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A LIMNOLOGICAL STUDY OF LOTIC WATER IN SRI GANGANAGAR DISTRICT OF NORTH RAJASTHAN

Dr Rajender Kumar Bishnoi and Dr. Indira Saharan

Dept. of Zoology Govt. Girls College Sri Ganganagar Rajasthan

Key words: lotic water, limnological, gang canal, physico-chemical

ABSTRACT

The present investigation deals with the limnological studies in a stretch of about 15 kilometers of Gang Canal near the town of Sri Ganganagar (Rajasthan, India), for its possible uses in irrigation, aquaculture (e.g.Cage culture) and domestic and drinking purposes. The study was conducted for a period of 14th Month from August 1990 to September 1991. The limnological characteristics viz., water temperature, speed of water current, transparency, pH, dissolved oxygen, free carbon dioxide, phenolphthalein and total alkalinity, TDS, NO3, orthophosphate and silicates were determined in surface water from four sampling stations in Gang Canal. In the present investigation pH was always neutral to slightly alkaline which is a general characteristic of any flowing water. The average total alkalinity was 82.2 mg/litre which shows that canal carries hard water. Carbonate alkalinity was always present though in small quantity (10 to 22 mg /litre). The absences of carbon dioxide could be attributed to the prevailing carbonate alkalinity. The nutrient load in the canal was low (phosphate 0.007-0.2mg/l and nitrate 0.02- 0.36 mg/l). The overall limnological features of Gang Canal show that the canal water would be useful for irrigation and even as a source of drinking and domestic water.

Introduction:

Limnochemistry is one of the most important aspect of the science of limnology because it gives the direct assessment of the polluted and unpolluted water. The limnochemistry of lacustrine waters is considerably different than that of lotic waters. The limnochemistry of lotic water is more dynamic as the water picks up part of earth during the flow and by erosion and leaching partially dissolves the same for its components. These components such as carbonates, bicarbonates, phosphates, silicates etc. are the same in any waters but in a lotic system their concentration are more variable due to changes in flow and other seasonal effects Our knowledge of canal and river. dynamics and ecological relationship is not as extensive as that of ponds and lakes Studies on man made irrigation canals should form a very interesting piece of research. However, this area appears almost totally neglected Only work in India available on man made canal is by Vashisht and Jindal (1980) and Jindal and Vashist(1981) on pucka stream in Patiala (Punjab) and tributaries of Sirhind canal at Sangrur again in Punjab, The notable contribution in the field of lotic system are by Palaria1983, Aggarwal1986, Rana and Palaria1988.

Material and Methods:

The material for the present investigation were collected from the Gang canal, located in the district Ganganagar in the desert north-western part of the state of Rajasthan. The canal system is brought to this region from the river Sutlej(Punjab). The Gang canal was built in 1927 and flows almost throughout the year. Water samples were collected in plastic bottles from 4 permanent stations within about 15 Km.stretch of Gang canal. . These stations were located at a distance of about 4 or 5 km from one another. Owing to the shallowness of the canal (7 ft) and good mixing of water, only the surface samples were collected. It was felt that this would give the representative picture of the entire water column because of the mixing noticed in the canal.

The physical characteristics noted were the velocity of the water current, temperature and depth of visibility. The chemical factors determined in the field were pl, dissolved oxygen, free Co. and Total alkalinity. For further analysis, the samples were fixed with a few drops of Toluene. These samples were subsequently used for the estimation of silicate, nitrate, orthophosphate and total dissolved solids. Standard methods of APHA (1905), Trivedi and Goel (1984). Adoni (1985) were followed.

Result and Discussion:

The physico-chemical characters of present investigation are shown in table number 1 to 4.

The chemical nature of running water varies from region to region and in these variations there is always a reflection of the local geography and climate. The ability to dissolve minerals from the drainage basin will alco differ with the mineral content of the area as the latter have differential solubility. Further, the biota of the waters also exerts selective effects on many dissolved substances. In majority of flowing waters, the turbulent mixing ensures a uniform distribution of dissolved substances except within pools and deep places. In such cases, there are distributional differences in dissolved substances which are called lateral differences. Such lateral differences are also caused by the entry of tributaries in a flowing system. In such cases, the lateral differences persist for a long distance as the in flowing waters from tributaries tend to follow the banks of the river in which it has entered.

Current is the principal characteristic of a lotic system. Even the slight changes in the flow-rate of a current have important effects on biotic life. The velocity of current of a water body generally depends upon the amount of water available and on its depth. In the present investigation, the velocity of water current was found maximum in November 90 at station 1, when the amount of water was the highest. At station 1, the depth of canal was also high. In the canal the velocity of water current has direct relationship with the amount of water available.

The temperature in aquatic ecosystem is considered as one of the major factors in determining the various chemical, biochemical and biological activities. The biological activity is enhanced by higher temperature up to 60°C. In the present investigation, the temperature of the canal water was under direct influence of the air temperature and varied with climate and season. This supports the statement of Welch (1952) that the thermal characteristics of small stream follow the air temperature much closer than those of a large river. The water temperature was high during summer and early monsoon. The low temperatures appeared in the winter months. There was no difference in surface and bottom water temperature due to efficient mixing of water and shallow depth (7 ft.) of the canal. The turbidity in running water mainly occurs due to all detritus and other non-living materials. In the present investigation, sediments (sand, silt and clay) had an important role in governing the turbidity, which enters the canal water through land erosion and scouring of the canal. In the Gang canal, the magnitude of turbidity was found highest in monsoon and early months of winter due to higher velocity of water current which caused land erosion. The turbidity was lowest in the late winter and summer months when the velocity of water was low.

In the present investigation, pH was always neutral to alkaline which is a general characteristic of any flowing water. During summer, pH was found higher due to higher photosynthetic activity. The low value was in monsoon due to low photosynthetic activity caused by high turbidity. Absence of free Co_2 further favours the neutral pH of the water. In Gang canal, the pH showed a direct relationship with alkalinity.

Dissolved oxygen is the most important chemical component influencing the aquatic life processes. In a healthy stream, the level of oxygen is generally close to saturation (7-9 mg/1). In the present investigation, the DO content ranged from 4.8 to 7.6 mg/1. It was found lower during monsoon due to low photosynthetic activity and high concentration of sediment yield thereby producing higher turbidity. The dissolved oxygen was the highest during February and March due to the low concentration of sediments and higher density of phytoplankton which increased the photosynthetic activity.

Sreenivasan and Sunder Raj (1967) reported a total lack of free carbon dioxide in the river Cauvery which is reconfirmed by the present investigation. This was due to the absence of macrophytes and decomposed organic matter. The absence of carbondioxide could be attributed to the prevail- ing carbonate alkalinity. The alkalinity of water is its capacity to neutralize a strong acid and is characterised by the presence of all hydroxyl ions capable of combining with hydrogen ion. Shah (1988) recorded alkalinity ranging from 76.9 to 237.2 ppm in river Jhelum. The total alkalinity of the Gang canal water varied from 66 to 98.0 mg/l with its peak in summer.

In the present investigation, the carbonate alkalinity ranged between 10 to 22 mg/l. In general, where free carbondioxide is totally absent the carbonates are always present.

Total dissolved solids (T.D.S.) are composed mainly of carbonates, bicarbonates, chlorides, sulphates, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese. In the present investigation. the total dissolved solids content varied from 110 to 216 mg/1. The peak was in monsoon due to the high sediment yield and the salts derived from the rainfall and surrounding runoff besides those coming from the upper reaches. Minimum T.D.S. was found in summer. Total dissolved solids have Inverse relationship with transparency i.e. peak of T.D.S. follows low transparency.

Nutrients i.e. nitrates and phosphates are the ions needed for plant growth. The main source of nitrates and phosphates in streams are rainfall and the land drainage. The nutrients enter streams primarily in particulate form and is then released fairly slowly. The high concentration of nitrate and phosphates in flowing waters are, therefore, indicative of pollution. In the present studies, the Gang canal flowing through the agricultural fields of Punjab and north Rajasthan picks up nutrients but at least in the canal stretch investigated, there are no rooted plants to remove the nutrients. In spite of this the nutrient load in Gang canal is probably low. In the present investigation. the phosphate content varied from 0.007 to 0.3 mg/l. The maximum values were recorded in monsoon due to higher silt content. The low density of phytoplankton in monsoon also supports this. The phosphate content has Inverse relationship with phytoplankton yield. The low values were in late winter month of February and early summer months (March, April) when the sediment content was also low. The high plankton density in these months indicates its inverse relationship with phosphate. The phosphate content, however, increased in down- stream. The low orthophosphates in the Gang canal could be favourably compared with a similar situation in the river Jhelum (Shyamsunder, 1988) and in Sirhind canal in Punjab (Jindal and Vasisht, 1981). Probably, the 5 Himalayan rivers flowing through Punjab are poor in nutrients and this is well reflected in the Gang canal arising from an impoundment on the river Sutlej.

In the present investigation, the maximum nitrate was found in summer and low in monsoon and winter. The reasons for this anomaly are difficult to explain. However, this could depend on the release of water from the Harike Barrage in Punjab. Nitrates showed a direct relationship with phytoplankton.

Silicates are less soluble constituent of river but its lower concentration is always present in the natural waters. The major source of dissolved silica in river is the weathering of rocks and minerals in the catchment area. In the present investigation the silicate content varied between 0.7 - 3.25 mg/l. The highest values were observed in monsoon and early winter months. This is due to the high sediment yield. The original source of silica here is from the river Sutlaj which arises from Himalayan ranges. Silica coming in from local runoff is unlikely in canal waters.

The overall limnological features of Gang Canal show that the canal water would be useful for irrigation and even as a source of drinking and domestic water.

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Table - 1 Physio-chemical characterization at station 1 in the Gang canal during 1990-91

		August	September	October	November	December	January	February	March	April	May	June	July	August	September
1	Speed of water current (m/sec)	0.94	0.98	0.97	0.99	0.82	0.79	0.9	0.8	0.88	0.81	0.83	0.91	0.92	0.97
2	Water temperature	27	26.4	25.3	23	20	14.1	16.6	21.8	25.8	27.1	28.8	27.2	27	25.8
3	pH	6.92	7.22	7.34	7.38	7.46	7.4	7.62	7.96	7.86	7.64	7.82	7.42	7.26	7.22
4	Transparency (cm)	6	7.5	10	23	22	28	31	35	31	29	30	24	12	9
5	Dissolved oxygen (mg/l)	5.2	4.8	5.2	6	5.6	6.4	7.6	7.2	7	6.8	7	5.6	5.2	6
6	Free CO2 (mg/L)	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab
7	Phenolphthalein alkalinity (mg/L)	6	5.8	7	8.4	11	9	10	6	8	6	6	8	7	5
8	Total alkalinity (mg/L	66	74	70	70	86	94	88	84	86	98	84	72	72	78
9	T.D.S. (mg/l)	186	216	188	176	160	148	170	178	160	120	138	152	146	158
10	Nitrate nitrogen (mg/l)	0.02	0.03	0.05	0.07	0.08	0.07	0.06	0.1	0.27	0.36	0.22	0.1	0.095	0.08
11	Orthophosphate (mg/l)	0.187	0.103	0.064	0.058	0.043	0.028	0.019	0.013	0.007	0.058	0.028	0.043	0.064	0.076
12	Silicates (mg/l)	3.25	2.65	2.65	2.2	2.1	1.8	1.1	1.2	1.1	1.2	0.7	0.9	2	2.65

Table - 2 Physio-chemical characterization at station 2 in the Gang canal during 1990-91

		August	September	October	November	December	January	February	March	April	May	June	July	August	September
1	Speed of water current (m/sec)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2	Water temperature	27	26.4	25.6	22.8	19.8	14	16.4	21.8	26	27.4	28.8	27	27	25.4
3	pH	6.94	7.16	7.38	7.42	7.52	7.32	7.76	7.96	7.78	7.66	7.84	7.48	7.24	7.28
4	Transparency (cm)	6	7.5	16	23	22	28	31	35	31	29	30	24	12	9
5	Dissolved oxygen (mg/l)	5.4	4.8	5	6	5.6	6.4	7.6	7	6.8	6.8	7.2	5.6	5.2	5.4
6	Free CO2 (mg/L)	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab
7	Phenolphthalein alkalinity (mg/L)	6	6	8	8	11	9	9	6	8	6	7	8	7	5
8	Total alkalinity (mg/L)	64	74	72	70	86	94	84	88	86	96	84	72	78	74
9	T.D.S. (mg/l)	178	210	182	168	164	148	172	180	168	118	134	148	132	150
10	Nitrate nitrogen (mg/l)	0.025	0.03	0.045	0.07	0.08	0.06	0.08	0.105	0.26	0.32	0.25	0.1	0.08	0.08
11	Orthophosphate (mg/l)	0.157	0.097	0.058	0.055	0.049	0.028	0.022	0.013	0.013	0.055	0.028	0.049	0.061	0.06
12	Silicates (mg/l)	3.25	2.3	2.3	1.95	2	1.8	1.1	1.2	1	1.1	0.75	0.85	1.95	2.3

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Table - 3 Physio-chemical characterisation at station 3 in the Gang canal during 1990-91

		August	September	October	November	December	January	February	March	April	May	June	July	August	September
1	Speed of water current (m/sec)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
2	Water temperature	27	26.8	25.6	23	19.8	14	16.2	21.4	26	27	28.6	27	26.6	25.6
3	pH	6.98	6.98	7.26	7.44	7.54	7.48	7.8	7.96	7.86	7.6	7.76	7.38	7.28	7.24
4	Transparency (cm)	6	8.5	17	23	22.5	28	30	34	32	29	28	24.5	12	8
5	Dissolved oxygen (mg/l)	5.2	5	5	5.8	5.4	6.2	7.2	7.4	6.8	7	7.2	5.6	5.2	5.8
6	Free CO2 (mg/L)	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab
7	Phenolphthalein alkalinity (mg/L)	7	6.4	7.6	8.8	10.4	8	9	6	7	6	7	8	7	5
8	Total alkalinity (mg/L)	64	74	72	72	82	92	86	86	84	94	88	74	76	80
9	T.D.S. (mg/l)	186	212	186	158	172	156	168	166	156	110	146	154	146	158
10	Nitrate nitrogen (mg/l)	0.025	0.035	0.045	0.08	0.08	0.06	0.08	0.1	0.26	0.325	0.215	0.09	0.09	0.06
11	Orthophosphate (mg/l)	0.196	0.1	0.07	0.061	0.046	0.043	0.022	0.022	0.007	0.061	0.025	0.043	0.061	0.067
12	Silicates (mg/l)	3.25	2.3	2.3	2	1.9	1.75	1.15	1.15	1	1.1	0.75	0.8	2	2.3

Table - 4 Physio-chemical characterisation at station 4 in the Gang canal during 1990-91

		August	September	October	November	December	January	February	March	April	May	June	July	August	September
1	Speed of water current (m/sec)	0.57	0.58	0.62	0.6	0.52	0.4	0.57	0.46	0.54	0.57	0.64	0.7	0.7	0.72
2	Water temperature	27	26.6	25.4	23	20	14	16.4	21.6	26	27.4	28.8	26.8	26.8	25.6
3	pH	6.94	6.96	7.18	7.4	7.56	7.44	7.82	7.92	7.9	7.72	7.84	7.46	7.2	7.18
4	Transparency (cm)	6	8.5	16.5	22.5	22	29	32	35	31	29	28	24.5	11	8
5	Dissolved oxygen (mg/l)	5.2	5	5.2	6	5.4	6.4	7.6	7.2	6.6	7.2	7.2	5.4	5.2	5.4
6	Free CO2 (mg/L)	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab	Ab
7	Phenolphthalein alkalinity (mg/L)	6	6	8	8.2	10	8	9	7	7	6	7	8	7	5
8	Total alkalinity (mg/L)	68	76	74	70	84	94	86	88	84	94	86	70	74	76
9	T.D.S. (mg/l)	182	212	186	158	166	160	174	176	158	122	142	156	138	148
10	Nitrate nitrogen (mg/l)	0.03	0.035	0.055	0.08	0.075	0.055	0.07	0.095	0.25	0.34	0.23	0.09	0.08	0.07
11	Orthophosphate (mg/l)	0.202	0.121	0.091	0.07	0.049	0.04	0.022	0.028	0.007	0.049	0.028	0.058	0.07	0.073
12	Silicates (mg/l)	3.25	2.65	2.3	2	2	1.8	1.1	1.1	0.95	1.2	0.85	0.9	1.95	2.45