CALCIUM EXCHANGES BETWEEN SEDIMENTS AND WATER IN SOME CULTURE PONDS WITH STRESS ON CARBONATE AND BICARBONATE ALKALINITIES

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ABSTRACT

The results of a short term study of the hydrological parameters like salinity, dissolved oxygen, phosphate, nitrate, nitrite, alkalinity, pH and dissolved calcium in the pond waters and the parameters, like available phosphorus, nitrate and exchangable calcium for the bottom sediments for three culture ponds at Narakkal are presented and discussed, for the period late pre-monsoon to late post monsoon of the year 1985. From the observed distribution of the various parameters in the sediment and overlying water, general conclusions as to the degree of exchange between sediment and overlying water are drawn. The calcium exchange between soil and overlying water seemed to be maximum during monsoon and that too in ponds where vertical turbulence is of a high degree due to tidal influences. Where the tidal influences are weak, retention of calcium in the sediments was high and likewise the carbonate alkalinity.

INTRODUCTION

Calcium is an essential element which should be present in the environment for life activities of organisms. Greenway Peter (1983) stated that marine decapods lose their 90% of body calcium during 'ecdysis', and calcification of new exoskeleton is achieved predominantly with the calcium absorbed from seawater. Banerjee (1967) opined that the pond with less concentration of available calcium both in soil and water will be less productive than others where calcium is abundant. Gupta and Naik (1981) has done work on calcium along with other parameters in the Mandovi and Zuari tide dominated river systems and observed that calcium along with magnesium appeared to take some part in the biogeochemical cycles of the river and behaves as a semi conservatives parameter. Krishna Swarup and Singh (1979), while working the limnology of Suraha lake have observed fairly high values of dissolved calcium in the lake water upto 207 ppm and the minimum values were observed during October and March. Mollah *et al.* (1979) observed an inverse relationship between calcium in water and calcium in soil in one of the ponds they worked, and in some others correlation was not clear.

MATERIALS AND METHODS

A short term study was carried out in three brackish water ponds at Narakkal, 11 km northwest of Cochin in the Vypeen Island from late May to mid September, 1985. The land strip is bordered by the Arabian sea in the west and by the Vypeen channel (a branch of Cochin backwater) in the east. The water samples from surface and bottom were collected from the ponds for the analysis of various parameters, and the sediment samples were collected using a plastic corer and were transfered to a polythene bag. The frequency of collection was once in a week. The water samples were analysed for pH, salinity, dissolved oxygen, nitrate, nitrite and reactive phosphorus, carbonate, and bicarbonate alkali-

nity and dissolved calcium. The sediment samples were analysed for available phosphorus, available nitrate and exchangable calcium. All the analyses were carried out employing standard methods.

Results

The surface to bottom differences in temperature in all the three ponds were negligible indicating good vertical mixing. In all the three ponds the range of temperature was more or less the same and as such a representative diagram only is produced (fig. 1). The maximum surface temperature was during September, which is not quite usual, and the minimum during monsoon.

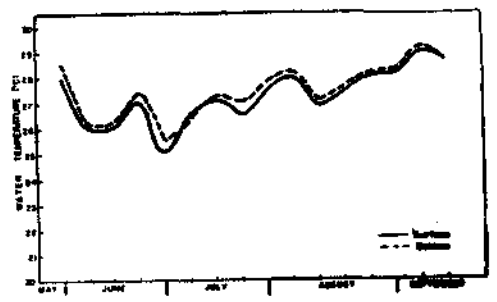

Fig. 1. Time distribution of water temperature in the representative pond.

But the aburpt decrease in salinity by the onset of monsoon was quite conspicuous, (fig. 2). Salinity considerations were comparable in all the three ponds. Dissolved oxygen contents were uniformly high

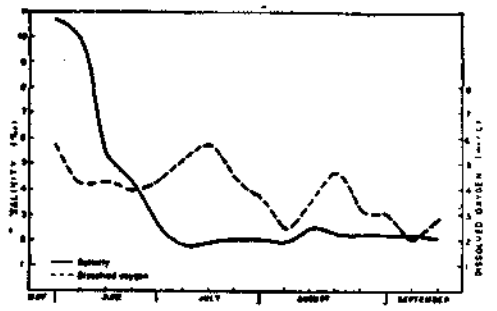

Fig. 2. Time distribution of salinity and dissolved oxygen in the representative pond.

ranging from 3 to 5.5 ml/l, the lowest being during late September (fig.2). In the linear plot of the time distribution pattern two conspicuous maxima could be observed during July and August in all the sites. In site 3 supersaturation could be observed (8 ml/l) during July and it may be pointed out that this site is minimum affected by the tides.

The time distribution of carbonate and bicarbonate alkalinities in conjunction with pH variations is shown in fig. 3. The general values for bicarbonate and carbonate alkalinities were 50–100 ppm and 0–30 ppm respectively (fig. 3). The pH values ranged from 7.5 to 8.5 in general. At site-1 the bicarbonate alkalinity was higher than site-II and likewise the pH values. At site-III the carbonate alkalinity was uniformly high, values during peak monsoon being of the order of 30–40 ppm. The usual trend viz. increase in carbonate alkalinity and decrease in bicarbonate alkalinity with increase in pH could be observed from the seasonal distribution patterns of the above properties.

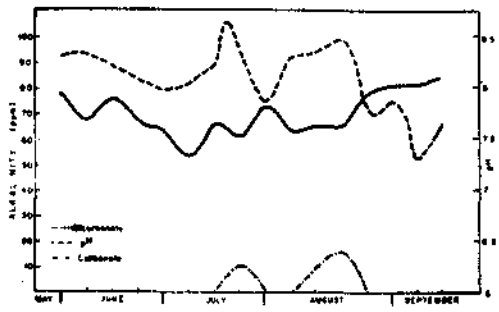

Fig. 3. Time distribution of bicarbonate, carbonate and pH in the representative pond.

The distribution of calcium content in the bottom sediments in the three sites was studied along with the amounts of dissolved calcium in the overlying waters. The maximum soil calcium content was in site-III which received minimum tidal influence. Calcium content of overlying waters was much lower and the distribution was similar in the three sites. A drastic decrease from the pre-monsoon values in both soil and

water calcium contents, during monsoon was observed (fig. 4). During monsoon the general trend was of a fluctuating nature especially for the soil calcium.

FIG. 4. Time distribution of calcium in the representative pond.

The phosphorus contents in the bottom sediments and overlying waters show conspicuous fluctuations during the investigational period (fig. 5). Maximum phosphate content occurred in site-I where the tidal fluctuations were high. It could be noticed that, when the phosphate content of the water was high, the corresponding soil phosphorous was low, and vice versa, especially in site-I. Sites-II and III exhibited different trends and in the latter a more or less direct relationship existed between the water and soil phosphorus contents. Of all the three sites, site-III had the maximum soil phosphorus.

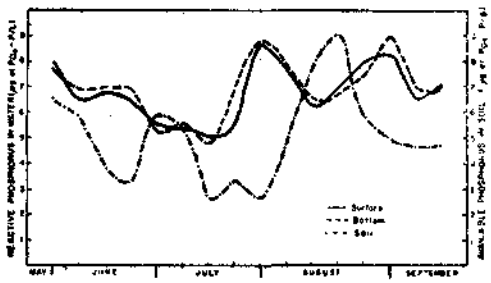

FIG. 5. Time distribution of reactive and available-phosphorous in the representative pond.

The nitrate content of the bottom sediments in all the 3 sites was low, values being less than 5 µg at. Nitrate-N/g, but the nitrate contents of the overlying waters were as high as 55-60 µg at. Nitrate/l occurring during the pre-monsoon and of the order of 25–35 µg at. Nitrate-N/l occurring during monsoon. Soil nitrogen content maintained a constant trend throughout the period of investigation. Nitrite nitrogen content of the water was found to be low, maximum being during pre monsoon and minimum during peak monsoon.

DISCUSSION

From the foregoing descriptions it can be observed that the tidal influence was maximum in site-I and the carbonate dissolution was also more there. The more or less stagnated condition of the site-III gave rise to maximum amount of carbonates and minimum bicarbonates. The conditions of exchange of varitions between soil and water are not so simple, as their passing from soil to water is mainly dependent on the amount of clay minerals. In the present case, it can be observed that maximum clay content was in site-III, where the soil calcium contents were also maximum. Lyzimetric investigations of ponds (Wrobel, 1967) has proved that calcium was the most easily washed-out factor. During monsoon in site-III the water calcium content was more than the other two sites.

The relationship between the calcium content of the soil and the water has been investigated in some tropical ponds previously also, (Sumitra, 1973). She has stated that the relation was most direct in one pond whereas it was inverse for most part of the year in the second pond. In the present case, soil calcium was more abundant than the water calcium in all the three sites. Mollah *et al.* (1979) while investigating some freshwater ponds, have stated that the calcium content of water showed an inverse relationship with that of the soil in one of the two ponds they worked and in the second pond correlation was not clear. Such an inverse relationship was observed by the onset of monsoon in site-I, whereas during the peak monsoon a more or less direct one was conspicuous. More or less the same features prevailed in site-III also.

Banerjee (1967), has stated that the availability of calcium from soil to water was likely to be influenced more by exchangable calcium and he attempted a correlation

between exchangable calcium and productivity in ponds and has inferred that there was no marked influence of exchangable calcium upon productivity. Hence it can be said that the nutrient exchange was more significant, as far as the plankton bloom and productivity are concerned.

In the present case it appears that vertical turbulence plays an important role in the exchange mechanisms. Lerman and Brunskill (1971) while studying the migration of major constituents from lake sediments to the lake water has suggested that the higher concentration of dissolved components in interstitial water than in lake water could indicate flux upward across the sediment water interphase and this flux accounts for some fraction of the chemical budget of the lakes. Components in the interstitial water in all approximation can be identified as those in sediments. The flux rate in the present case seems to be small except for monsoon and post-monsoon.

The seasonal salinity distribution patterns at the surface and the bottom in the present investigational sites were more or less the same and as such the salinity influence over the changes in properties of the sediment and soil phase was more or less the same. So the exchange processes between sediment and water are inferred to be controlled by other criteria. Mortimer (1941 and 1942) while discussing oxygen, have observed that nutrient ions are produced by the decomposition of precipitated organic matter. Under oxidising conditions the ions except nitrite and nitrate are adsorbed on soil colloids. Thus the retention capacity of the sediments with respect to nitrite and nitrate seems to be small which feature was observed in the present case also. Throughout the investigational period the nitrate contents of the bottom sediment were below 5 μg at./g, whereas in the overlying water a maximum of 60 μg at./g during the pre-monsoon and another high peak during the monsoon period were observed. The nitrite contents also were high during this period.

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REFERENCES

BANERJEE, S.M. 1967. Water quality and soil condition of fish ponds in some states of India in relation to fish production. *Indian J. Fish.*, **14** (1 & 2): 115-143.

GREENWAY PETER 1983. Uptake of calcium at the post moult stage by the marine crabs, *Calbectes saoudes* and *Carcinus meanas*. *Comp. Biochem. Physiol.*, **75** (A2): 181-184.

GUPTA, R. AND SUGANDHINI NAIK 1981. Studies on calcium, magnesium and sulphate in Mandovi-Zuari river system, Goa. *Indian J. Mar. Sci.*, **10** (1): 24-34.

KRISHNA SWARUP AND S.R. SINGH 1979. Limnological studies of Suraha lake (Ballia) and variations in the water quality. *J. Inland Fish. Soc. India*, **1**: 22-33.

LERMAN ABRAHAM AND GREGG. J. BRUNSKILL 1971. Migration of major constituents from lake sediment into lake water and its bearing in lake water composition. *Limnol. and Oceanography*, **16** (6): 880.

MOLLAH, M. F. A., A. K. M. AMINOL HAQUE, M. EAQUB, M. IDRIS AND M.Y. CHOWDHURY 1979. Interaction between pond bottom soil and water qualities. *Indian J. Fish*, **26** (1–2): 101–112.

MORTIMER, C.H. 1941. The exchange of dissolved substances between mud and water in lakes. *J. Ecol.*, **29**: 280-329.

MORTIMER, C.H. 1942. The exchange of dissolved substances between mud and water in lakes. *J. Ecol.*, **30**: 147-201.

SUMITRA VIJAYARAGHAVAN 1973. A comparative account of soil water relationship in three tropical ponds. *Indian J. Flish.*, **20** (2): 617-623.

WROBEL STANISLAW 1967. The role of soil in fish production of ponds. *FAO. Fish. Rep.*, *No* **44**, vol. 3: 153-163.