CARBONDIOXIDE EQUILIBRIA AND NUTRIENT AVAILABILITY IN TWO CULTURE PONDS AT NARAKKAL DURING THREE MONSOON AND POSTMONSOON MONTHS, JUNE-SEPTEMBER, 1984

C. P. RAMAMIRTHAM AND ANNIE MATHEW
Central Marine Fisheries Research Institute, Cochin.

ABSTRACT

The nutrient availability did not show a definite pattern and not much correlation was observed between the biological cycle of nutrients and carbondioxide content. The variations of the different hydrological parameters of the ponds as well as their diurnal variations are discussed.

The study was conducted during the period June-September 1984 in two brackishwater culture ponds at Narakkal in Vypeen island, situated 11 km northwest of Cochin. Regular weekly collections were made during the entire three months. The parameters carbon dioxide, pH, phosphate, nitrate, nitrite, salinity, dissolved oxygen and temperature were studied. The diurnal variations of the parameters were also studied. As the ponds were shallow with depth ranging from 0.5 m to 1.0 m, there was good vertical mixing and, hence, the collections were made at mid-depth only.

The sampling was carried out during morning hours between 9 AM and and 10 AM. Samples for carbon dioxide were taken in amber-coloured bottles without entrapping air bubbles and the bottles were tranferred to ice box to maintain temperature below the *in situ* temperature. Samples for dissolved oxygen, nutrients and salinity were also collected, and temperature and pH were measured on the spot.

Results and discussion: The time distributions of different parameters studied are presented in figures 1-6. The direct influence of Arabian sea over the ponds was weak as the tidal impacts was brought in through a connecting channel. Hence, the monsoon changes in the sea were not reflected in the ponds in a noticeable way and whatever effect of monsoon were there were those resulting from heavy precipitation and local runoff and the very small tidal amplitude of nearly 50 cm.

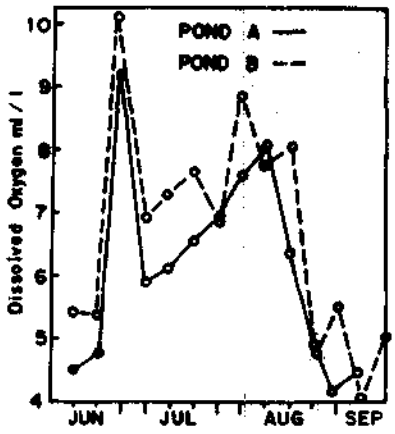

FIG. 1. Time distribution of dissolved oxygen

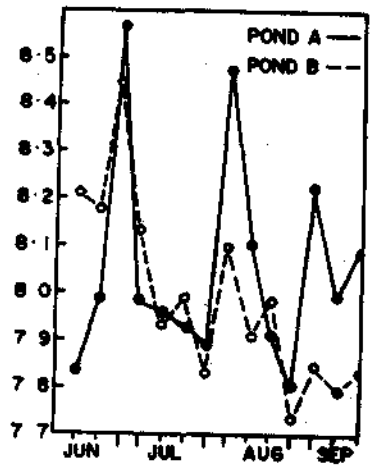

FIG. 2. Time distribution of pH

For the sake of convenience, the ponds are designated as pond A and B. In pond A the maximum temperature of 32°C was observed during early August, when in pond B the temperature was 33.4°C. The minimum temperature in both the ponds was noticed during peak monsoon.

Salinity changes in the ponds were more gradual and well defined than the temperature. The minimum salinity observed was 1.8‰ during the peak monsoon. As almost all the observations were carried out during the period of low tides, the effect of the latter was observed in reducing the salinity in the ponds. From July onwards there was a gradual increase and, during mid-September, the values were of the order of 3.6 ‰ and 4.2 ‰ in pond A and Pond B.

Supersaturation with respect to dissolved oxygen was observed during 2 days in the investigational period (Fig. 1). These collections were made in the noon hours. Except for this the distribution was uniform, values ranging from 3 to 3.4 ml|l.

The high values of dissolved oxygen were associated with high pH values also (Fig. 2). Except for this, the range of pH in both the ponds was between 7.7 and 8.25. Comparatively the pH values were lower during the peak monsoon period. The minimum occurred during late August when the temperature was also minimum.

These relationships are reflected in the time distribution pattern of free carbon dioxide in both the ponds (Fig. 3). The maximum value in pond A was 3.9 mg/l and in pond B it was 4.9 mg/l. These maxima were associated with minimum pH and minimum dissolved oxygen content. The general trend was an increase in the values with time. The relation between pH and carbon dioxide appeared to be more regular than the relation between oxygen and carbon dioxide.

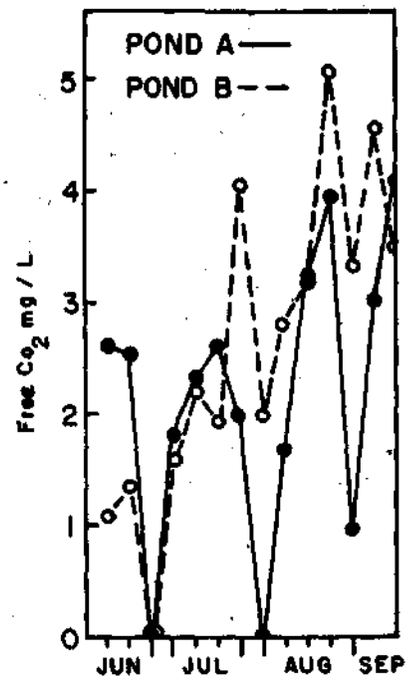

FIG. 3. Time distribution of free carbondioxide

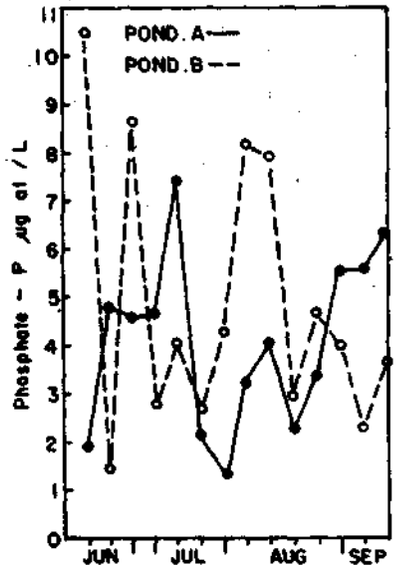

FIG. 4. Time distribution of phosphate -P

The time distribution of phosphate exhibited a better relationship with dissolved oxygen than with free carbondioxide (Fig. 4). High values of phosphate corresponded to high peaks in dissolved oxygen content. The general trend was for high phosphate content when the waters were depleted of free carbondioxide.

Maximum values for nitrite-N were in pond B during late monsoon and post monsoon, the value being 12 and 13 µg. at.|. In pond A the values ranged between 9 and 10 µg. at.|l. Nitrite and phosphate contents showed an inverse relation (Fig. 5).

The maximum value for nitrate N in pond A was 35 µg. at.|l. and for pond B it was 31 µg. at.|1. High values of nitrate N corresponded to high values of dissolved oxygen and to low values of carbondioxide content. An inverse relation was exhibited between nitrite N and nitrate N. The minimum values were 3.94 and 5.67 for pond A and pond B, respectively.

The diurnal variation studies were started at 1030 hrs on a particular day and were closed at 0830 hrs the next day. Frequency of sampling was once in two hours.

The diurnal variations in salinity were negligible. The temperature variations showed a maximum at 1430 hrs and a minimum at 0430 hrs (Fig. 6). The maximum pH of 8.5 was again at 1430 hrs and the minimum at 0630 hrs (value 7.79). Free carbondioxide was more or less absent till 1830 hrs. Thereafter a gradual increase in carbondioxide was observed up to 0630 hrs, when it showed a maximum, corresponding to the minimum of dissolved oxygen and to the lowest pH.

The nitrite contents showed three maxima during the day. The inverse relation between nitrite and nitrate as mentioned earlier could be observed in the diurnal variation also. The range of variation of phosphate was from 3.6 to 6.8 µg. at.|1. the minimum occurring at 0030 hrs and the maximum at 1830 hrs. The dissolved oxygen content was maximum at 1630 hrs and minimum at 0630 hrs.

From the foregoing description it can be understood that the nutrient contents, free carbondioxide and the temperature conditions in the culture ponds were subject to a wide range of variations during the period of observation. The tidal amplitudes in the ponds were very low and, hence, the relationship between the amplitude and temperature observed in the Cochin backwaters by Qasim and Gopinathan (1969) and Shynamma and Balakrishnan (1973) was not present in the ponds, and the diurnal variations in salinity due to tidal influence was very little.

The high amounts of dissolved oxygen have a close relationship with temperature, as has been observed by Kasturirangan (1957). But the observation by Qasim and Gopinathan (1969), Singbal (1973), and Rao and Rao (1962) in the Cochin backwaters, Zauri estuary and Waltair coast, respectively, are contradictory to these observations.

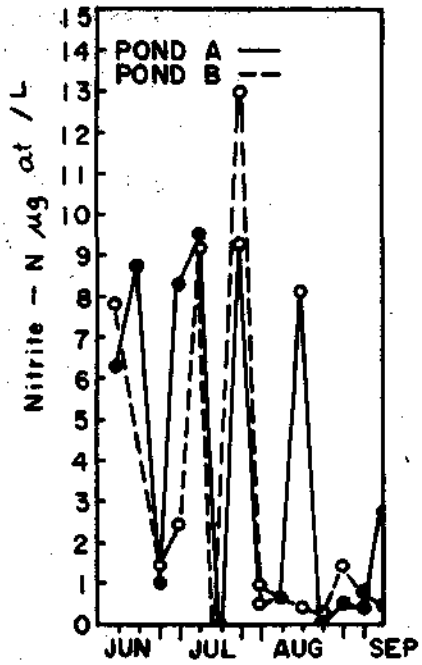

FIG. 5. Time distribution of Nitrite -N

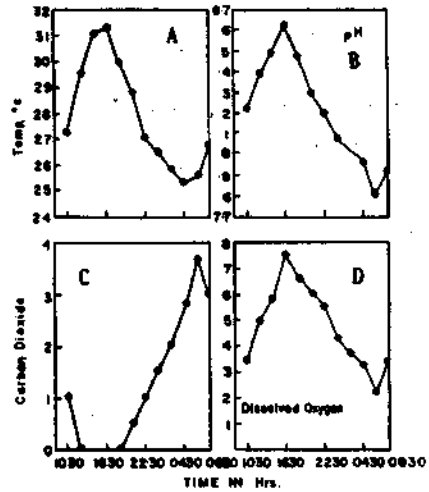

FIG. 6. Diurnal variation of hydrological parameters: A — Temp.; B — pH; C — CO2; D — Dissolved Oxygen.

It is normally inferred that the increase in carbondioxide is counterbalanced by other processes that tend to increase the pH of the water. But in the present case a more or less well-defined inverse relationship between pH and carbondioxide has been observed.

The free carbondioxide in the ponds are high during monsoon. A definite relationship between carbondioxide and temperature is not evident in the present case, although the high values of carbondioxide corresponded to high temperatures during the monsoon. Apurba Ghosh et al (1974) and Krishna Swarup and Singh (1979), while discussing hydrological conditions in sewage ponds, have stated that the high temperature during summer and monsoon accelerated the bacterial decomposition of organic matter and results in the formation of carbondioxide. The liberation of carbondioxide in large quantities helps to cause thick algal blooms in the pond. In the present case the lack of such a relationship may be due to some other factors in the pond ecosystem. The inverse relationship between nitrate and dissolved oxygen and the direct one between phosphate and nitrate observed in the present case are also postulated by the above authors.

In the present case the biological cycle of nutrients is observed to be independent of free carbondioxide. Park Kilho et al (1969), while investigating the carbondioxide and the nutrient contents in the Columbia river, have not noticed any correlation between these two parameters and as such the biological cycle of nutrients seems to be independent of free carbondioxide.

The authors wish to express their thanks to Dr. P. S. B. R. James, Director, for encouragements in the investigations and to Dr. P. V. R. Nair for his interest in the studies. The helps rendered by Shri N. P. Kunhikrishnan during the preparation of the paper are acknowledged. One of the authors (Annie Mathew) wishes to express thanks to the Indian Council of Agricultural Research, for award of Junior Research Fellowship during the tenure.

REFERENCES

APURBA GHOSH, L. HANUMANTHA RAO AND S. C. BANERGEE. 1974. *J. Inland Fish. Soc. India.* Vol. VI: 51-61. KRISHNA SWARUP AND S. R. SINGH. 1979. *J. Inland Fish. Soc. India.* Vol. II (1): 22-23. KASTURIRANGAN, L. R. 1957. *Indian J. Fish.* 4(1): 134-149. MATHEW, P. M. 1975. *J. Inland. Fish. Soc. India.* Vol. VII: 16-24. MOORE, B., E. S. EDIE, E. WHITELY AND W. J. DAKIN. 1912. *Biochem. J.* 6: 255. PARK, P. KILHO. 1969. *Limnol. and Oceanography,* 14(2): 179-186. QASIM, S. Z. AND C. P. GOPINATHAN. 1969. *Proc. Indian Acad. Sci.,* 69(6): 336-348. RAO, T. S. S. AND V. CHALAPATHI RAO. 1962. *J. mar. biol. Ass. India,* 4(1): 22-43. SHYNAMMA, C. S. AND K. P. BALAKRISHNAN. 1973. *J. mar. biol. Ass. India* 15(1): 391-398. SINGHBAL, S. Y. S. 1973. *Indian J. mar. Sci.* 2(2): 90-94. THOMAS, E. HOOVER AND D AVID, C. BERISSHIRE. 1969. *J. Geophys. Res.,* 74(2): 456-464.