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Dial variations in temperature, salinity and dissolved oxygen from the neritic waters off Cochin during April (peak summer)

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ABSTRACT

Dial variations of important hydrographic parameters were studied continuously for 7 days at a 100 m depth station off Cochin. The frequency of observations varied from 1-3 hourly intervals. In surface waters, the ranges in temperature, salinity and dissolved oxygen values recorded during 10-17 April were 30.64°-32.36°C, 34.56-34.68 x 10^{-3} and 4.06-4.65 ml/1 respectively. The STD profiles in the diurnal study revealed clearly the premonsoon warming (30°-31°C) in the upper 0-30 m depth zone. In the water column up to 50 m depth, mean salinity values ranged from 34.6 to 35 x 10^{-3} while dissolved oxygen values were above 4 ml/l. Time series observations on the production and utilisation of dissolved oxygen revealed wide fluctuation from hour to hour. Vertical gradients in the diurnal study indicated the existence of thermocline around 60 m depth with sharp decline in temperature and dissolved oxygen and increase in salinity below 60 m. The diurnal variation on the distribution of temperature and dissolved oxygen exhibited significant rhythmic tidal impulse of a semi-diurnal wave pattern which was more prominent in the bottom layer below 60 m.

INTRODUCTION

Knowledge on the diurnal and day-to-day variations of the oceanographic parameters in different seasons are essential for proper understanding of the dynamics of the marine environment. Although dial variations on the hydrographic parameters are studied from the coastal aquatic ecosystems, similar studies from the open ocean around India are meagre. In the oceanic environment, factors such as seawater temperature, salinity and dissolved oxygen play very important role on the distribution and abundance of pelagic and demersal fishery resources. In recent years, sea-water temperature is considered as one of the important parameters in the remote sensing technology to assess the productive fishing zones of the ocean. One of the major constraints faced with this is the diurnal and day-to-day variations of the parameter.

The present study deals with the diurnal and day-to-day variations of seawater temperature, salinity and dissolved oxygen at different depths in the neritic waters off Cochin during a peak summer.

MATERIALS AND METHODS

During 10-17 April 1991, time series data were collected at the 100 m depth station off Cochin (09°44'N, 75°42'E) as below:

1) Temperature and salinity at three hourly interval from 10 April (0600 hrs) to 16 April (0600 hrs) at 1, 10, 20, 30, 50, 60 and 90 m depths.
2) Temperature and salinity at one hour interval from 16th (0600 hrs) to 17th (0600 hrs) at 1,10, 20, 30, 50, 60 and 90 m depths.
3) Dissolved oxygen at three hourly interval from 14th (0300 hrs) to 16th (0600 hrs) at 1, 30, 50, 60 and 90 m depths.
4) Production and utilisation of dissolved oxygen from 14th (0600 hrs) to 16th (0600 hrs) on the water samples collected at 1 and 30 m depths from the same station.

The seawater temperature, salinity and depth were determined by the Micro computer (MICOM STD PROFILE Instrument); dissolved oxygen by the Standard Winkler-titration method (Strickland & Parsons, 1968) and the productivity of water was calculated.

RESULTS

The results obtained on the diurnal variation of temperature, salinity and dissolved oxygen for the different depths at three hourly interval for 6 days are presented in Fig. 1 and of temperature and salinity at one hour interval for 25 hours are depicted in Fig. 2.

Temperature

Sea surface temperature (at 1 m depth) ranged from 30.64° to 32.36°C showing a variation of 1.72°C in seven days while the bottom temperature at 90 m varied from 22.26° to 27.36°C showing wide variation of 5.1°C (Fig 1). Among the different depths, watermass at 10 m showed the minimum variation of 0.65°C in 7 days of diurnal observation. In general, the bottom layers (60-90m) showed wide variation (>3°C). The overall mean temperature of the 7 days showed the maximum of 30.97°C at surface with gradual decrease up to 60 m and sharp fall below 60 m to the minimum of 24.5°C at 90 m depth.

The day-to-day changes in the daily mean temperature at surface (1 m) varied from 30.8° to 31.2°C with the difference of 0.4°C. At 0-50 m water column, the variation was 0.3-0.4°C while it was 1.4°-1.6°C at 60-90 m depth zone. The study revealed that the diurnal variation observed in 24 hours was not constant on all the 7 days. It varied

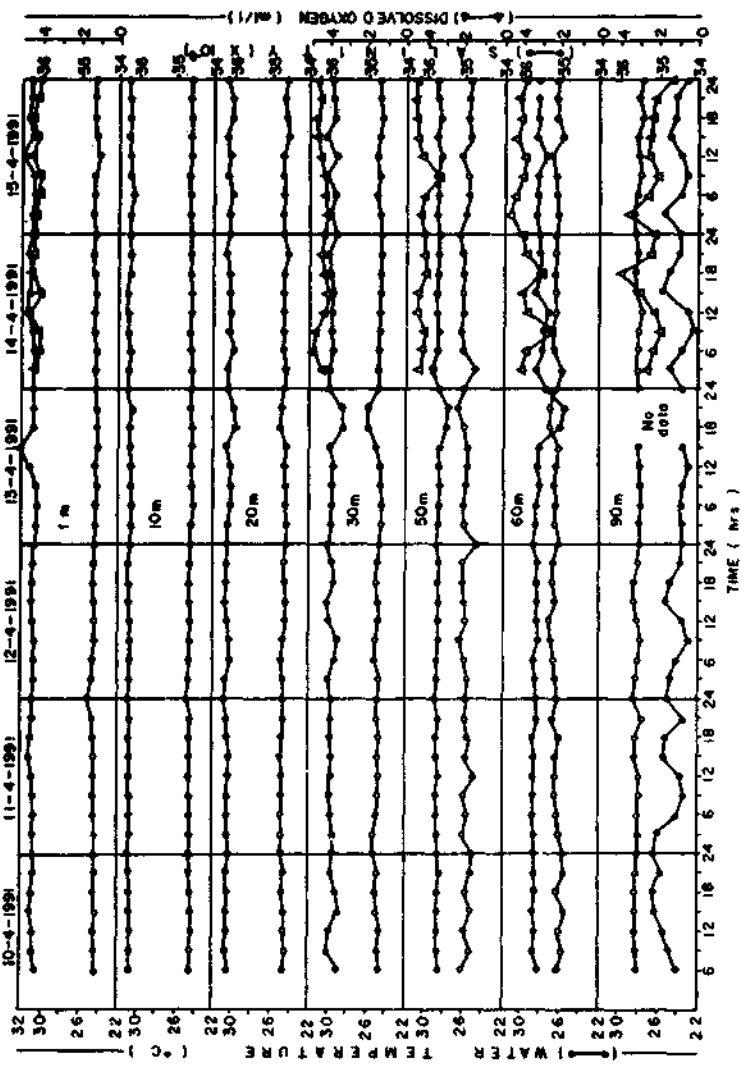

Fig. 1 - Diurnal variation in temperature, salinity and dissolved oxygen at three hourly interval

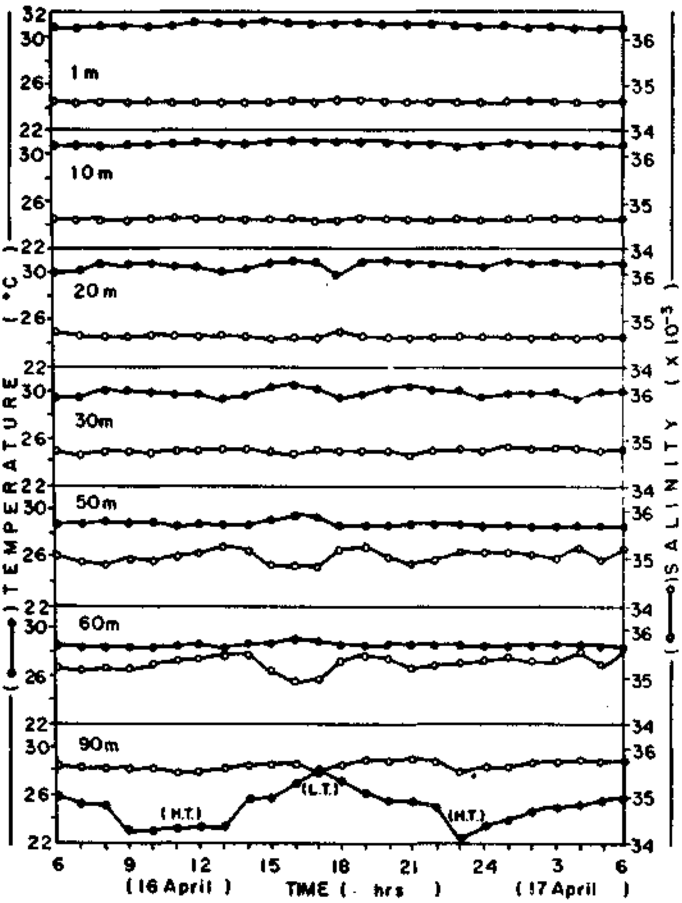

Fig. 2 - Diurnal variation in temperature and salinity at one hour interval

much at different depths in the shelf waters. The variation was higher at 30 m (>1°C) and at 60-90 m water column (>3°C). The diurnal study carried out at one hour interval for 25 hours showed hour to hour variation in temperature at different depths and it was prominent below 60 m during the diurnal rhythmic rise and fall in temperature (Fig.2).

Salinity

At surface (Fig.1), salinity ranged from 34.56 to 34.68 x 10^{-3} and at 90 m, it was 34.98-35.76 x 10^{-3} during the 7 days of observation. The variation showed the minimum (0.1 x 10^{-3}) at 10 m depth. The variation and the overall mean values at different depths showed increasing trend towards bottom with the maximum recorded at 90 m depth. The day-to-day changes in the daily mean values of 7 days and the hourly changes within 24 hours of the day showed, in general, less variation at 0-30 m. The hour to hour variation in 24 hours was $<0.4 \times 10^{-3}$ during April and it was relatively very less at 0-10 m.

Dissolved oxygen

In surface waters, the dissolved oxygen values varied from 4.06 to 4.65 ml/l. Depthwise distribution showed wide variation with increasing trend from surface to bottom. At surface, the daily average values ranged from 4.33 to 4.6 ml/l with the highest mean (4.48 ml/l) recorded at 30 m depth. The oxygen values were always 4 ml/l in the upper 0-50 m water column during April which showed abrupt decline below 60 m. The day-to-day changes also indicated the same trend with high variation at 60 m depth.

The hour to hour variation in the dissolved oxygen values was generally high during diurnal rise and fall in values. The variation was less at 0-30 m water column (0.3-0.6 ml/l) and high between 60 and 90 m depths (1.4-1.6 ml/l). The rise and fall in values at the bottom layer (60-90 m) showed rhythmic periodicity. Time series observations on the production and utilisation of dissolved oxygen in the upper layer (0-30 m) at three hourly interval showed variation from time to time within the day without indicating any diurnal periodicity (Table 1). The production of oxygen varied from 0.0205 to 0.2720 ml/l/h and utilisation from nil to 0.093 ml/l/h.

Table 1- Diurnal variations in the production and utilisation of dissolved oxygen at 0-30 m depth zone (incubation time is 3 hours)

Date	Time (hrs)	Oxygen produced ($ml\ O_2/l/h$)	Oxygen utilised ($ml\ O_2/l/h$)
14 April '91	0600	0.0975	0.0930
	0900	0.0910	0.0140
	1200	0.1415	0.0615
	1500	0.0400	0.0045
15 April '91	0600	0.0665	0.0235
	0900	0.0205	0.0205
	1200	0.1255	0.0
	1500	0.2720	0.0
16 April '91	0600	0.0390	0.0285

DISCUSSION

The results revealed that the sea surface temperature (SST) was at its daily minimum during early hours (0300-0600 hrs) and the maximum around 1500 hrs of the day (Figs 1 and 2), while such periodicity was not significant at 10-50 m depths. At 60-90 m depths, temperature showed the lowest value around 0900 hrs and the highest around 1500 hrs in general. The diurnal periodicity for the minimum and maximum temperature coupled with wide variation (1.72°C) observed during the seven days indicated clearly that the SST was directly influenced by the atmospheric cooling and solar heat radiation. The STD profiles in the diurnal study revealed clearly the premonsoon warming (30°-31°C) in the upper euphotic zone up to 30 m depth. Hareesh Kumar & Rao (1987) observed a minimum SST of 29.5°C at 0800 hrs and the maximum at 1500 hrs in the inshore waters (<50 m) off southwest coast of India during May 1985. They observed the influence of solar heating in the top 20 m water column in the diurnal study. However, the vertical temperature distribution in the shelf waters may not be totally governed by the local surface heat exchange process alone. Tidal effects, freshwater discharge and ocean currents may also have significant role in it. Vertical temperature profile is therefore expected to exhibit complex patterns in the shelf waters. The wide variation in water temperature recorded especially at 30 m depth in the day-to-day and diurnal observation (Figs.1,2) might be attributed chiefly to the changes in the intensity of summer heating and partly to the changes in the intensity of tidal forces from time to time. The very low variation in water temperature observed at 10 m depth in the present study indicated that the daily rate of solar radiation and nocturnal cooling has immediate effect in the surface layer upto 10 m depth only; while the influence of solar heating attributed upto 30 m depth could be a slow process of heat exchange in the water during summer.

The sharp fall in temperature below 60 m and the wide variation observed in the bottom layer (60-90 m) than in the middle layer (30-60 m) indicated the existence of thermocline around 60 m depth (Fig.3). The indications of diurnal periodicities for the lowest and highest temperature observed at 0900 and 1500 hrs in the diurnal study coupled with the wide fluctuations in temperature, salinity and dissolved oxygen at 60- 90 m water column might be attributed to the influence of high tide (HT) and low tide (LT) respectively.

The hourly variation in temperature, salinity and dissolved oxygen of the middle and bottom layers further indicated that the watermass present in an unit area was not always static, but changes due to the influence of underwater tidal currents in the shelf region. The wide variations observed from hour to hour by the increase in temperature and dissolved oxygen and decrease in salinity values at this station might be due to the influence of low tide currents pushing the lesser saline warm watermass from the inshore shelf region. The variation observed by the decrease in temperature and dissolved oxygen and increase in salinity values might be attributed to the influence of high tide currents bringing the higher saline colder watermass from the oceanic region into this area at the respective depths.

The fluctuation in the day-to-day diurnal variation of temperature and dissolved oxygen noticed among the different days of diurnal observations might be attributed to the different intensities and changing pattern of the mixed type of semidiurnal tides (Fig.4) prevailing in this coast.

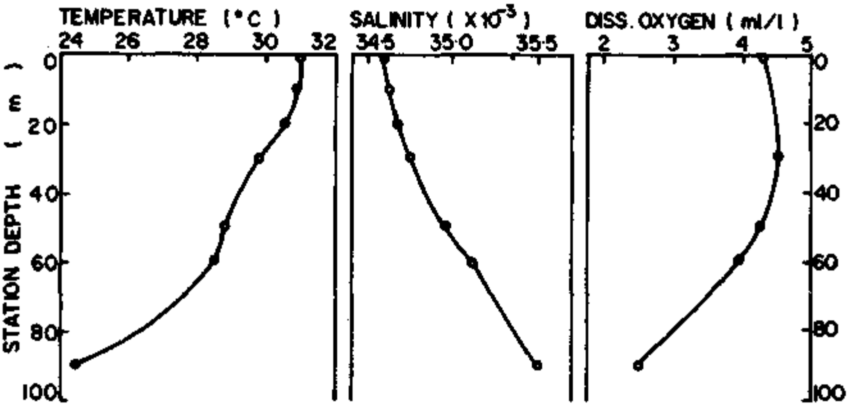

Fig. 3 - Vertical profiles of temperature, salinity and dissolved oxygen

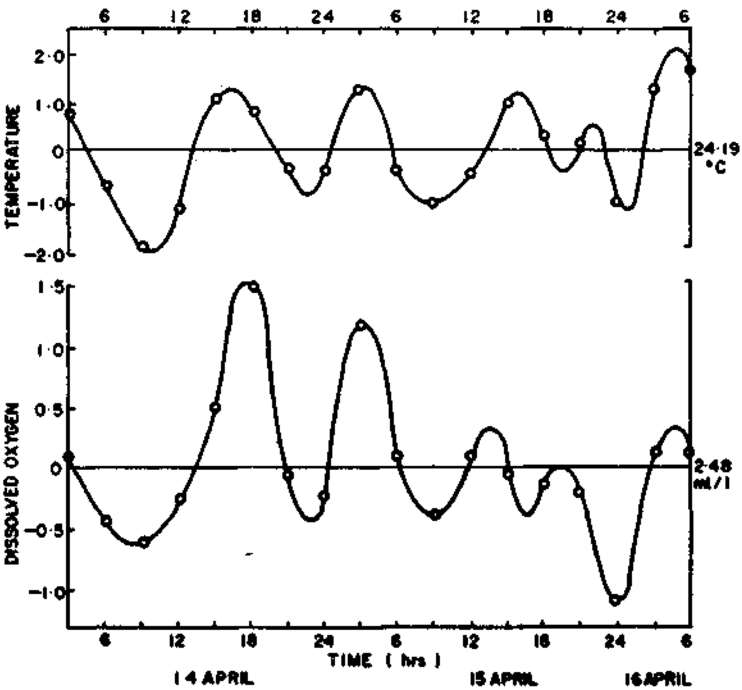

Fig. 4 - Rhythmic diurnal rise and fall in bottom temperature and dissolved oxygen values indicative of mixed semidiurnal wave pattern

The higher level of diurnal variation in salinity recorded between 20 and 50 m depth and another at 60-90 m depth with very low values at 50 - 60 m indicated the possibility of existence of stratification in the water column with different physico-chemical properties and separated by the thermocline. Banse (1968) reported the presence of strong seasonal thermocline in the shelf during late April and early May between 30 and 50 m. Varma *et al.* (1980) observed thermocline at 50 m in late April. According to Somayajulu *et al.* (1980), the seasonal thermocline forms due to intense surface heating and subsequent heat exchange process downwards. The domes/ridges and troughs in the subsurface layers (Fig.1) indicate the oscillation of internal waves.

The results of the time series experiments conducted on the production and utilisation of dissolved oxygen in the 0-30 m water column at three hourly interval (during 14-16 April) indicated that the rate of production and utilisation of oxygen was varying from hour to hour in a day without any regular diurnal periodicity (Table 1). This revealed that the watermass in the euphotic zone also was changing from time to time, possibly by the influence of tides and currents. When the hourly variation in temperature and salinity was relatively less in the upper 0-10 m water column, the wider variations recorded at 20 m and below could be chiefly due to the influence of tidal oscillation. The relatively low variation in salinity observed at 90 m than at 60 m depth could be due to the fact that the bottom salinity distributed between the inshore shelf and the shelf edge may not have much variation during this premonsoon month as compared to that of 60 m depth.

Apart from the importance of temperature profile and thermocline studies on the distribution of plankton and related fisheries aspects, Somayajulu *et al.* (1980) found that the sound velocity profiles closely resemble the shape of temperature profiles than that of salinity, indicating the marked dependence of sound velocity on temperature structure which could be applied in navigation purposes.

In conclusion, results of the diurnal experiments revealed that the production of oxygen in the water was much higher than its utilisation in the unit area. The availability of higher levels of dissolved oxygen in the euphotic column up to a depth of 50 m at this station (4 ml/l) and the high rate of production of oxygen than utilisation confirmed the existence of a very favourable environment for the biological productivity in the shelf region off Cochin during the premonsoon month of April. Among the different depths studied at this station, the subsurface water column around 10 m depth appeared to be ideal with less of diurnal variation in temperature and salinity. Hence, sea truth data at this depth will be a good indication for remote sensing applications during premonsoon season. Similar studies for the other seasons are desirable.

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