On the Ionic Composition of Five Tropical Fish-Ponds of Aligarh (U.P.), India

by

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(with 1 fig.)

A great deal of literature exists on the ionic composition of temperate waters. Important communications are those of BIRGE & JUDAY (1911), PEARSALL (1921), CLARKE (1924), LOHAMMAR (1938), OHLE (1935), and MAUCHA (1932). From Australia, the ionic composition of surface waters has recently been published by WILLIAMS & SIEBERT (1963). RODHE (1949) making use of the earlier information, has established the constancy of ionic proportions in carbonate waters. Work on these lines from Indian waters is lacking. The present paper deals in brief with the ionic composition of five fish-ponds of Aligarh.

Aligarh (lat. 27°34′30″ N, long. 78°4′26″ E) is an important district of the vast, mainly agricultural, plains of North India. The formations are all recent, Aligarh being in the zone of older Alluvium. The older formation nearest to the place, is the Arravali range extending to south of Delhi, hardly eighty miles from here. Innumerable freshwater bodies, like the ones dealt in this paper, dot the plains throughout its length and breadth. This makes this region very important as a limnological zone.

METHODS

Surface samples were collected away from the shore and were immediately transported to the laboratory. Chemical analysis was

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completed within twenty-four hours of the time of collection. Only the major ions, namely calcium, magnesium, sodium and potassium among the cations and bicarbonate, chlorides and sulphate among the anions, were investigated. The methods adopted were as follows:

Calcium and Magnesium

Calcium was precipitated as oxalate and titrated with 0.1 N potassium permanganate. From the filtrate magnesium was precipitated with sodium biphosphate and finally weighed as oxide. The estimation was further confirmed by first determining the hardness, then precipitating the calcium as oxalate and determining the magnesium from the filtrate as above. The difference gave the amount of calcium. The final values of the constituents, from the two procedures, agreed fairly well.

Sodium and Potassium

Sodium and potassium were first estimated together by the gravimetric method, as recommended by THREOX et al. (1943). Potassium was then estimated separately by the chloro-platinate method. The difference between the two was taken as the amount of sodium. The concenteration was also checked by the difference of positive and negative radicals. For the gravimetric procedures adopted, the volume of samples taken for determinations was always large.

Bicarbonate and Carbonate

Bicarbonate and carbonate was estimated by titration with 0.1 N sulphuric acid using methyl orange and phenolphthalein as indicators.

Chlorides

By direct titration with silver nitrate using potassium chromate as indicator.

Sulphate

Sulphate was estimated turbidimetrically using amyl alcohol conditioning reagent and barium chloride.

DESCRIPTION OF THE PONDS

As is true for most of the freshwater bodies of the area, these ponds are quite large covering an area of approximately 0.5 acres ($\pm$ 0.2 ha) with a maximum depth of about four feet (1.2 m). The area and depth of a pond, however, vary greatly during a year. In the monsoon months, the rainwater, the only influent source, fills them to capacity.

With no exit the water evaporates during rest of the year. The ponds as a result shrink to their minimum during the summer months of May and June. The annual loss of water as a result of evaporation is great, the average depth of the pond being reduced by about six feet.

Two of the ponds – Noomaish Tal and Moat – are situated on the outskirts of the city, being three miles to the west and four miles to the south respectively. As isolated bodies with practically no human interference, they represent the typical conditions of the area. The two other ponds Achal Tal and Chau Tal are situated inside the city amidst congested localities. They are exposed to heavy pollution from various sources such as wallowing cattle, city wastes and garbage. The pollutants are all organic in origin. The last pond Nagala Tal is unproductive and lies about two miles to the south of the city.

All the ponds, excepting the moat, are naturally occurring depressions. The Moat as the name indicates surrounds a Maratha Fortress built in the eighteenth century. It was excavated in the form of a circle to surround the fort completely from all sides. The ponds, except the Nagala tal which is unproductive, are of low transparency and of deep green colour showing a permanent bloom of *Microcystis aeruginosa* (KÜTZ.).

Results and Discussion

All the ponds have been sampled during their lean period. This is also the close of the post-monsoon season, a period of great stability. For obvious reasons of pollution Achal Tal and Chau Tal show a disturbance in their chemical make-up. Noomaish Tal and Moat can be said to be depicting the true picture while the last pond which is unproductive holds the water with little change during the whole year.

Table I

Name of the pond	Date of sample	T.D.S.	Cl	SO_4	HCO_3	CO_3	Ca	Mg	Na	K	pH
1. Noomaish Tal	10/5/65	290	16	14	156	27	48	15	10	5	9.2
2. Moat	7/5/65	370	22	18	208	22	52	16	14	5	9.1
3. Chau Tal	7/5/65	410	50	24	202	36	66	18	32	8	9.3
4. Achal Tal	10/5/65	550	82	76	178	30	86	22	36	9	9.2
5. Nagala Tal	11/5/65	420	22	8	256	6	66	10	27	5	8.3

The concentration of the individual ions in milligrams per litre and the equivalent ionic ratios between various pairs of ions have been given in Table I and II. The figure illustrates the concenterations of individual ions, the area of the polygons being equal to the concentration of the ions in milligrams per litre.

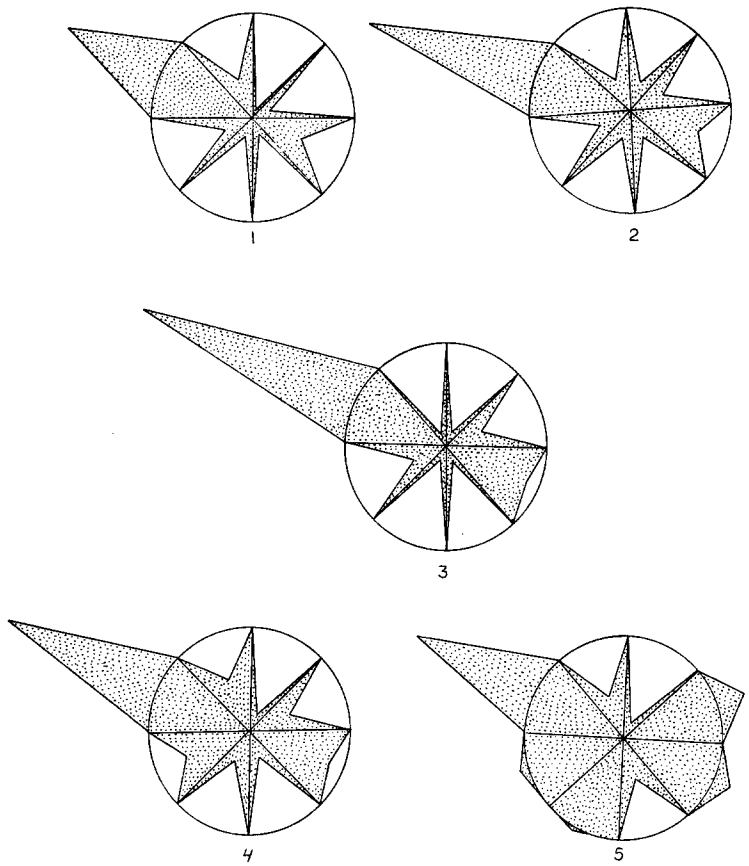

Fig. 1. Diagrammatic representation of the ionic composition of the ponds : 1 Noomaish Tal. 2, Moat, 3, Nagala Tal, 4, Chau Tal. 5, Achal Tal. The areas of the polygons represent the concenteration of the ions in mg/l. The polygons of the left side are from the top – carbonate, bicarbonate, chlorides and sulfate, while of the right, from the top represent – potassium, sodium, calcium and magnesium.

The salinity ranges from 290 to 550 mg/l. The maximum figure is lower than the one given by UPADHAYA (1961) in his physico-chemical survey of Uttar Pradesh waters. The range of variation of the different ions are: chlorides ranged from 16 to 82, sulphate ranged from 8 to 76, bicarbonate ranged from 156 to 256, carbonate ranged from 6 to 36, calcium from 48 to 86, magnesium from 10 to 22, sodium from 10 to 36 and potassium ranged from 5 to 9.

From the figures quoted above it will become clear that calcium and bicarbonate are the major cations and anions respectively. Calcium forms about 60% of the total cations while bicarbonate forms about

75% of the total anions. These values agree fairly well with RODHE's (1949) general summarization for all parts of the world.

It would be worthwhile to point out at this stage that the ionic composition is also very important in the study of the ecology of freshwater phytoplankton as emphasized recently by LUND (1965). In the present case the first four ponds show a permanent bloom of *Microcystis aeruginosa* and hence their chemical make-up will throw light on the type of water in which this alga exhibits phenomenal success of reproduction and growth.

Bicarbonate, important as it is in the economy of the ponds, is fairly abundant, enough to shoulder the eutrophic conditions in the first four ponds. Its ratio to the carbonate concentration is a fair indication of the productive level of the ponds. The lowest figure of 1.8 (Table II) is in Chau Tal which happens to be the most productive (based on chlorophyll estimations, to be published later). A fish tank in Delhi (GEORGE 1962), showing a permanent bloom of *M. aeruginosa* also showed a carbonate – bicarbonate ratio of 1.8 during the period. As limitations to active photosynthesis, in all seasons, are but few the carbonate content seems to be very important in productivity evaluation in this area.

The generalisation carbonate is greater than chlorides which is greater than sulphate holds true for the first two ponds and the last one, but not in the polluted Achal Tal and Chau Tal. In the equivalent ratios between various pairs of anions, the bicarbonate chloride ratio is quite high in Noomaish Tal, Moat and Nagala Tal as compared to the two other ponds. The greater chloride content of these ponds lowers the figure in their cases. The same is true for carbonate chloride ratio, excepting the Nagala Tal where due to lack of photosynthetic activity, it is the same as in the polluted ponds. There is no clear cut pattern in the relationship of sulphate to other anions. The sulphate values are, however, much lower than GEORGE (1962) has reported from a fish tank in Delhi.

Potassium is the least of all cationic constituents. For the first two ponds and the last one, the generalisation calcium is greater than magnesium which is greater than sodium which in turn is greater than potassium holds true. Nagala Tal has a calcium magnesium ratio just double of the rest of the ponds and also has a high sodium content.

In equivalent ratios between various pairs of ions, it is the calcium carbonate relationship that deserves attention. This depends on the bicarbonate utilisation during photosynthesis. The most productive Chau Tal again shows the lowest figure. The secondary role of magnesium is too well exposed by its uncertain relationship to other anions. Contrary to expectations potassium is not very significant in

TABLE II

Name of the Pond	T.D.S.	Ca/ Mg	Ca/ Na	Na/ K	Mg/ Na	HCO_3/ CO_3	CO_3/ Cl	Cl/ SO_4	HCO_3/ Cl	CO_3/ SO_4	Na/ Cl	Ca/ HCO_3	Ca/ CO_3	Mg/ CO_3	Mg Cl
1. Noomaish Tal	290	1.7	5.1	7.5	2.8	2.7	2.0	1.3	5.9	2.8	1.0	0.8	2.6	1.4	2.9
2. Moat	370	2.0	3.5	9.0	1.3	4.1	1.2	2.3	5.1	2.8	0.9	0.6	2.8	1.4	4.0
3. Chau Tal	410	1.9	2.4	6.3	1.2	1.8	0.3	2.5	2.5	2.3	1.0	1.0	1.2	0.9	1.2
4. Achal Tal	550	2.0	2.5	11.3	1.1	2.2	0.3	1.5	1.2	0.5	0.7	1.4	4.3	2.2	0.8
5. Nagala Tal	420	4.2	3.2	8.5	0.7	21.0	0.3	3.5	5.5	1.1	1.7	0.9	27.4	4.1	1.3

its relationship to anions. Sodium except balancing the chloride content, is playing no significant role.

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Summary

The ionic composition of four very productive and one unproductive fishpond has been investigated. The concentration of various ions is typical of carbonate waters except in two ponds for reasons of pollution. Calcium and bicarbonate are the major cation and anion while inspite of high productivity potassium is not very abundant. Because of the geographical position the area enjoys, the carbonate content seems to be important in productivity evaluation. For the same, its equivalent ratio to calcium and bicarbonate is very significant.

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