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STUDIES ON OCEANOGRAPHIC CONDITIONS OF THE SURFACE AND BOTTOM WATERS OF THE BAY OF BENGAL OFF VISAKHAPATNAM DURING 1968-1972

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ABSTRACT

The inshore hydrographic data in the region off Waltair for the period from October 1968 to March 1972 were observed in order to study the seasonal variation of temperature, salinity, dissolved oxygen content, phosphate and silicate. Salinity showed lesser variation at bottom than at surface. Changes of salinity from maximum to minimum and vice versa were quite rapid with a minimum in October and a steady maintenance in the maximum for a long period from April to July. Temperature variation gave rise to double maxima and double minima in the annual trend. Bottom waters showed consistantly higher values than surface with a maximum during September-October. Phosphates indicated two maxima, one during onset of monsoon and another during winter. Silicates showed a steady increase from January to December during 1971.

INTRODUCTION

BASED on a series of oceanographic investigations on the surface waters of the near-shore areas upto 18 metres off Visakhapatnam, a fairly accurate picture of their hydro-biological conditions is now available (Ganapati and Sarma, 1958; Ganapati and Rao, 1958; Rao and Rao, 1962). The existence of upwelling and sinking along the Waltair Coast (LaFond, 1954) and their probable importance in understanding the fluctuations in the pelagic fishery resources (La Fond, 1955) have also emerged out from these investigations. But the extensive exploratory trawling operations by Government of India vessels since 1959, have helped to establish the richness of the continental shelf for groundfish fisheries along the Waltair Coast (Sekharan *etal.*, 1973; Virabhadra Rao, 1973; Sekharan, 1973). That these resources have fluctuated widely over the years is also known. In order to understand these fluctuations better, it became necessary to investigate the hydrological conditions of the bottom waters. The present paper reports the results of such an investigation carried out from October 1968 to March 1972 on both the surface and bottom waters. The earlier investigations on the sub-surface layers in this region and beyond have covered only a part of the year (Ganapati *et al.*, 1956; LaFond and Bhavanarayana, 1956) and hence of limited usefulness.

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Material and Methods

Area of operation

The present work covers an area of about 200 square miles off Waltair bounded by Latitude 17°30′N to 17°50′N and Longitude 83°10′ to 83° 40′E. The region comprises of three statistical squares, *viz.*, 17-83/C5 and parts of 17–83/B4 and 17–83/D5 as adopted by the Government of India trawlers for reporting their catches.

Collection of water samples

The water samples both from the surface and bottom for analysis were collected from October 1968 to March 1972 on board the vessels, at different places of the fishing areas as an integral part of the exploratory fishing programme. The bottom samples upto a depth of 55 metres were collected with the help of 'Casella' bottle. Water temperatures were recorded immediately after each collection.

Analysis

The analytical procedures outlined by the author (1967) were followed without any modification during the present investigations also.

In view of the seasonal limit of collection, the data for the years 1968–69, 1969–70, 1970–71 were analysed in a comprehensive manner for the season October to March. The data from January 1971 to March 1972 were analysed to study their annual variations.

Results and Discussion

Temperature

The temperatures of the air, of sea surface and of bottom water for the season October through March are presented in Fig. 1a, b and c. A common feature of the temperature distribution of the air and sea is that, it was minimum sometime in the middle (December–January) of the season. Similar observations were made previously with respect to air and surface water temperatures of the Bay of Bengal off Waltair, (Ganapati and Sarma, 1958; Mojumder, 1967). The temperature of the sea surface was within a range from about 25.5°C to 29.5°C during the season. The upper limit of the air temperature was almost same as that of the sea surface, but the lower limit was 24.5°C thereby increasing the range of air temperature by about one

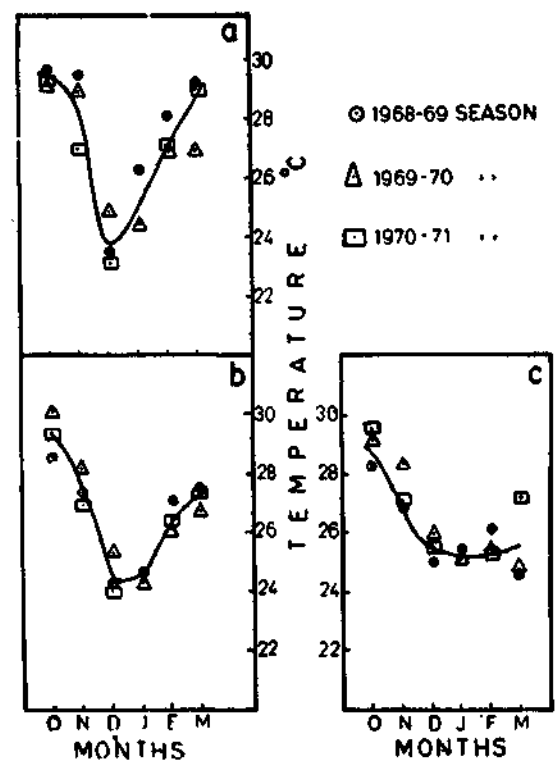

Fig. 1. Seasonal variations of temperature : a. Air temperature, b. Surface water temperature and c. Bottom water temperature.

degree more. The bottom water temperatures ranged from about 29°C to 25.5°C. The shortest range of bottom water temperature is note-worthy. It is interesting to notice that

the minimum of the bottom water temperature persisted over a longer period. The data of the individual years did not differ much and hence gave scope to maintain the main trend of the parameter.

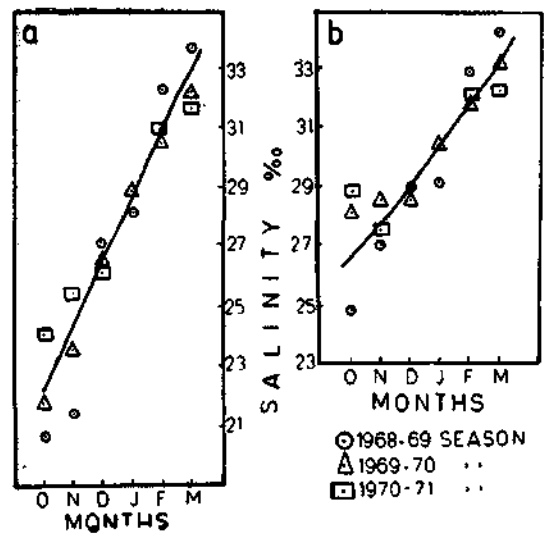

Fig. 2. Seasonal variation of salinity : a. Surface water salinity and b. Bottom water salinity.

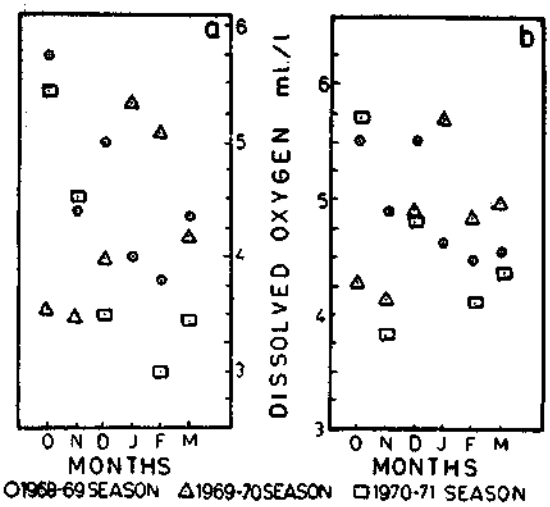

Fig. 3. Seasonal variations of dissolved oxygen : a. Surface water dissolved oxygen and b. Bottom water dissolved oxygen.

Salinity

The surface salinity for the season is shown in Fig. 2 a and Fig. 2 b represents the salinity of the bottom waters tor the same season. It is evident from these two figures that the salinity (either of surface or of bottom water) raised almost linearly from October till March. Similar trend in the surface salinity off Visakhapatnam Coast was observed earlier by Ganapati and Rao (1953), Ganapati and Murthy (1954), Ganapati and Sarma (1958) and Mojumder (1967). The range of surface salinity for the season was from 22‰ to 33‰. The salinity at bottom ranged from 26‰ to about 33‰ with the result that the season started with a wide difference of salinity between the bottom and the surface and this difference narrowed down as the time advanced and the water column (surface to bottom) attained almost uniform

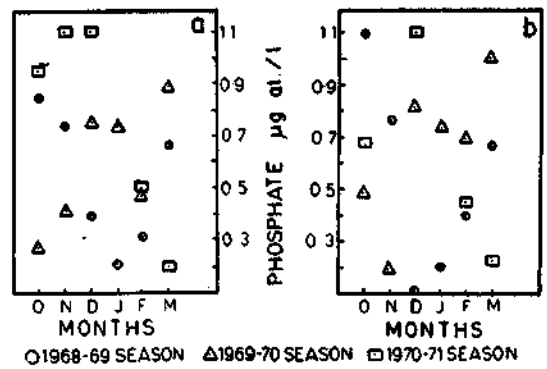

Fig. 4. Seasonal variations of phosphate : a. Surface water phosphate and b. Bottom water phosphate.

salinity by the end of the season. Just like the temperatures, the salinity data also showed reproducibility over the years. From the fishery point of view, it is interesting to observe that the bottom waters maintain relatively warm and steady temperature and relatively higher salinity with less rapid changes when compared with the surface water conditions.

Dissolved oxygen

The dissolved oxygen distribution over the season for surface and bottom waters are shown in Fig. 3 a and 3 b respectively. The data over the years 1968 to 1971 for dissolved-oxygen showed much scattering and is thus nonreproducible. This feature is probably due to the effect of diffusion processes and is related to the biochemical processes taking place in the sea (Ganapati and Sarma, 1958; Ganapati and Rao, 1953). However, the general trend of oxygen distribution is to decrease during the season for the years 1968–69 and 1970–71, but opposite for the year 1969–70. Although the scattered oxygen values was too much, the bulk of the data ranged within the limits of 3.5 ml/l and 4.5 ml/l for both of the surface and the bottom waters.

Phosphate

The inorganic phosphate content of the surface and bottom waters are presented in Fig. 4 a and 4 b respectively. Like the oxygen data, the phosphate values also indicated much scatter over the season rendering the data nonreproducible. Nevertheless, the general trend of phosphate indicates a decrease during the season for the years 1968–69, 1970–71 and an opposite trend for the year 1969–70 just as in the case of oxygen. Irrespective of seasonal trend of phosphate values for different years, the observations of both the surface and bottom waters varied within the limits of 0.2 µg at/l to 1.0 µg at/l.

Silicate

The silicate values for surface and bottom waters are presented in Fig. 5 a and 5 b respectively. Like phosphate, the silicate values also showed wide scatter during the season. However, the seasonal trend of silicate is to increase for the year 1968–69 and to decrease for the remaining years. The silicate values for the season mainly range from 10 µg at/l to 20 µg at/l both for surface and the bottom waters.

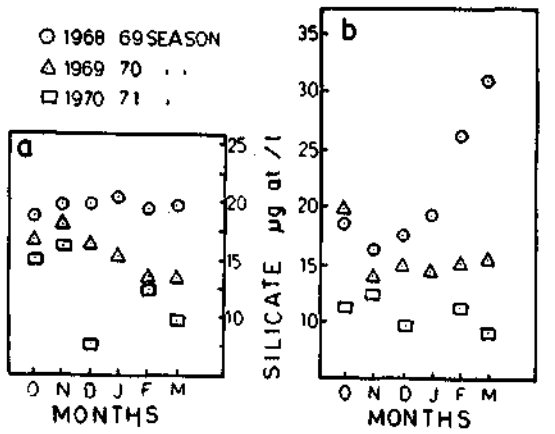

Fig. 5. Seasonal variations of silicate : a. Surface water silicate and b. Bottom water silicate.

ANNUAL VARIATIONS

Temperature

The annual variations (from January 1971 to March 1972) of atmospheric temperature and surface and bottom water temperatures

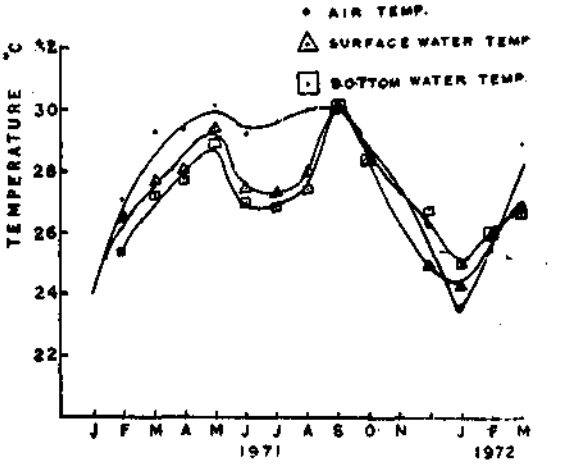

Fig. 6. Annual variations of temperature.

are shown in Fig. 6. All the three temperature curves indicated a rise from January to May

followed by a decline from May to September. This decline coincided with the southwest monsoon season characterised with less incoming radiation due to dense and widespread cloud cover. Thus, this decline gives rise to a second maximum of temperature in September from which month onwards the temperature decreased to reach its winter minimum. Similar observations with respect to air and surface water were made by Murty (1965).

Salinity

The annual distribution of salinity is shown in Fig. 7. Except for a single observation in December (bottom water) all the observations (both surface and bottom) fall in a general trend. The salinity rised to its maximum (about 32‰) in April and maintained this concentration till July and therefrom the salinity declined rapidly to its minimum (about 20‰) in October. The salinity again increased from October onwards. It is interesting to note that the minimum was sharp occurring in a single month whereas the maximum spreads over a number of months. Identical trend was observed in the seasonal distribution of salinity of surface water at Waltair earlier (Murty, 1965; Mojumder, 1967).

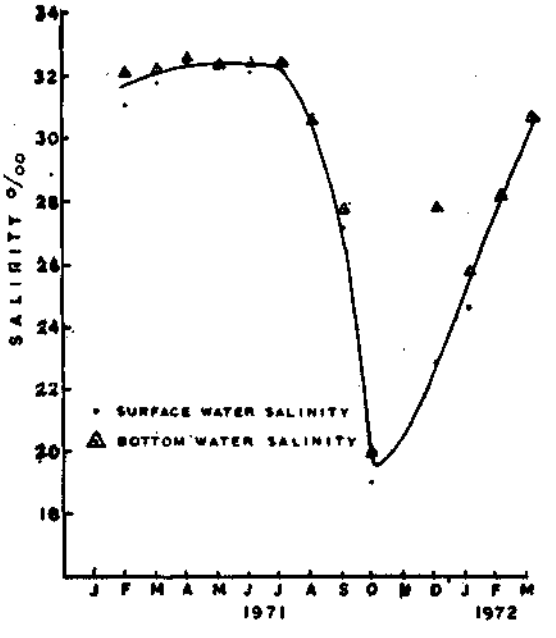

Fig. 7. Annual variations of salinity.

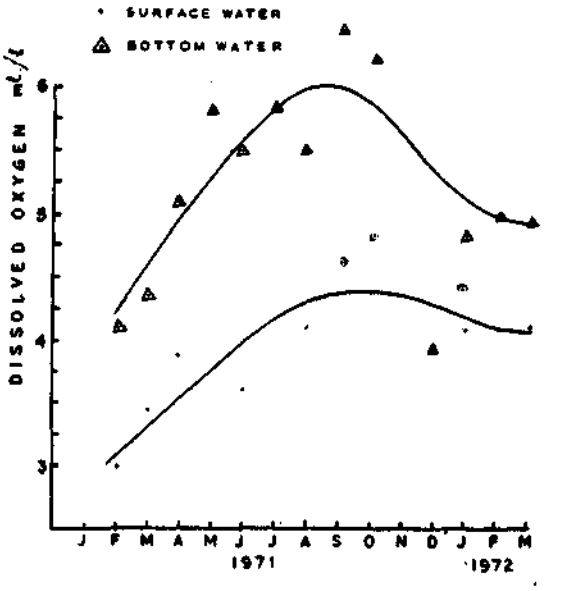

Fig. 8. Annual variations of dissolved oxygen.

Dissolved oxygen

The annual variations of dissolved oxygen are presented in Fig. 8. In preparing this figure, the data for December are excluded as the corresponding values (both for surface and bottom water) deviate much from the trend. Dissolved oxygen increased from January 1971 and reached maximum during September–October. The October–March season of the year 1971–72 showed a decrease of oxygen during this season. Another feature of dissolved oxygen is that the bottom water always contained higher amount of dissolved oxygen (about one ml/l more) than the surface waters. Thus the difference is much more during the transition period of the southwest and northeast monsoon seasons. This difference may be attributed to the biological activity of the bottom waters.

Phosphate

The month to month variations of phosphate from January 1971 to March 1972 are presented in Fig. 9. The annual trend (for surface

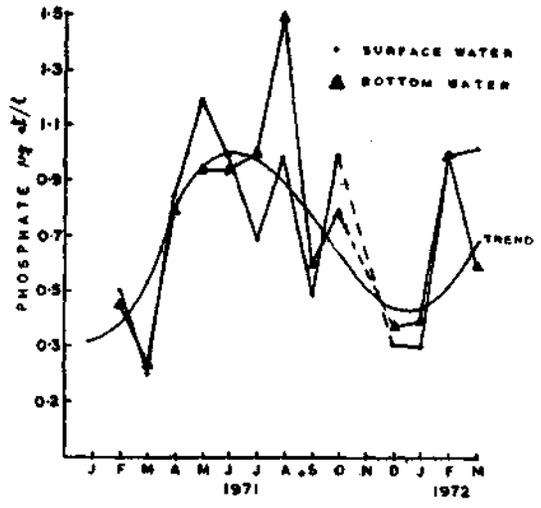

Fig. 9. Annual variations of phosphate.

and bottom together) is also shown. From the trend it is clear that phosphate was minimum during December–January and maximum during May–July.

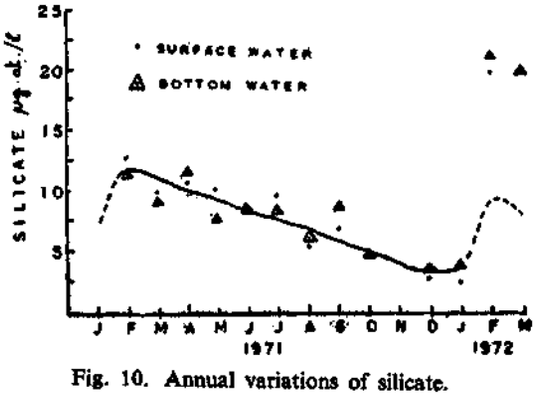

Fig. 10. Annual variations of silicate.

Silicate

The annual variation of silicate is presented in Fig. 10. The annual trend indicated a linear decrease of silicate from about February 1971 till December 1971 or January 1972. (The data for February and March 1972 were eliminated as they deviate much from the trend).

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