

PROCEEDINGS OF THE SYMPOSIUM
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OCEANOGRAPHIC FEATURES AND ABUNDANCE OF THE PELAGIC FISHERIES ALONG THE WEST COAST OF INDIA

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ABSTRACT

The results of a study on the hydrographic properties such as temperature, salinity and Sigma-T (density) content of the surface waters along the west coast of India collected during the cruises of *R. V. Varuna* and other vessels are presented as an average distribution of the factors month-wise for each degree square. This has been used to investigate the relationship of the hydrographic conditions with the pelagic fishery landings such as those of the oil sardine and the Indian mackerel month-wise. The importance of the coastal phenomena like upwelling and sinking in relation to the fishery landings is pointed out.

INTRODUCTION

A GOOD amount of work has been carried out on the hydrographic features along the west and east coasts of India by the Central Marine Fisheries Research Institute since 1957 (Ramamirtham, 1966, 1967; Ramamirtham *et al.*, 1960, 1963, 1964, 1965; Patil *et al.*, 1963, 1964; Rao, 1967; Rao *et al.*, 1964, 1965; Jayaraman *et al.*, 1959, 1960, 1961; Subrahmanyam, 1959, 1965; Ramasastry *et al.*, 1960; Sharma 1967, 1968; Murthy *et al.*, 1964). As the coastal waters are to a greater extent susceptible to the influence of the two monsoons, *viz.*, the north-east and south-west monsoons, the seasonal changes in the properties of the waters are striking. In the present account, the effect of these changes on the abundance of the pelagic fisheries, oil sardine and mackerel, are examined with reference to the surface oceanographic conditions.

The hydrographic data were collected for 3,300 stations during the cruises of *M. V. Pratap*, *M. O. Kristensen*, *R. V. Kalava* and *R. V. Varuna* from September 1957 to September 1965 along the west coast of India. Monthly averages for each one degree square were computed for properties such as temperature, salinity and sigma-T (density) at the surface. The distribution of these properties has been charted out in a horizontal plane along the sea surface, month-wise. The fish landing data pertaining to oil sardine and mackerel for the above period have been averaged out for each month in each zone (Fig. 1) along the west coast, and the consolidated picture showing their abundance in relation to surface oceanographic conditions has been prepared and given in Figs. 2-10. The year-to-year variation, in the oceanographic properties as well as the fish landing data, have not been considered.

OBSERVATIONS

July (Figs. 2 & 3).—The surface temperatures are low, the lowest being 25.4° C occurring off Trivandrum. Along the coast, the abundance of both oil sardine and mackerel is very low compared to the other months, the catches being mostly below 50 tonnes. In the region between Cochin and Mangalore the oil sardine catches are more than those of mackerel and vary between 500 and 1,000 tonnes. The maximum landings for mackerel is found off Cochin and is 200 tonnes only. Near the coast the salinity values are less than 32.5‰ being the effect of precipitation and run off during monsoon. These low salinity values appear more favourable to sardine than mackerel.

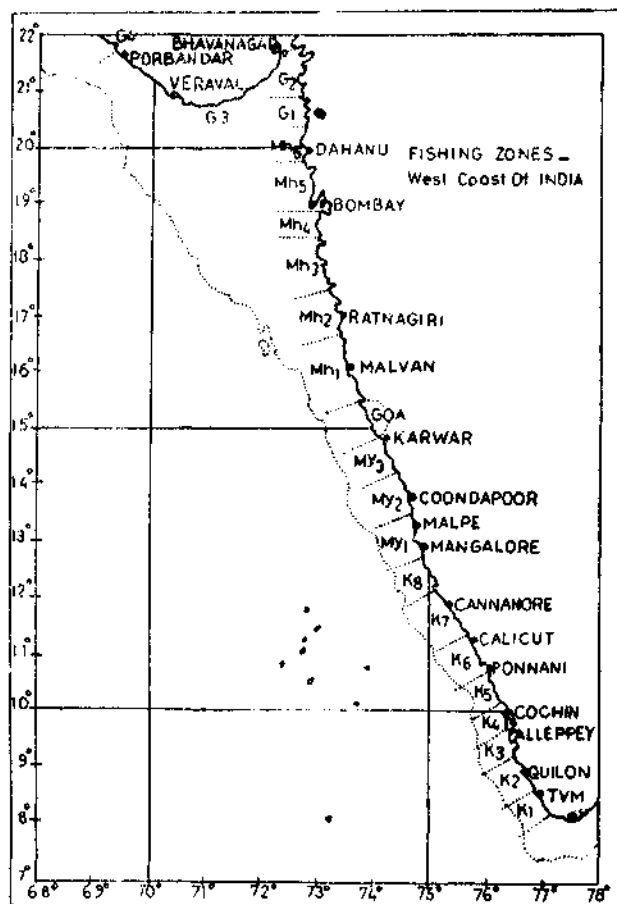


Fig. 1

August (Figs. 2 & 3).—The temperature values have increased by about 0.7°C . There is a considerable enhancement in the catches of sardine along the coast although the abundance of mackerel remains more or less the same. The higher catches of sardine are still confined to the region between Cochin and Mangalore where the salinity values are less than 31‰ .

September (Figs. 2 & 3).—Associated with the increase of temperature throughout the coast, the fish landings are also much higher than those of August. Still oil sardine abounds more than mackerel. The maximum catch for mackerel is nearly 2,000 tonnes and is found off Ponnani and is much less than the sardine catches. With the general increase in temperature there is a general increase in salinity too. The major fishing zone is still confined between Alleppey and Mangalore. In the high salinity region north of Mangalore the catch varies from 50 to 200 tonnes, for both the fisheries whereas in the southern regions (Off Cannanore) the sardine catch is about 8,500 tonnes where salinity is 33.5‰ . With the change in the hydrographic conditions, the abundance of mackerel is far better than in the previous months, landings as high as 1,500 tonnes, occurring in the region Ponnani to Calicut. It may be seen that the salinity is higher by nearly 0.5‰ , in the region of maximum mackerel catch, than of the region of maximum sardine catch.

October (Figs. 2 & 3).—By October the temperature values are considerably higher than in September and the mackerel fishery extends up to Karwar. This seems to be the peak season for mackerel. There is a remarkable increase in the abundance of both the fisheries. The salinity values vary from 34‰ to 34.5‰ in the region where good sardine fishery is observed. Again maximum sardine catches are found between Calicut and Cannanore and maximum abundance of mackerel is found off Coondapoor.

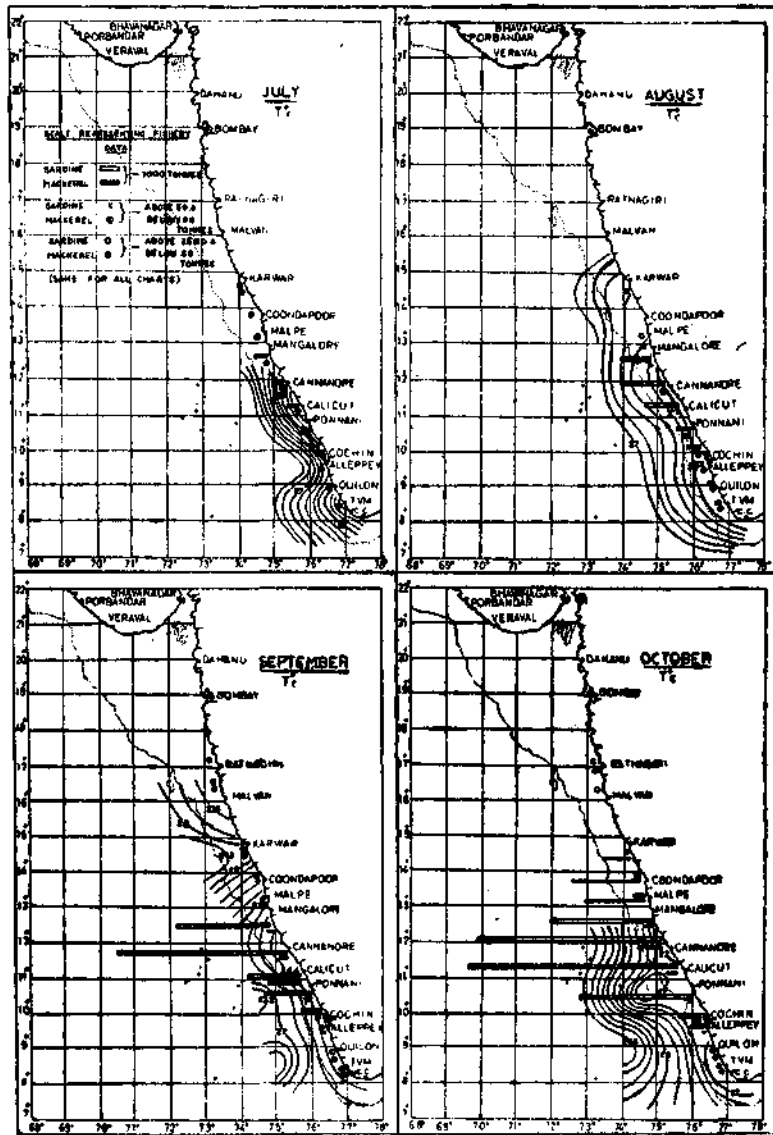


FIG. 2

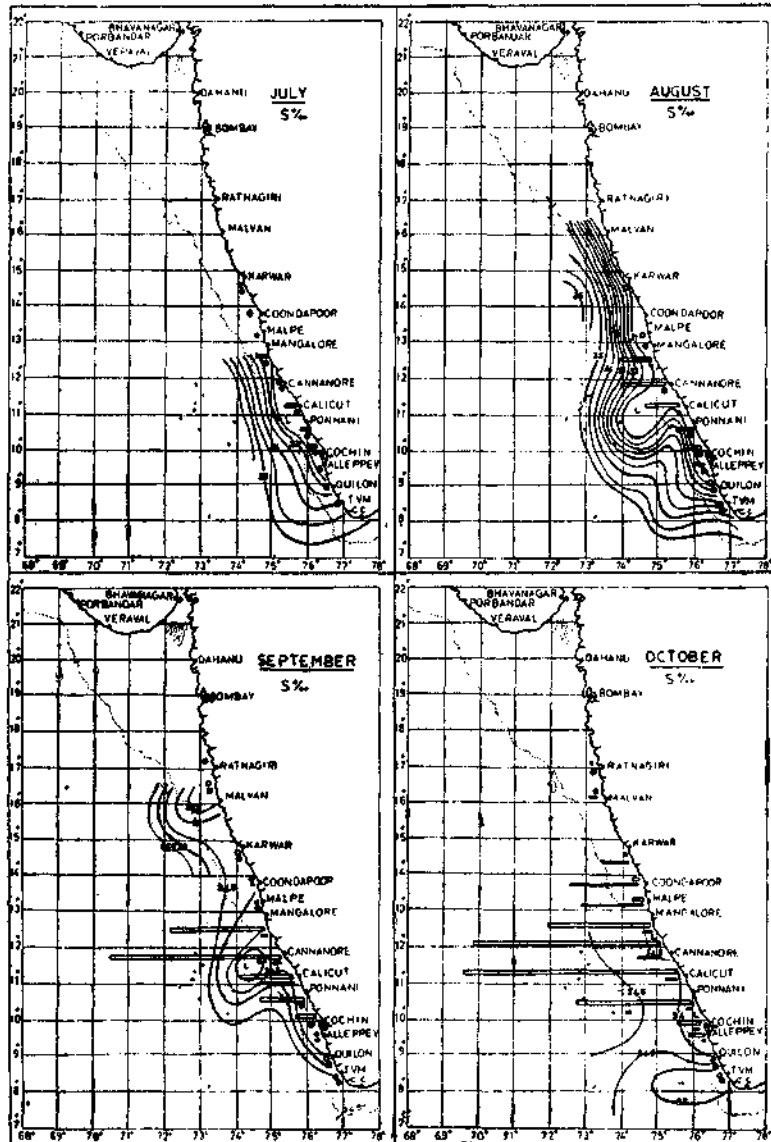


FIG. 3

November (Figs. 4 & 5).—The coastal temperature values have increased by 2° C and a more even distribution of the fishery (oil sardine and mackerel) is observed along the coast. Mackerel fishery is dominant in the region north of Calicut, but the sardine fishery extends from Alleppey northwards.

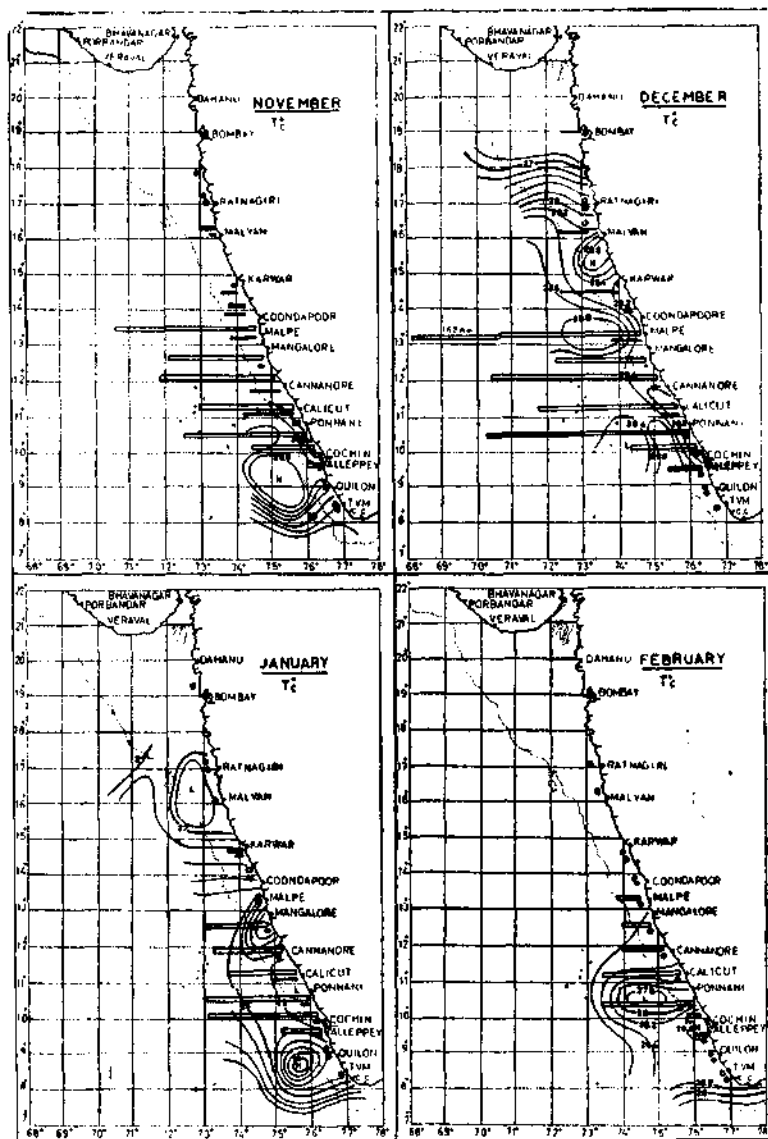


FIG. 4

December (Figs. 4 & 5).—The peak season for oil sardine seems to be December when a record catch of 16,200 tonnes is observed off Malpe. The temperature values along the coast are little less than November and more or less a uniform distribution is observed all along the coast. The abundance of mackerel in the northern regions has increased, the maximum being off Karwar where the temperature varies between 28·2° and 28·4°C. The mackerel catch in the southern region (south of Mangalore) has decreased, compared to that in November. Although the temperature distribution along the coast is more or less uniform, the salinity varies from 33·5 to 36·0‰ and it is seen that the mackerel fishery is concentrated in the high saline regions north of Mangalore. Sardine fishery is mostly confined to the region between Alleppey and malpe.

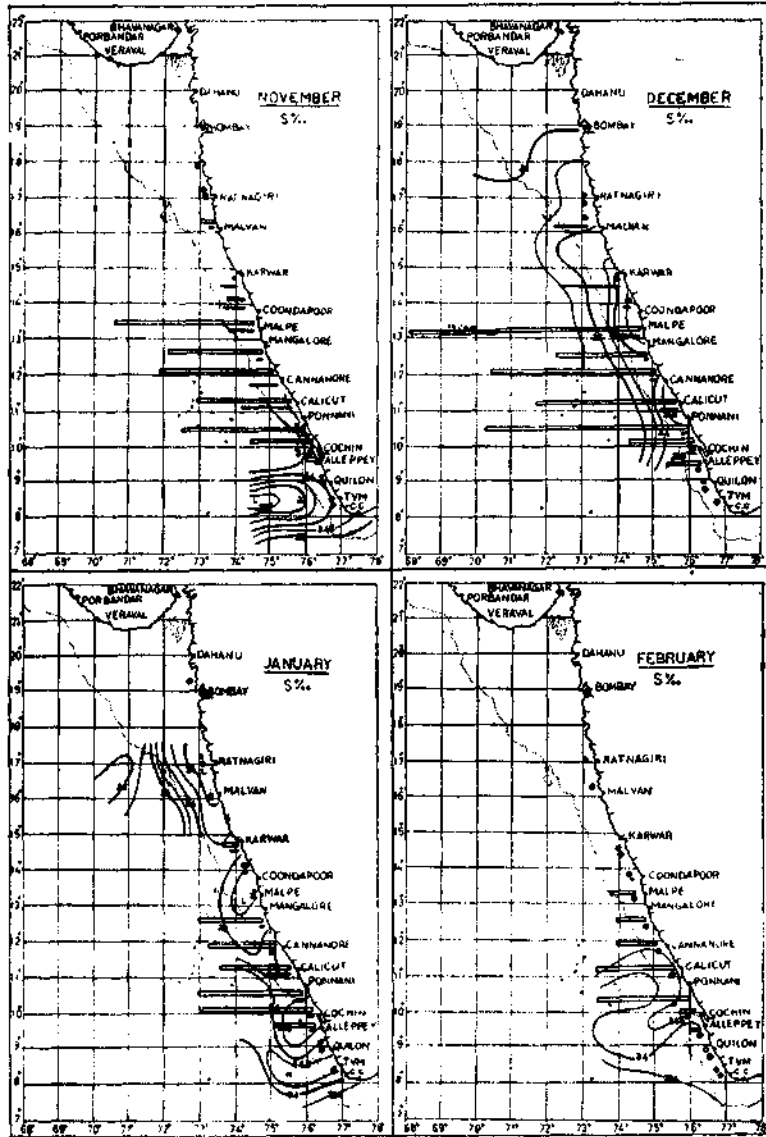


FIG. 5

January (Figs. 4 & 5).—The temperature distribution is uniform along the coast up to Coondapoor except for the two high temperature cells one off Quilon and another of Mangalore. North of Coondapoor, the temperature values are little less than the southern regions. The overall fish landings have decreased considerably than the previous month and the mackerel fishery seems to be affected more adversely than the sardine fishery. The salinity ranges are more or less the same as in December.

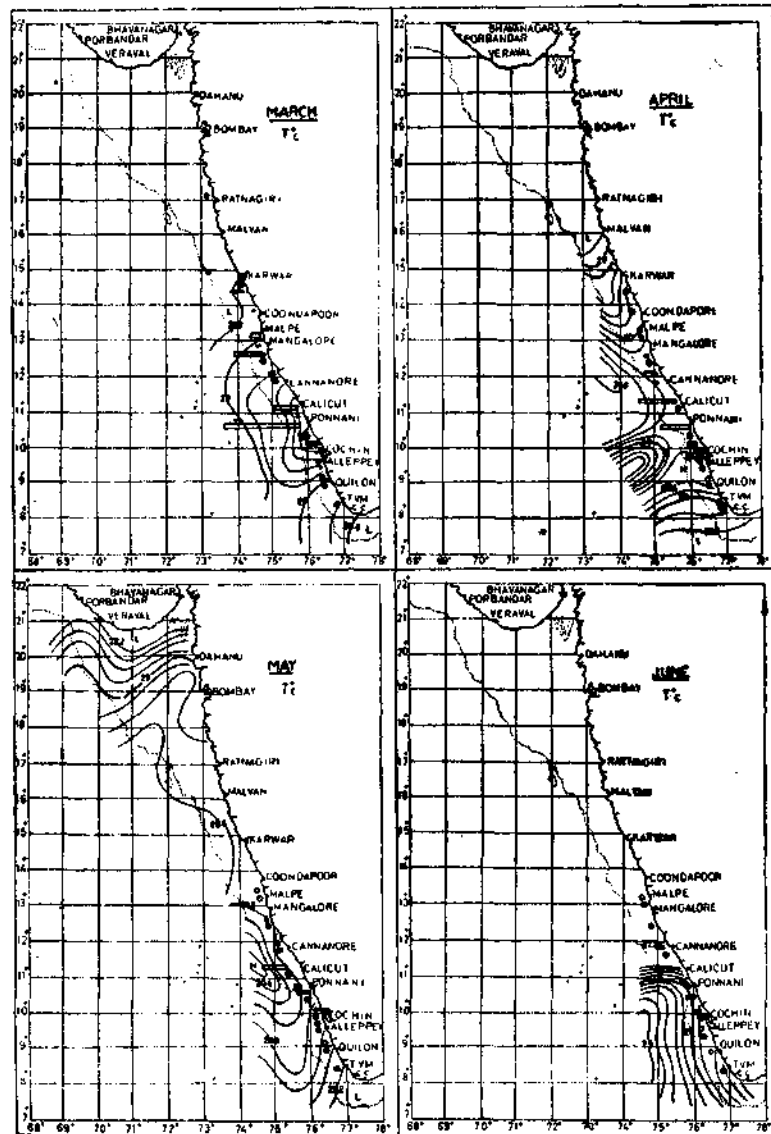


FIG. 6

February (Figs. 4 & 5).—By February the temperature values have decreased a little and the mackerel catches all along the coast have reduced, the catches being mostly below 50 tonnes. The sardine fishery is also adversely affected. Salinity varies from 33.5 to 34.5‰.

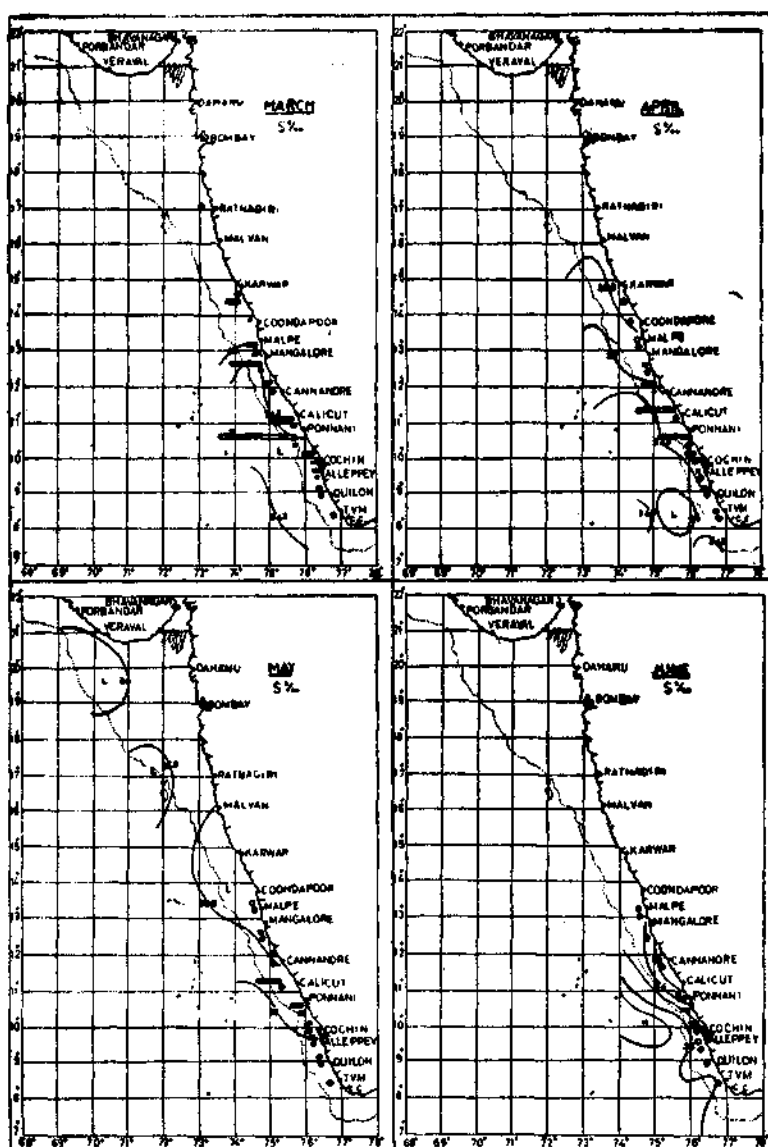


FIG. 7

March (Figs. 6 & 7).—By the approach of summer, during March, the coastal temperatures have increased and values as high as 30°C are observed in the region Cochin to Calicut. The overall fish landings have still decreased and except for the Karwar zone, the mackerel landings are never greater than 200 tonnes. The abundance of oil sardine is much more (4,000 tonnes) off Ponnani, although the values are comparatively lower than the previous month. The salinity shows more or less uniform distribution along the coast (34.5‰).

April (Figs. 6 & 7).—With still higher temperatures, during April, the landings are still less, the landing figures for mackerel being mostly less than 100 tonnes all along the coast. Maximum sardine landings amounted to 1,900 tonnes only, off Calicut. Salinity values vary from 34.5 to 35.5‰.

May (Figs. 6 & 7).—Along the whole coast the temperature values are much higher during May, values ranging from 28.2° to 29.6° C in the northern regions and from 29.2° to 30.4° C in the southern regions. Fish landings are considerably less than in the previous months, the mackerel landings being mostly below 50 tonnes. Although the sardine landings are better than the mackerel, values over 1,200 tonnes are not found along the coast. Salinity values are uniformly high (35.5 to 36.00‰) throughout the whole coast.

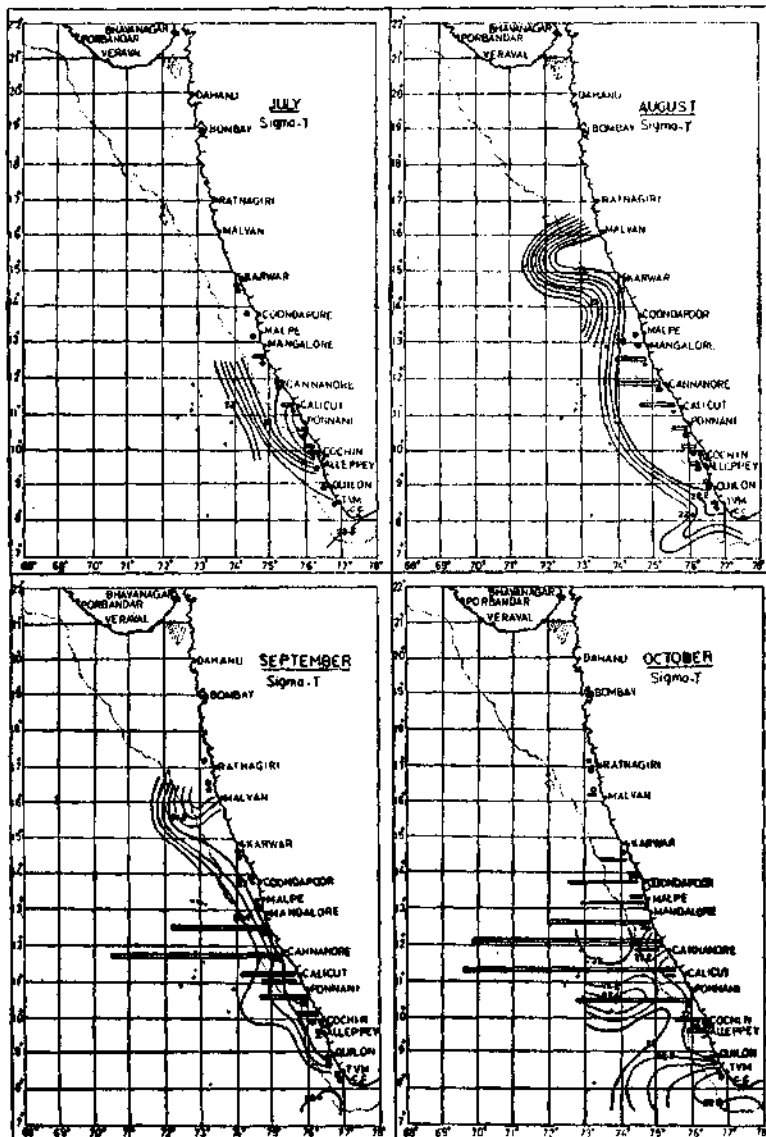


FIG. 8

June (Figs. 6 & 7).—By the approach of monsoon conditions, a gradient is found in temperature eastwards. Coastal temperatures have decreased considerably by about 2° C and the overall landings along the coast are minimum during this month. Salinity values also show noticeable decrease.

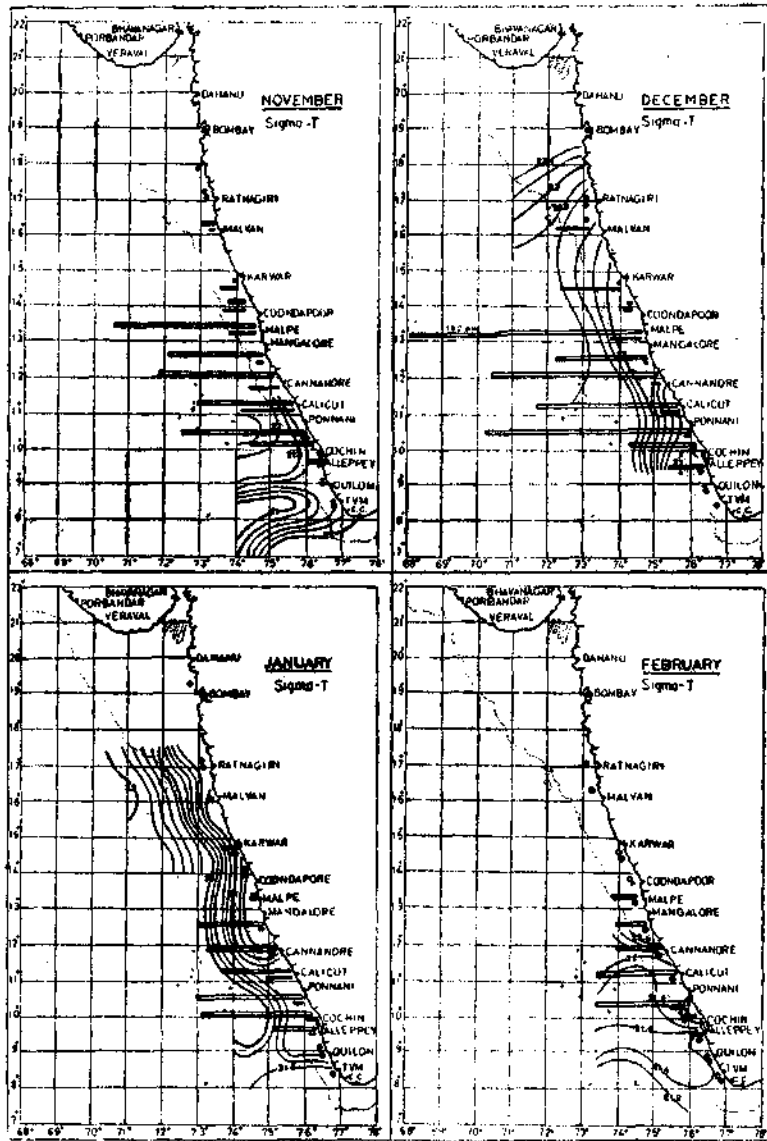


FIG. 9

Distribution of sigma-T (Density).—(Figs. 8-10). During the monsoon season, due to the freshwater influx from the shore the coastal density values at the surface are low and during this season it will not be correct to ascertain the movement patterns from the surface density values alone. These features prevail from July to September. During October, eddy structures predominate at

the surface which are observed during November also. During December, the northerly movement associated with the sinking phenomenon is clearly observed and during January, this movement takes up a more well-defined pattern. February and March present the dissipation of this regular current system and during April and May more or less stagnant conditions exist along the west coast. Again, during the south-west monsoon, the low density belt along the coast is developed by June.

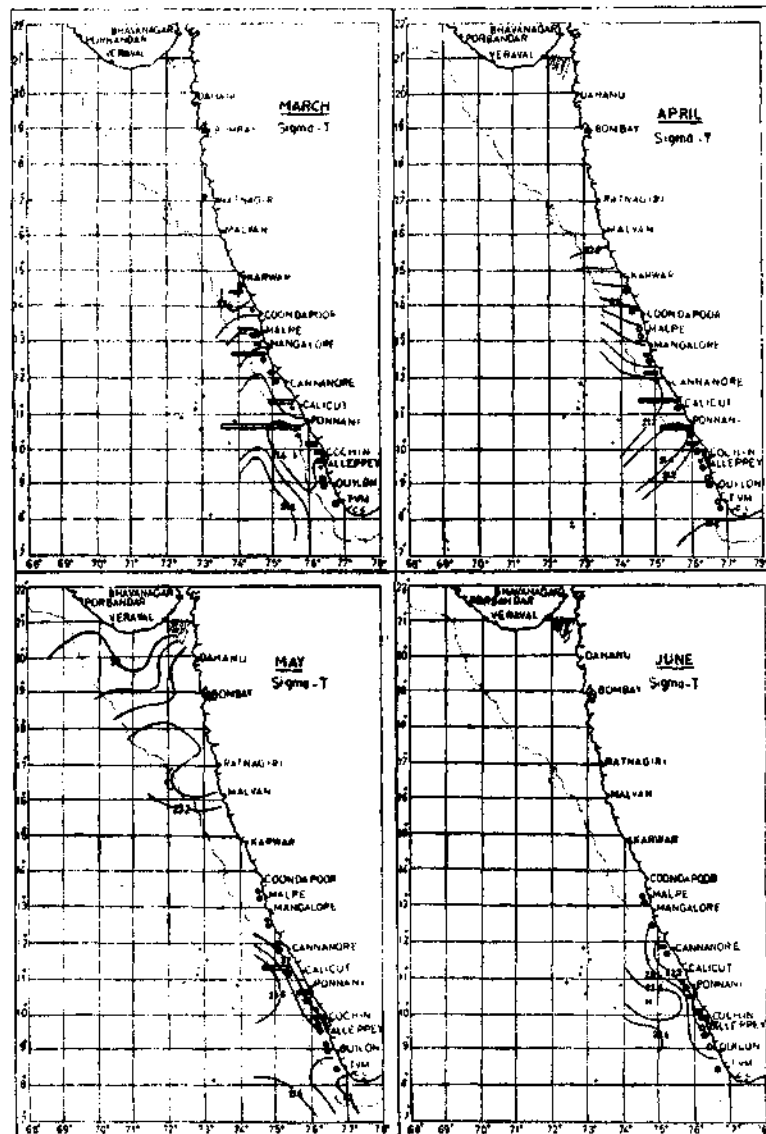


FIG. 10

DISCUSSION

The oil sardine fishery appears to dominate in the region between Alleppey and Malpe and the mackerel fishery from Calicut to Malvan. Thus, the northern regions appear more favourable

for the mackerel fishery. This may primarily be due to a change in the hydrographic conditions especially with regard to salinity, namely, a sudden increase in salinity occurring northwards from the region off Mangalore (Ramamirtham *et al.*, 1965) during major part of the year. December appears to be the peak season for the oil sardine fishery and October for mackerel. In December sinking of the offshore waters (coastal convergence) occurs over the shelf and a well defined isothermal layer of about 75 to 100 m thick is present along the west coast (Ramamirtham and Jayaraman, 1960). Moreover, convergence brings about a concentration of zooplankton (Hela and Laevastu, 1961). It is observed that zooplankton dominates in the food of the oil sardine (Noble, MS). Thus the high abundance of sardine during December may be related to the convergence phenomenon along the coast.

Mackerel normally feeds at the surface (Hardenberg, 1956). Rao and Rao (1957) have observed that juvenile mackerel is selective in its food habits and that adult ones are plankton feeders, consuming large quantities of phytoplankton along with some zooplankton. Mackerel at Karwar were observed to consume more phytoplankton in April, July and August (Noble, 1962). Hence, it is probable that an area where phytoplankton productivity is high, constitutes a favourable environment for mackerel. During the south-west monsoon period, owing to abundant rains, there is a decrease in the salinity of water which is considerable at times in the surface layers. At this period of lower salinity, the conditions are favourable for the growth of phytoplankton (Subrahmanyam, 1959). Sometimes a bloom of phytoplankton appears even when the salinity is as high as 34 to 35‰. (Subrahmanyam, *l.c.*) It has also been observed that during the peak south-west monsoon period (July and August) upwelling occurs along the west coast and the maximum intensity of the phenomenon is felt between Calicut and Karwar (Patil and Ramamirtham, MS). During this period the demersal fisheries are poor and the pelagic fishes like the oil sardine and mackerel are also not found in the normal fishing zones. The drastic decrease in the temperature which amounts to nearly 6 to 7° C compared to other seasons combined with the oxygen poor upwelled waters (Ramamirtham, 1967) could be a probable cause. The intense upwelling brings up nutrients from the deeper layers resulting in production of phytoplankton all along the coast. It has been observed that peak production of phytoplankton occurs during the south-west monsoon months (Subrahmanyam *et al.*, 1965) and this may primarily be related to the high abundance of mackerel during October. In both the fisheries, the maximum abundance is found between Mangalore and Malpe where the maximum intensity of upwelling during the south-west monsoon is prevalent (Patil and Ramamirtham, MS). Thus one may expect the area mentioned to be the most fertile as regards organic production; hence indicative of a potentially rich fishery which follows. The mechanised fishing operations in the area between Cannonare and Mangalore proved to be better during the post-monsoon period of the year 1962 than in the South Malabar coast, where upwelling was not so intense during the same period (Ramamirtham, 1967).

The sigma-T distribution at the surface cannot be considered as representing the actual flow patterns during monsoons as the effect of freshwater at the surface modifies the density distribution to a great extent. But the general current patterns have been deduced from the distribution at sub-surface levels and it has been found that the main current during the south-west monsoon and immediate post-monsoon is southwards in the surface layers with a transition during November. During winter the flow is mainly northward. Abundance of both the fisheries is found during winter in the northern regions when the northward movement of water along the coast is prevalent. The fishery becomes more and more abundant from Quilon northwards from September (Figs. 2 to 9). It is possible that the fish moves along with the northward current as this northward current produces convergence zones where zooplankters accumulate and this migration of these pelagic fishes is related to feeding conditions.

SUMMARY

The results of an average distribution study of the hydrographic properties such as temperature, salinity and sigma-T (density) of the surface waters along the west coast of India collected during

the cruises of *R. V. Varuna* and other vessels from September 1957 to September 1965 are presented month-wise. The averaged fishery data for this period is superimposed on these distribution charts. Noticeable regional and seasonal variations in the abundance of the oil sardine and the mackerel along the coast are described. In general, the abundance of the mackerel is more in the northern regions (north of 13° N) than the southern regions. The higher salinity values in the northern regions appear to be more favourable to mackerel than the oil sardine. The low abundance during monsoon is conspicuous in both cases. The upwelling occurring along the coast during monsoon enriches the waters to a great extent leading to a high organic production and a good fishery after the monsoon.

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