HYDROGRAPHY OF THE INSHORE WATERS OF MADRAS FOR THE PERIOD SEPTEMBER 1967 TO JULY 1970

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ABSTRACT

Observations were made on salinity, dissolved oxygen, pH, phosphate, nitrate, nitrite and silicate of the inshore surface waters of the Madras coast, from September 1967 to July 1970. The changes observed in salinity follow a pattern without much variations from year to year. The surface layers are rich in dissolved oxygen and the pH remains around 8.4 throughout. The fluctuations of phosphate, nitrate and nitrite show almost similar trends and those of silicate exhibit an inverse relationship to changes in salinity.

INTRODUCTION

Hydrographic observations on the inshore waters of the Madras coast have been few and far between (Jayaraman 1951, Ramamurthy 1953, Varma and Reddy 1959 and Subrahmanyan and Sen Gupta 1965). The present paper is based on the observations made on the surface waters along the Madras coast, especially from the fishing areas off the bar-mouths of the rivers Cooum and Adayar and Nochikuppam landing centre, from September 1967 to July 1970. The general pattern of variations observed in the different parameters studied to understand the trends during the different seasons of the year and from year to year is presented here. In the absence of any continuous record of changes taking place in the waters along the Madras coast, the data presented here help to fill up a gap.

MATERIALS AND METHODS

Seawater samples were collected from the fishing grounds off the bar-mouths of Cooum and Adayar once a week and Nochikuppam landing centre twice a week. Standard procedures were used for the collection and preservation of samples in the field. For the determination of phosphate, nitrate, nitrite and silicate, water samples were collected in 500-ml polythene bottles with a few drops of chloroform. Standard methods were followed in the laboratory for the analyses of the samples for the various properties.

Results and Discussion

Salinity

The variations in salinity follow same pattern during the three consecutive years of study (Fig. 1). In general, each twelve-month period from September to the following August is punctuated with three distinct periods of change. The first, extending from October to December, witnesses dilution when a marked decline in salinity is observed. A similar feature during October-December was earlier recorded by Sewell (1929), Jayaraman (1951) and later by Varma and Reddy (1959) and Subrahmanyan and Sen Gupta (1965). It was also postulated by Sewell and later confirmed by other workers that this phenomenon was due to the southerly current. October-December is the period of cyclones and the North East Monsoon, when the east coast of India experiences spells of rain which flood the perennial as well as the seasonal rivers. The decline in salinity is more perceptible with the onset of the monsoon and La Fond (1954) explained that this dilution of the surface waters is due to discharges from the rivers.

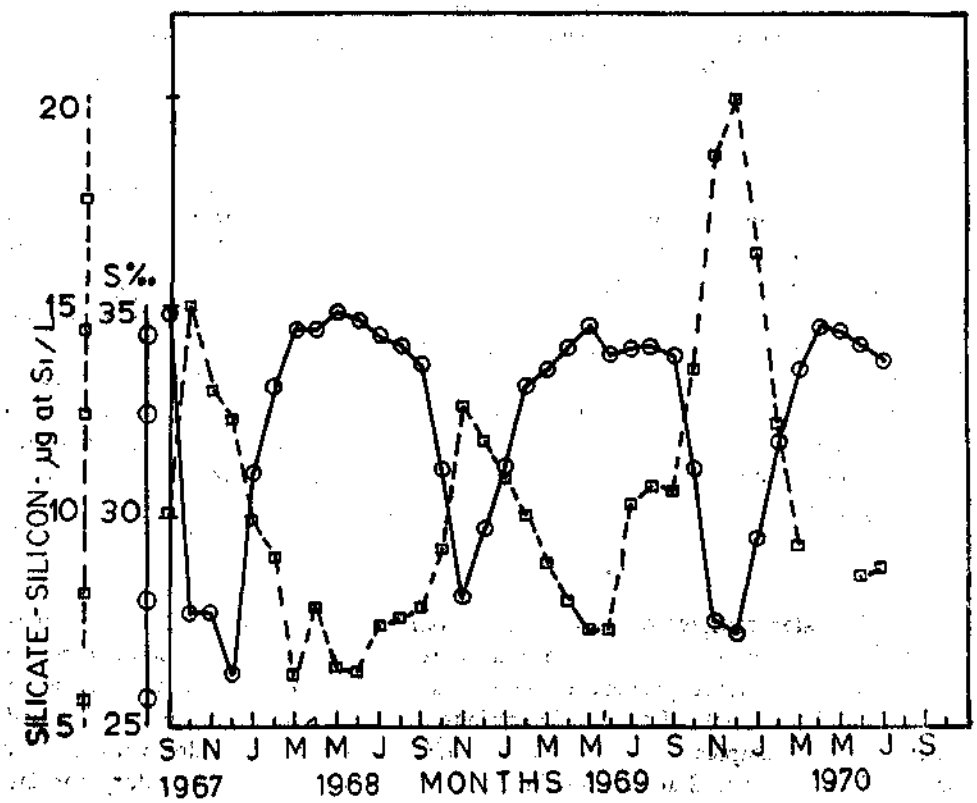

Fig. 1. Seasonal variations of salinity and silicate.

The succeeding five months from January to May is a period of restoration when the upward trend in the salinity values is kept up till the summer maximum is reached in May. Varma and Reddy (1959) observed a steady increase from January to March and attributed it to the northerly current pointed out by Sewell (1929). But Subrahmanyan and Sen Gupta (1965) recorded the highest value for salinity in May. However, Fig. 1 clearly projects a rapid phase of restoration from January to March and the upward trend is prolonged to May. This is followed by four months of lull from June to September when a slight decline in salinity was observed. One possible explanation for the decline could be the flow of lighter surface waters brought by the northerly current from June to August, which period coincides with the South West Monsoon. Subsequent observations made from May 1972 to March 1973 also show a similar pattern.

Oxygen

The surface waters of the Madras coast are rich in dissolved oxygen throughout the year and the values are comparable to earlier findings. Jayaraman (1951) opined that high oxygen values for surface waters could indicate increased photosynthetic activity. Such a direct relationship between the dissolved oxygen content and photosynthetic activity is yet to be established for these waters. Subrahmanyan and Sen Gupta (1965) discussed in detail the lack of correlation of the oxygen content of the surface waters of the Madras coast to the interdependant factors like the photosynthesis and depletion of the nutrients and they attributed it to the demand for oxygen by various other processes going on simultaneously in the surface layers. Therefore no correlation is attempted in this paper.

The fluctuations in the dissolved oxygen content differed widely (Fig. 2). A notable feature is a stepwise increase observed from year to year during the period of study. A critical examination of the trend indicates that the segment, representing the changes taking place from July 1968 to May 1969, hardly differs from what was noted by Varma and Reddy (1959) for the period July 1956 to May 1957. It is highly significant that a decline in the dissolved oxygen content usually occurred in the month of September and the succeeding months normally witnessed an increase, as was also observed by Varma and Reddy (1959) and Subrahmanyan and Sen Gupta (1965). This transient fall in oxygen values in September is due perhaps to the withdrawal of a favourable influence exerted by the monsoon winds since in September neither the South West nor the North East Monsoon is generally active over this region.

The oxygen values recorded during the three years of observation were not far from the saturation point for their corresponding values of salinity. There appears to be a stable mean level for the dissolved oxygen content of the surface waters and a rise or a fall from this level perhaps takes place with the assistance of the various factors which bring about this physical change. This may be the reason for the wide variations observed during the corresponding periods of the different years and a lack of a trend characteristic of any one of the seasons.

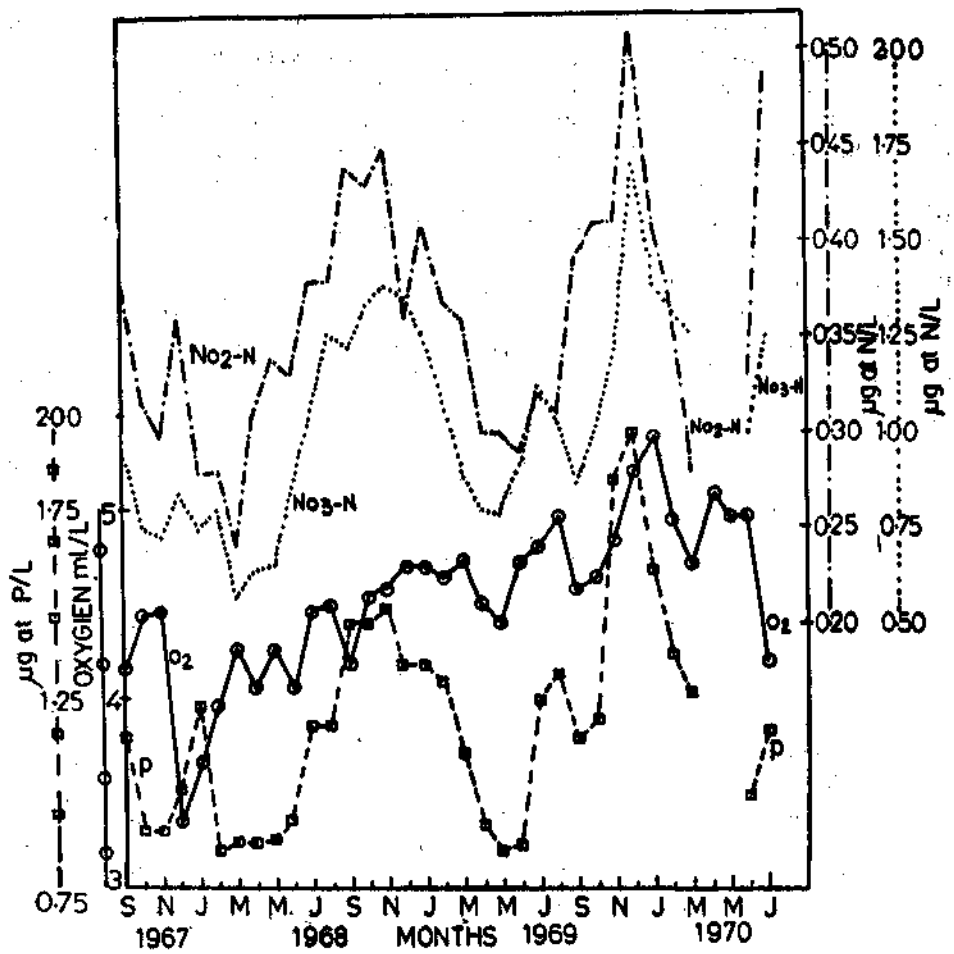

FIG. 2. Seasonal variations of dissolved oxygen, phosphate, nitrite and nitrate.

pH

The pH remained around 8.4 throughout the period of study, and pH values of 8.2 or 8.6 were not recorded at any time during the observation.

Nutrients

Nitrate and phosphate show a similar trend in their withdrawal from the waters off Madras though the Nitrate-Phosphate ratio is low. Jayaraman (1951) observed an anomaly of the nitrate-phosphate ratio in the waters along the Madras coast. The fluctuations in nitrate and nitrite are almost similar. Jayaraman (1951) also observed this trend and pointed out that the curves for nitrate and nitrite are almost parallel to each other. Any deviation observed here may be due to the activity of the perpetually-present nitrate reducers reported by Velankar (1950) in this region.

Subrahmanyan and Sen Gupta (1965) stated that the seasonal fluctuations of the different parameters along the Madras coast vary from year to year. Their deductions appear to be significant and the observations made from 1967 to 1970 support their findings. The decline in value of these parameters observed from September 1967 is absent in 1968 but has shifted to July-August and is less pronounced in 1969.

The observed nutrient replenishment of the waters off Madras from June to August (Fig. 2) may be due to many reasons. According to Prasad (1951) the current pattern at the time of the South West Monsoon is such that it carries the rainfall of the Western Ghats round Ceylon to the Bay of Bengal. The South West Monsoon Drift that joins the clockwise circulation of the Bay of Bengal (Takashi Ichiye 1966) can also bring with it nutrient-rich Antartic bottom water suggested by Sewell (Prasad 1951). The southwest wind at this time displaces the surface waters towards the eastern side of the bay, thus facilitating the surfacing of the deeper layers. Perhaps this process of upwelling is a prolonged one as it was observed by La Fond (1955) along the Waltair coast.

The North East Monsoon which follows resulting in the large scale discharge from the rivers finally boosts up the values to reach a maximum either in November or December according to the prevailing conditions. Effluents from Madras city, referred to by Prasad (1951), appear to be the major contributor to the large increase observed during this season.

When the monsoon recedes the calm conditions conducive to phytoplankton activity witness the progressive depletion of the nutrients up to May. This period appears to be the highly productive part of the year since the progressive depletion of the nutrients observed up to May coincides with the intensity in the activity and production of phytoplankton earlier reported by Subrahmanyan and Sen Gupta (1965).

Silicate

To bring out clearly the seasonal fluctuations in silicate content of the inshore waters off Madras to the water movements and the influx of the river waters, it is depicted in apposition with salinity in Fig. 1. The fluctuations seem to be less regular than those of phosphate and nitrate (Jayaraman 1951). It was observed that the North East Monsoon period corresponded with high silicate content and lowering of salinity as a result of large influx of river waters rich in silicate as observed by various workers (Jayaraman 1951, Varma and Reddy 1959, Subrahmanyan and Sen Gupta 1965). When the monsoon ceased and the bar-mouths of Cooum and Adayar closed and the salinity showed a sharp upward trend, a steady withdrawal of silicate appears to proceed up to May. This depletion of silicate and the nutrients corresponds to an increase in plankton content, which reached its peak bloom in May 1960 as observed by Subrahmanyan and Sen Gupta (1965). The slow increase in the nutrient content during the

South West Monsoon period was discussed earlier in this account. The local influence on silicate and salinity at this period is minimum and hence the factors responsible for the increase in the nutrients during this period equally hold good for silicate also.

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References

Jayaraman, R. 1951. Observations on the chemistry of the waters of the Bay of Bengal off Madras city during 1948-49. *Proc. Ind. Acad. Sci.*, **33B**: 90-99.

La Fond, E. C. 1954. On the upwelling and sinking off the east coast of India. *Mem. Oceanogr. Andhra Univ. Waltair*, **29** (1): 117-21.

La Fond, E. C. 1955. On upwelling and fisheries. *Curr. Sci.*, **25**: 258-59.

Prasad, R. R. 1951. *Geographical and climatic features of India and the hydrology of the surrounding seas.* Handbook of Indian Fisheries, prepared for the third meeting of the Indo-Pacific Fisheries Council, Madras: 17-23.

Ramamurthy, S. 1953. Seasonal changes in the hydrogen ion concentration and dissolved oxygen content of the surface waters of the Madras coast. *J. Madras Univ.* **23B** (10): 52-60.

Sewell, R. B. S. 1929. Geographic research in Indian waters (Part V). *Mem. Asia. Soc., Bengal*, **9** (5): 207-356.

Subramanian, R. and R. Sen Gupta. 1965. Studies on the plankton of the east coast of India, Part II. *Proc. Indian Acad. Sci.*, **61B** (1): 12-24.

Takashi Ichiye. 1966. *Currents.* Indian Ocean. The encyclopedia of oceanography: 384-391.

Varma, P. Udaya and C. V. G. Reddy. 1959. Seasonal variations of the hydrological conditions of the Madras coastal waters. *Indian J. Fish.*, **6**: 298-305.

Velankar, N. 1950. Bacterial survey of sea water from the coast of Madras city (Bay of Bengal). *Proc. Indian Acad. Sci.*, **32B**: 80-86.