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A STUDY ON THE NEAR-SHORE WATER OF THE KARWAR BAY IN THE NORTH KANARA COAST

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ABSTRACT

The temperature of the sea-water and the maximum-minimum atmospheric temperature exhibit typical double oscillations and parallel seasonal fluctuations. But, for the temperature of the air over the sea a double oscillation is of doubtful occurence. The temperature of the water which is generally above the one of the air, falls below it in July-August when the monsoon is most active and the atmosphere highly humid. The salinity if high in March-April and low in July-August. The pH and the dissolved oxygen in the water show double oscillations in a year and the percentage saturation also has more or less the same trend. Saturation or supersaturation is a rare occurrence mostly confined to May-June and January-February. The study of the near-shore water is important here in relation to the local coastal fishery for the Indian mackerel.

INTRODUCTION

STUDIES on the seawater off the North Kanara Coast have been published by Ramamurthy (1963) and Noble (1968) and that of the Karwar Bay by Annigeri (1968). Besides these, Noble (1972) has made some observations also on the relation between the mackerel fishery of the bay with the temperature of the water, its oxygen content and the local rainfall. As schools of the mackerel come close to the shore to contribute to the commercial fishery at Karwar and the fishing during the season is restricted to the 2.4 km belt (Pradhan, 1956) a study of the nearshore hydrography appeared important and this along with some related meteorological observations embody this paper. Its bearing on the fishery of the Indian mackerel, however, will be dealt with elsewhere.

MATERIAL AND METHODS

At Karwar everyday from April 1960 to December 1964, samples of the seawater were collected from the bay very near the shore where the depth was around a metre and the pH, salinity and dissolved oxygen were studied by methods already referred to (Noble, 1968). The percentage saturation of the dissolved oxygen was found by using the nomogram in Richards and Corwin (1956). The atmospheric temperature over the sea where the water was collected was also recorded. The temperature of the seawater at surface was observed *in situ* from January 1960 to December 1964. Observations on the maximum-minimum temperatures of the atmosphere (recorded in the morning hours for the five years), and the humidity (read at noon for 1962-64 only) by using wet and dry bulb, were conducted in the laboratory on shore located not far off from the collection spot of the seawater.

RESULTS

Observations on the temperature of the seawater and the atmosphere, the local rainfall and humidity are illustrated in Fig. 1. The temperature of the seawater shows a typical double oscillation in a year having a major peak in April-May and a minor one in November, and the first fall in August and

the second in January. Between the major and the minor peaks the values differ widely, whereas between the two falls it is less. The temperature of the atmosphere over the sea surface is very low in January. It steeply increases in March and April and attains the primary peak in May. During June-September it becomes low and reaches the primary fall in January, showing at times a slight rise in October. The maximum values of the atmospheric temperature show the typical double oscillations with the primary and secondary peaks in April-May and November respectively and the primary fall in August and the secondary one in January. The minimum temperature shows extremely low values in January and the steep climb in subsequent months towards the peak in May, whence it falls down in the rainy season and shows the secondry fall in August. The values again show a secondary rise in October before the primary fall of January.

The monsoon starts in May and becomes most active in June-August. The maximum rainfall occurs in July. The monsoon gets weaker in September when the precipitation is also correspondingly lower and subsequently stops generally by early November. However, in 1962, there were a few showers in December also. The relative humidity is the lowest in February. It increases in March and remains almost the same in April and May. In June it again rises and reaches the peak in August. It declines in the following months and reaches the minimum values in February. During the trough, the humidity had reached very low values such as 32% on a day in the first week of February 1963 and 38% in the second week of February 1964. On the other hand, 100% humidity was noticed on some days when there were continuous down pour locally.

Data on salinity, pH, dissolved oxygen and the percentage saturation are presented in Fig. 2. The salinity values are very high in summer months and the peak occurs in March-April. The high values persist upto the beginning of May, whence they start declining with increasing rainfall. Very low values of salinity occur in August during the southwest monsoon period. The values start increasing from September and subsequently reach the peak of the summer months. An inconspicuous peak and fall is also noticed between the primary fall of 1962 and the primary peak of 1963. The pH remains high during January-April and falls in May-July. It reaches the lowest values in August. It further rises in September and attains a peak in October and slightly lowers in November and again rises and remains static during January-April in high values as already mentioned. The dissolved oxygen shows a double oscillation in its seasonal distribution, attaining a secondary peak in February and the primary peak in August, and the secondary fall in April and primary fall in November. The percentage saturation also shows, more or less, a double oscillation with a peak in February, a small fall in August, another rise in July and then a steep fall in November. Saturation or supersaturation occurred seldom only. In 1963, the oxygen did not reach saturation level. On the contrary, very low saturation point was observed in November.

General Observations and Discussion

The temperature of the seawater and the maximum-minimum atmospheric temperatures show parallel curves in their seasonal fluctuations. However, the temperature of the air over the sea, in its seasonal changes, is not strictly parallel to that of the water. The temperature of the seawater is higher than that of the atmosphere over the sea save the rainy season when the latter becomes slightly more than the former (Fig. 1). Ramamurthy (1963) also observed the water temperature at Karwar to be below the air temperature during the rainy season. At Mandapam in the east coast also it has been observed to be in May-July (Prasad, 1957).

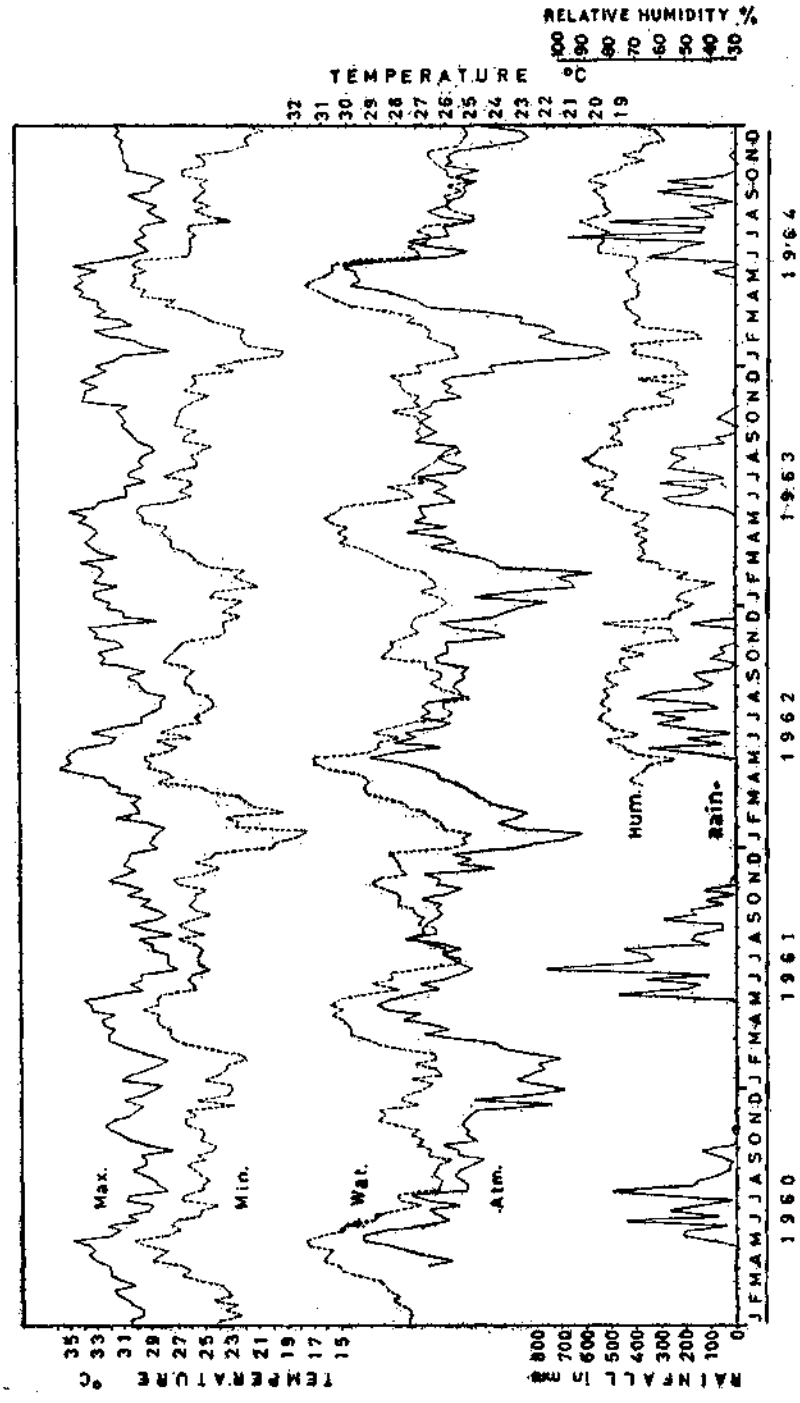

Fig. 1. The seasonal distribution of the temperature of the seawater and the atmosphere above the sea surface, the maximum-minimum air temperature, rainfall and the relative humidity at Karwar (weekly averages).

The consolidated average value for the entire five year period under study (Fig. 3) shows the atmospheric temperature to be just closely over the seawater temperature in August only. The range between the two increases in the post-monsoon months. They are wide apart in February. In summer the differences are comparatively less. By the beginning of the rainy season they come still closer and the atmospheric temperature exceeds the water temperature in August as already stated. The gap between the maximum and minimum atmospheric temperature is great in winter (widest in January), and it is comparatively less during July-September (Figs. 1, 3).

The temperature of the seawater and the maximum-minimum atmospheric temperature show definite double oscillations in the course of a year. But with regard to the atmospheric temperature over the sea, a secondary peak is of doubtful occurrence (Fig. 3) as it has been noticed sufficiently clearly only in 1961 (Fig. 1) of the years under observation.

Bal *et al.* (1946) observed that at Bombay the maximum and minimum temperature of the water fell almost within the same range as the daily maximum and minimum temperature of the air. The pattern of curves in the temperature of the seawater and the maximum atmospheric temperature at Karwar is the same, both having the primary and secondary peaks in May and November respectively and the primary fall in August and the secondary fall in January (Fig. 3). They agree well with the minimum atmospheric temperature and the temperature of the air over the sea in having their primary peaks also in May. But the secondary peaks in them occur a month ahead in October. Their falls also coincide with the occurrence of the falls of the seawater temperature. But contrary to the primary fall in August and secondary fall in January of the seawater temperature and the maximum atmospheric temperature, the fall in January becomes the primary and the one in August (found only in the minimum atmospheric temperature) the secondary.

The values at the primary peaks are well high over the values at the secondary peaks in all temperatures. With regard to the falls, the major and minor ones are more or less of the same magnitude in the seawater. In the maximum atmospheric temperature the range between the two falls are more and in the other two they are wider.

In January the atmospheric temperature over the sea in the morning hours is of the same magnitude as that of the minimum records of the air temperature at Karwar (Fig. 3). In 1962, it was even slightly more (Fig. 1). During February-May the minimum temperature is above the temperature over the sea. But when the rains start they cross over and remain vice-versa in June - December. In September - October these temperature values come close to each other, but move apart in November - December.

The fall in the temperature after the primary peak coincides with the southwest monsoon (Fig. 3). The peak of the rainfall, however, as notified elsewhere (Noble, 1968) occurs in July, whereas the fall in temperature appears in August only. A similar phenomenon occurs at Mandapam on the east coast (Prasad, 1957) where also the lowest temperature were always recorded soon after the local north east monsoon. The surface temperature falls only slightly during the southwest monsoon which is weak over there and Prasad (1957) further suggests that it is due to the prevalent strong winds which create turbulence and promote cooling of the water through rapid evaporation.

During June - September, the atmosphere is more humid at Karwar and the peak in the relative humidity also happens to be in August (Fig. 3) after the heavy rains, when the temperatures are low.

The relation between the salinity and the temperature and pH as in the inshore waters off the North Kanara Coast (Noble, 1968) is direct and between salinity and the rainfall it is inverse. The pH and oxygen show parallel movements during October - April, but exhibit opposite trends during May - September, a relation already found peculiar to this coast (Noble, 1968).

The peaks in January - February and August and the falls in April - May and November of the dissolved oxygen occurred simultaneously with the falls and peaks of the seawater temperature. High values of the oxygen also coincided with the occurrence of low salinity.

The dissolved oxygen in the seawater in the Karwar Bay and the percentage saturation as for the coast (Ramamurthy, 1963) also, more or less, go hand in hand in their seasonal distribution. The percentage saturation is high in February and June. In April it is low and in November it becomes the lowest. At Calicut also (Kasturirangan, 1957) the percentage saturation is said to closely follow the oxygen content. However, according to the five year average values at Karwar (Fig. 3) the water is comparatively undersaturated when the oxygen is at its maximum.

Saturation or supersaturation is reported rare along the North Kanara Coast (Ramamurthy, 1963). They were seen only sparingly,

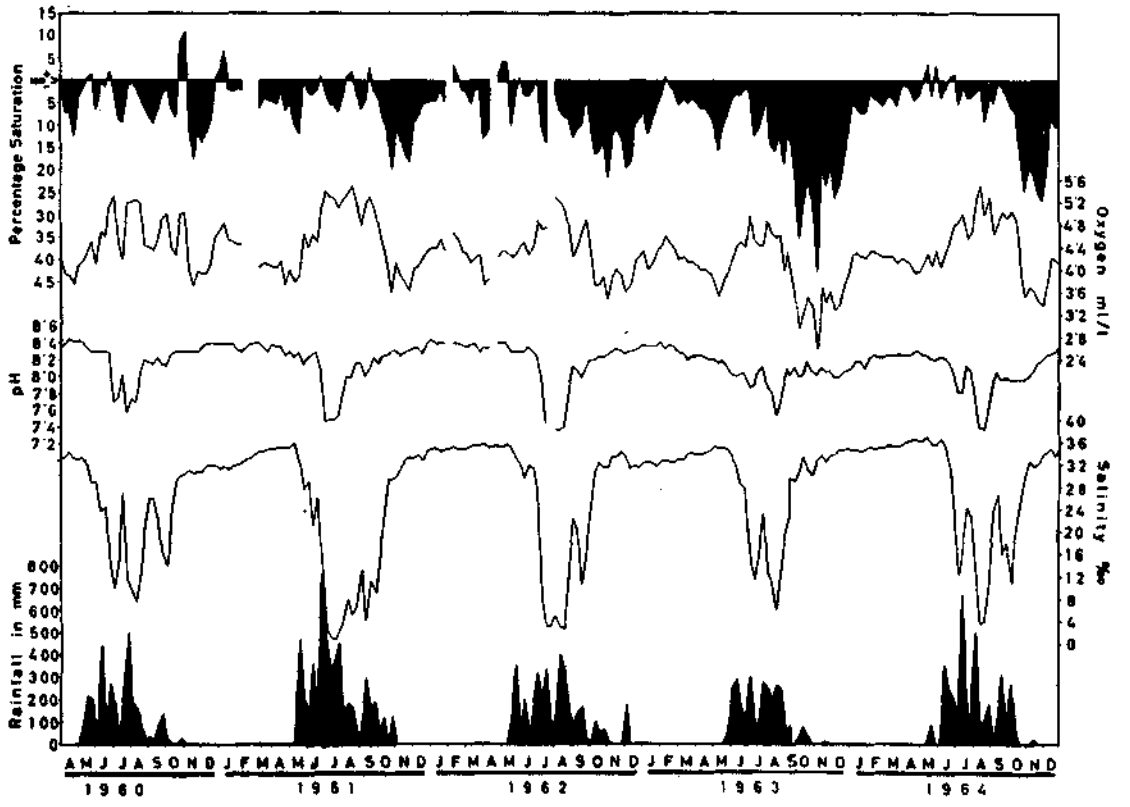

Fig. 2. Salinity, dissolved oxygen, percentage saturation, pH and rainfall at Karwar (weekly averages).

occurring mostly in May-June and January-February in the present study also (Fig. 2). Besides being scarce in occurrence, the degree of supersaturation also is not sufficient to register it in the overall average values (Fig. 3) waters, and below surface the water was always undersaturated. At Madras (Ramamurthy, 1953) it is reported never to move far away from saturation, a condition supposed to be typical of tropical seas and Mandapam waters

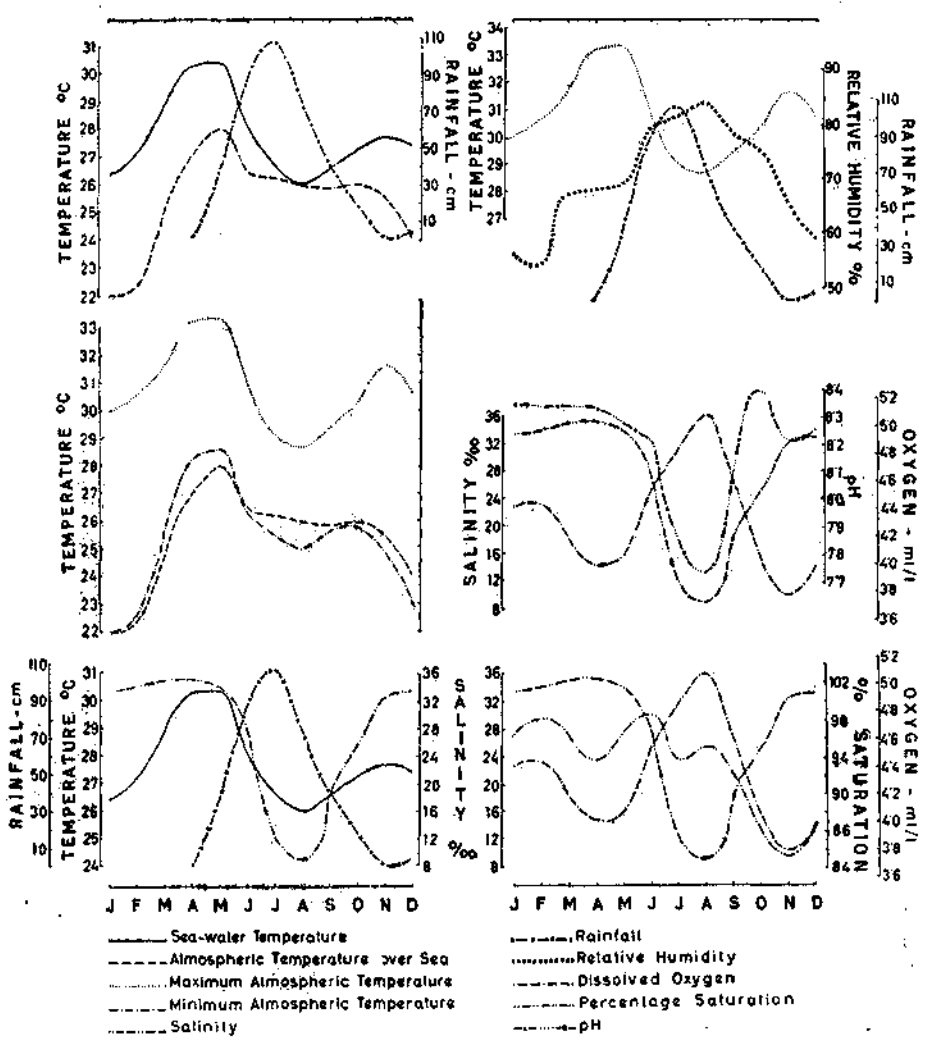

Fig. 3. Monthly mean values for the five year period of the various factors showing their inter-relationships.

for the years under consideration here. Subsequent studies in the inshore waters of the Karwar Bay (Annigeri, 1968) hardly show 2 or 3 values at supersaturation level and a few values near saturation point at surface appear always undersaturated (Jayaraman, 1954). On the contrary, at Calicut (Kasturirangan, 1957), supersaturation is found frequently in the inshore waters and more often in the offshore areas, particularly at times of

phytoplankton predominance. Subrahmanyan (1959) noticed that during phytoplankton outbursts oxygen concentration increases and even exceeds saturation point superseding the demand for respiration and oxidation in the environment. The tendency to develop saturation or supersaturation was seen mostly associated with the occurrence of a good number of phytoplankton in the plankton collected even in the inshore water of the Karwar Bay (Noble, MS). When the temperature and salinity of the water are the lowest in August immediately after the peak of the rainfall in July, a condition conducive for saturation, the oxygen in the water attains its peak. Still the water is much less saturated. Evidently it could take in more oxygen, and the occurrence of high dissolved oxygen content in the water simply does not mean its saturation or supersaturation as has been stated by Kunjukrishna Pillai (1968) at Bombay.

The dissolved oxygen content of the inshore water of the Bay was found to be less when the mackerel catch was more and more when the catch was less (Noble, 1972), and the catch was less when the local rainfall was high and *vice versa*. In the like manner, it has also been found (Noble, 1972) that when the minimum value of the temperature of the surface water in the inshore area was less the duration of the season for the mackerel fishery in the Karwar Bay was long and it was short when the temperature was more. The appearance of the mackerel shoals in the area of the *Rampan* operations seems to coincide with the occurrence of definite changes in the hydrological conditions on the waters very close to the shore. Their correlation with the fishery, fluctuations in the availability of the fish within a season, and the magnitude of the catch is inevitable to evaluate the optimum environmental conditions of the fishery in the Bay.

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