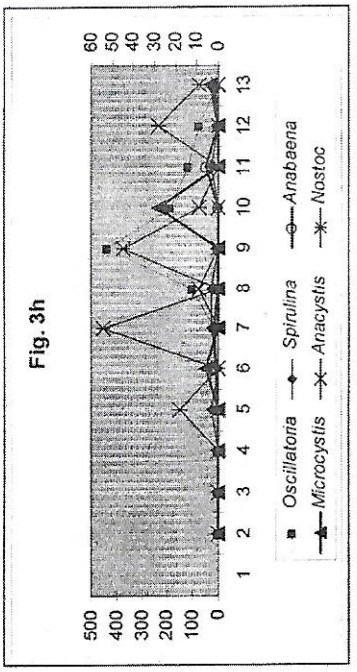


Fig. 3h
500
400
300
200
100
0
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13
Oscillatoria
Spirulina
Anabaena
Microcystis
Anacystis
Nostoc

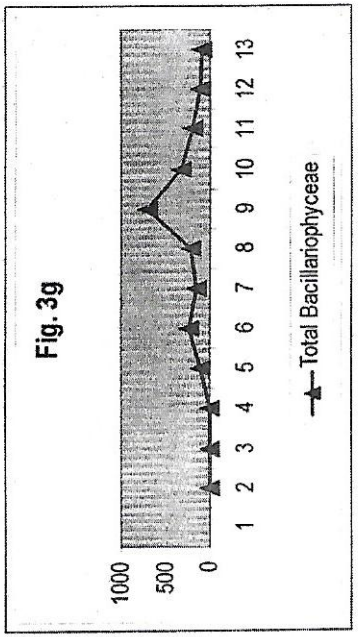


Fig. 3g
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13
Total Bacillariophyceae

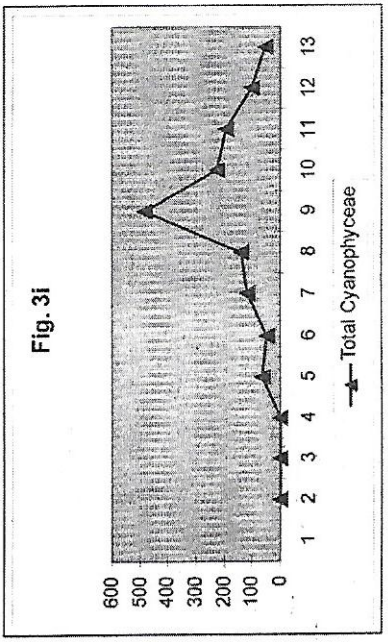
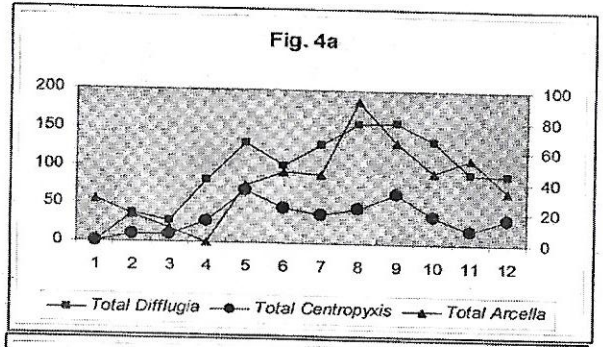
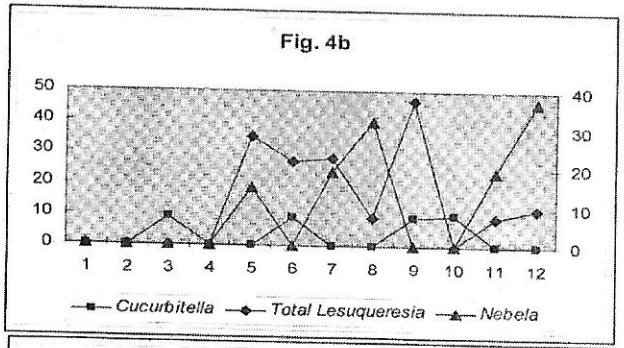
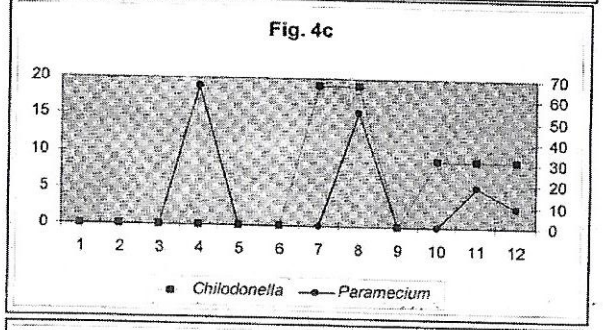


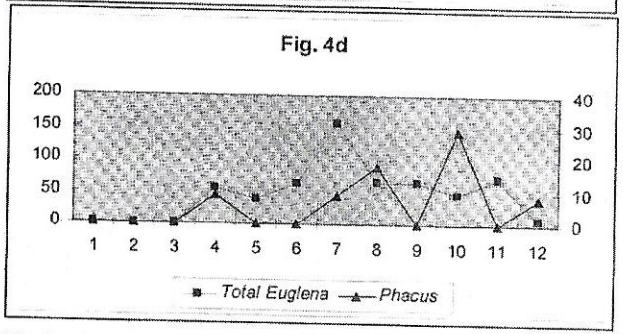
Fig. 3i
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13
Total Cyanophyceae

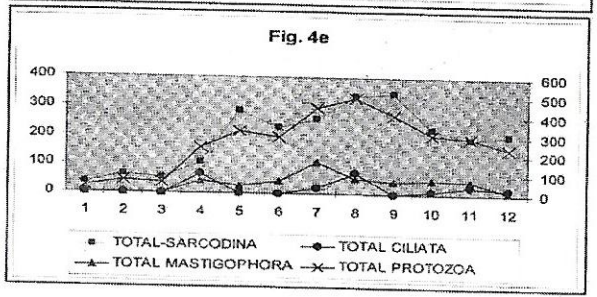
Figs. 4a to 4m showing mean graphical variations of various zooplanktonic genera in four paddy fields, near Nagri bus stand, Kathua.

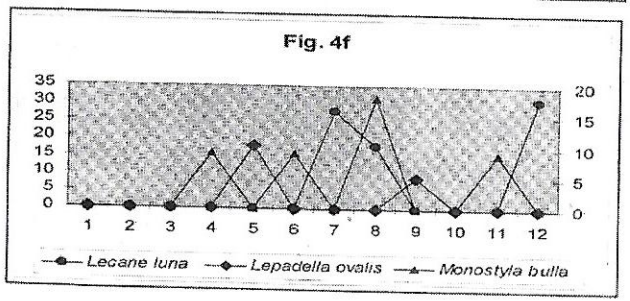












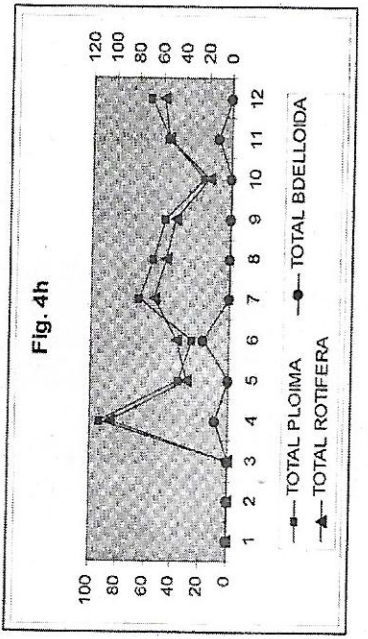


Fig. 4h
TOTAL PLOIMA
TOTAL BDELLOIDA
TOTAL ROTIFERA

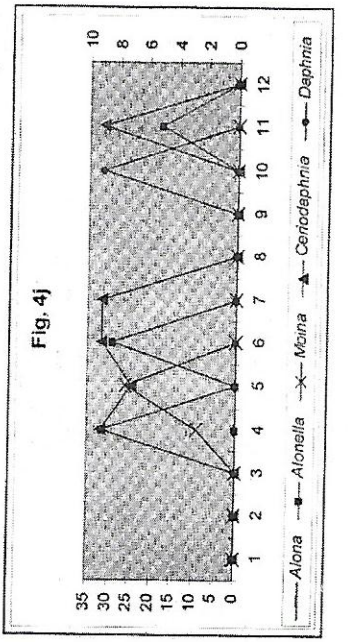


Fig. 4j
Alona
Alonella
Moina
Ceriodaphnia
Daphnia

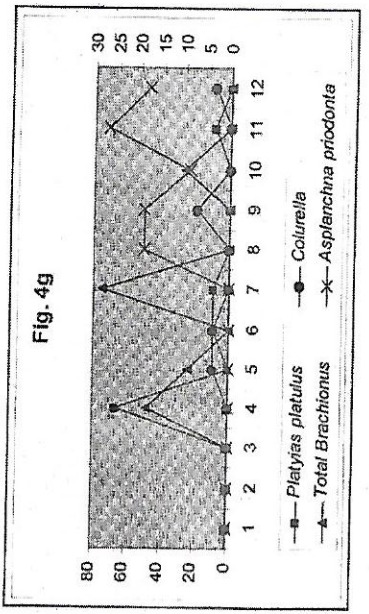


Fig. 4g
Platyias platulus
Colurella
Total Brachionus
Asplanchna priodonta

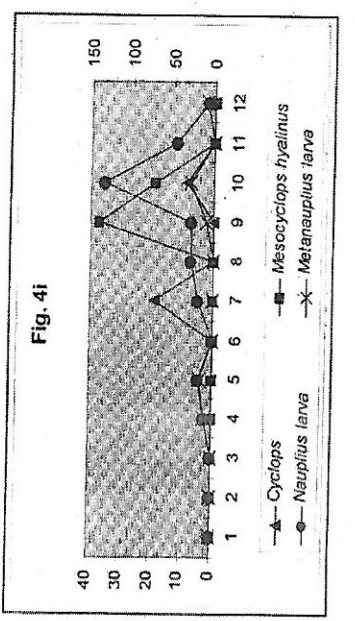


Fig. 4i
Cyclops
Mesocyclops hyalinus
Nauplius larva
Metanauplius larva

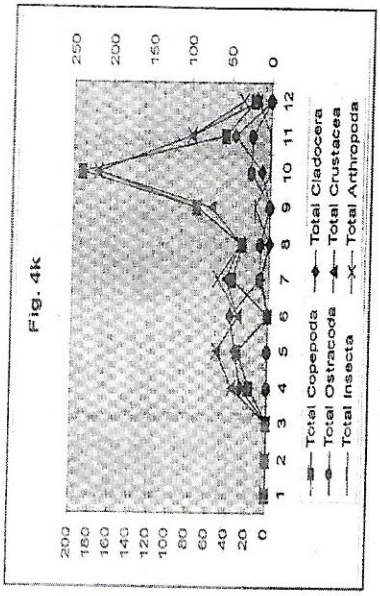


Fig. 4k
Total Copepoda
Total Cladocera
Total Ostracoda
Total Crustacea
Total Insecta
Total Arthropoda

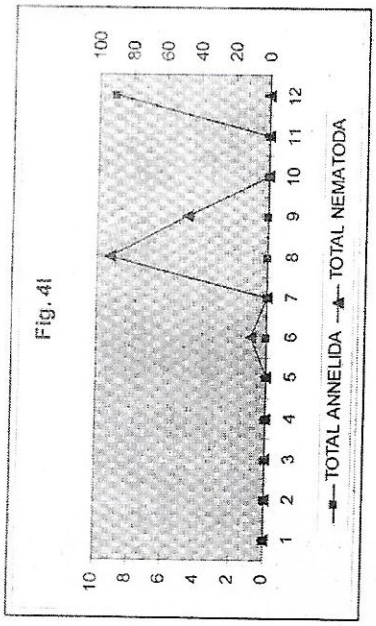


Fig. 4l
TOTAL ANNELIDA
TOTAL NEMATODA

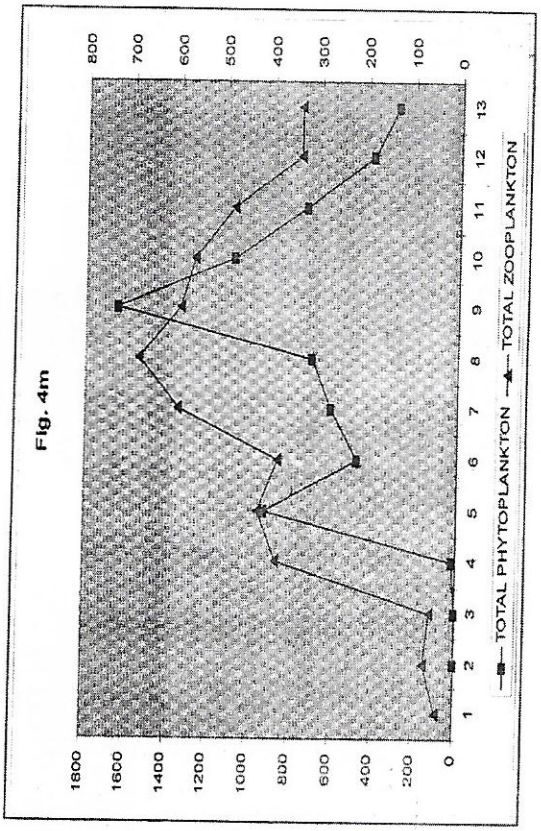


Fig. 4m
TOTAL PHYTOPLANKTON
TOTAL ZOOPLANKTON