Chapter 4

HYDROGRAPHY

4.1 Introduction

Among the various biotic and abiotic factors which influence the physico-chemical properties of the environment and in turn the life of marine organisms, temperature, salinity and dissolved oxygen are vital. Either individually or together they are taken to be very important in influencing the biology of the organisms (Kinne, 1963). The hydrographical features play an important role in sedimentation and the distribution of fauna.

Temperature affects most of the biochemical and physiological processes of organisms. Water temperature is one of the most critically important regulators of the distribution, abundance and activity of marine biota. Kinne (1963) conducted a comprehensive review of the effects of water temperature on marine and brackish water animals. The results of this review indicated that biological processes may be greatly affected by water temperature fluctuations, gradients, ranges, and averages, as well as by the frequency and intensity of changes, duration of patterns, and accumulated heat units. Most marine and estuarine species or populations within species, have characteristic tolerable temperature ranges that include specific high
and low lethal temperatures. Gradual water temperature changes are usually better tolerated by all species than sudden changes (Kinne 1963).

There is an obvious increase in temperature in the Arabian Sea from north to south in shallow waters but in deep waters, there is a decrease in temperature observed from north to south (Qasim, 1982). Temperature is an important factor which influencing the density of polychaetes (Jayaraj et al., 2007). Temperature is an important factor which influencing the distribution pattern of infauna (Ganesh and Raman, 2007). Joydas and Damodaran (2009) reported that a progressive decrease of temperature with increase in depth and it was found to be analogous to the decrease in the abundance and biomass of macrofauna. The bottom temperature and depth were the most important parameters explaining the distribution of nematode communities along the western Indian shelf (Sajan et al., 2010).

The salinity of the ocean has great importance and it is the most widely recognized property of sea water. Distribution of organisms is determined in part by their salinity tolerances. Marine biota shows a wide range of ability to withstand salinity changes also. Salinity in the surface layers of Arabian Sea decreases from north to south (Babu et al., 1980; Qasim, 1982, Joydas and Damodaran, 2009; Sajan et al., 2010). Low surface salinity in the south is due to intrusion of the Bay of Bengal waters (Darbyshire, 1967). Babu et al ,(1980) and Shetye et al,(1991) reported a layer of maximum salinity in the 50m and 100m depth range. The most important factors affecting benthos were temperature, salinity, dissolved oxygen, sand and depth, and no single factor could be considered as an ecological master factor (Harkantra and Parulekar, 1991, Jayaraj et al., 2007). Ganesh and Raman (2007) reported that infauna was strikingly influenced by the salinity
variations. Salinity was found to negatively correlate with copepods, biomass of total meiofauna and diversity (Sajan et al., 2010).

Dissolved oxygen play a significant role in the distribution and diversity of benthic fauna. Shallow-water infaunal species typically exhibit responses at changes in oxygen concentrations. Distribution of organisms showed direct relationships to the oxygen profiles, but the biological responses to the oxygen concentrations varied with respect to the type of organisms. Meiofauna appear to be more broadly tolerant of oxygen depletion than the macrofauna (Giere, 1993). Generally, crustaceans and echinoderms are the next most sensitive, followed by annelids, selected molluscs, although there are exceptions (Diaz and Rosenberg 1995, Gray et al., 2002, Karlson et al., 2002). The decrease of benthos in deeper waters may be due to the low value of dissolved oxygen (Jayaraj et al., 2007). Joydas and Damodaran (2009) reported that a progressive decrease of dissolved oxygen with increase in depth in western continental shelf of India and it was corresponding to the decrease of numerical abundance and biomass of macrofauna. Among the hydrographical parameters, dissolved oxygen showed a positive correlation with biomass and density for all the meiofaunal groups and diversity of nematodes (Sajan et al., 2010).

4.2 Results

In the late post monsoon period, the data of hydrographical parameters were analyzed and the results were as follows:

4.2.1 Temperature

Depth-wise variation in each transects:-Depth-wise variation of bottom temperature in each transect is presented in Table 4.1. It showed great variation in each transects along the two coasts. The range of bottom
temperature was from a minimum of 13.06°C (off Kochi, 229m) and a maximum of 29.29°C (off Kannur, 50m) in the southwest coast and a minimum of 13.45°C (off Chennai, 200m) and a maximum of 27.37°C (off Krishnapatnam, 31.7m) along the southeast coast.

Along southwest coast, transects, off Kannur, off Kozhikode, off Vadanapilly and off Trivandrum showed a decrease in bottom temperature with increase in depth. Off Kollam transect, bottom temperature showed an increase from 30m to 75m depth range and then decreased. Along southeast coast, off Nagapatnam transects showed a decrease of bottom water temperature from 30m to 200m depth ranges. Off Cuddalore and off Chennai transects, temperature increased from 30m to 50m and then decreased to 200m depth ranges. Off Krishnapatnam showed a decrease in temperature from 30m to 50m and increased to 100m and sharply decreased to 200m depth ranges.

When both the coasts were taken into consideration, the maximum difference of bottom temperature observed off Kochi transect and it was 15.43°C along the southwest coast whereas off Cuddalore and the value was 13.81°C along southeast coast. The minimum difference was noticed off Vadanapilly and it was 13.86°C in the southwest coast and off Krishnapatnam and the value was 12.7°C along the southeast coast. The mean temperature along southwest coast decreased from off Kannur to off Vadanapilly and increased to off Trivandrum and again decreased to off Cape Comorin. Whereas along southeast coast, bottom temperature decreased from off Krishnapatnam to off Cuddalore and increased to off Nagapatnam.
Latitudinal variation in different depth ranges: The latitudinal variations in temperature in different depth ranges along the southwest and southeast coast were presented in the Table nos. 4.2, 4.3 and Fig. no 4.1, 4.2.

Along southwest coast at 30m depth range, the bottom temperature showed a decrease from off Kozhikode to off Vadanapilly and then increased to off Kochi and then the values were homogenous upto off Cape Comorin. In the 50m depth range, bottom temperature showed an increase from off Kannur to off Kozhikode then decreased to off Vadanapilly and again increased upto off Trivandrum and decreased at off Cape Comorin. At 100m and 200m depth ranges, the bottom temperature showed an irregular variation along transects.

Along southeast coast at 30m depth range, showed a decrease from off Krishnapatnam to off Chennai and then increased to off Nagapatnam. At 50m depth range, bottom temperature increased from off Krishnapatnam to off Cuddallore and decreased off Nagapatnam. Off Chennai and off Cuddallore showed similar temperature. In the 100m depth range, bottom temperature showed a decrease from off Krishnapatnam to off Cuddallore and then sharply increased to off Nagapatnam. In the 200m depth range, bottom temperature decreased from off Krishnapatnam to off Cuddallore and then increased to off Nagapatnam.

4.2.2 Salinity

Depth-wise variation in each transects: - Depth-wise variation of bottom salinity in each transect is presented in Table 4.1. Salinity varied from a minimum of 33.72‰ (off Cape Comorin, 50m) to a maximum of 35.92‰ (off Kozhikode, 110m) along the southwest coast and a minimum of 32.09‰
(off Chennai, 33.4m) to a maximum of 36.42‰ (off Cuddalore, 169m) along the Southeast coast. Salinity showed slight variation with depth.

Along southwest coast, transects, off Kannur and off Trivandrum showed a decrease in bottom salinity with increase in depth. Off Kozhikode showed an increase in salinity from 30m to 100m and decreased to 200m depth ranges. Off Vadanapilly and off Cape Comorin, salinity decreased from 30m to 50m then increased to 100m and again decreased to 200m depth ranges. Whereas in the off Kochi and off Kollam, an increase in salinity from 30m to 100m and a decrease to 200m depth ranges were observed. Along southeast coast, off Nagapattinam, off Cuddalore and off Chennai transects showed an increase of bottom water salinity from 30m to 200m depth ranges. Whereas Off Krishnapatnam showed a decrease in salinity from 30m to 50m and increased to 200m depth ranges.

When both the coasts were taken into account maximum difference in salinity within a transect was noticed 1.79‰ off Kollam in the southwest coast, whereas 2.78‰ off Cuddalore in the southeast coast. Minimum difference in salinity within a single transect was noticed 1.38‰ off Cape Comorin in the southwest coast, whereas 1.5‰ off Krishnapatnam in the southeast coast. The mean salinity showed an irregular variation along southwest and southeast coasts.

Latitudinal variation in different depth ranges: - The bottom salinity during the sampling time at different depth ranges was presented in Table 4.2 & 4.3, Fig.4.3 & 4.4.

Along southwest coast at 30m depth range, the bottom salinity showed an increase from off Kozhikode to off Kollam then decreased to off
Trivandrum and increased to off Cape Comorin. In the 50m depth range, bottom salinity showed a decrease from off Kannur to off Kochi then increased to off Cape Comorin. At 100m depth range, salinity showed an irregular variation along transects. In the 200m depth range, the bottom salinity showed a decrease from off Kozhikode to off Vadanapilly then increased to off Kochi and again decreased to off Cape Comorin.

Along southeast coast at 30m depth range, salinity showed an irregular variation along transects. At 50m and 100m depth ranges, bottom salinity increased from off Krisnapatnam to off Cuddallore and decreased off Nagapathnam. In the 200m depth range, salinity showed an irregular variation along transects.

4.2.3 Dissolved Oxygen

**Depth-wise variation in each transects:** Depth-wise variation of dissolved oxygen in each transect is presented in Table 4.1. Generally there was a sharp decrease in dissolved oxygen with increase in depth. Along the southwest coast it ranged from 1.12 ml/l (off Kollam, 186m) to 4.53 ml/l (off Kochi, 29.60m and off Kollam, 33.80m) and 1.13 ml/l (off Krishnapatnam, 203m) to 4.41 ml/l (off Nagapatnam, 30m).

Along southwest coast, transects, off Kannur, off Kochi, off Kollam off Trivandrum and off Cape Comorin showed a decrease in bottom dissolved oxygen with increase in depth. Off Kozhikode and off Vadanapilly showed an increase in dissolved oxygen content from 30m to 50m and then decreased to 200m depth ranges. Along southeast coast, off Nagapatnam and off Chennai transects showed a decrease of bottom water dissolved oxygen from 30m to 200m depth ranges. Whereas off Cuddallore
and off Krishnapatnam showed an increase of dissolved oxygen from 30m to 50m and then decreased to 200m depth ranges.

When both the coasts were compared, maximum difference in dissolved oxygen within a transect was noticed 3.41 ml/l off Kollam in the southwest coast, whereas 3.37 ml/l off Krishnapatnam in the southeast coast. Minimum difference in dissolved oxygen within a single transect was noticed 3.16 ml/l off Cape Comorin in the southwest coast, whereas 2.61 ml/l off Nagapatnam in the southeast coast. The mean dissolved oxygen along southwest coast showed an irregular variation along transects. Whereas along southeast coast, dissolved oxygen decreased from off Krishnapatnam to off Chennai or off Cuddallore (both transects showed same value) and then increased.

**Latitudinal variation in different depth ranges:** - The dissolved oxygen level in the sea bottom during the cruise number 230 & 233 along the Southwest and Southeast coast was presented in Table 4.2, 4.3 and Fig.4.5, 4.6.

Along southwest coast at 30m depth range, the bottom dissolved oxygen showed an increase from off Kozhikode to off Kollam then decreased to off Cape Comorin. In the 50m depth range, bottom dissolved oxygen showed an increase from off Kannur to off Vadanapilly then decreased to off Kochi and increased to off Kollam and again decreased to off Cape Comorin. At 100m depth range, dissolved oxygen showed an increase from off Kannur to off Kozhikode then sharply decreased to off Vadanapilly then increased to off Kochi and again decreased to off Cape Comorin. In the 200m depth range, the bottom dissolved oxygen showed an increase from off Kozhikode to off Kochi and decreased to off Kollam and again increased to off Cape Comorin.
Along southeast coast at 30m depth range, dissolved oxygen showed a decrease from off Krishnapatnam to off Cuddallore then increased to off Nagapatnam. At 50m and 100m depth ranges, dissolved oxygen showed an irregular variation along transects. In the 200m depth range, bottom dissolved oxygen showed an increase from off Krishnapatnam to off Nagapatnam.

4.3 Discussion

Hydrographical parameters like temperature, salinity and dissolved oxygen shows variation with different depths and latitudes. Among them, temperature showed highest variations along both the coasts. While, comparing both the coasts, Arabian Sea was warmer than the Bay of Bengal. Temperature shows the highest variation and salinity the least. The general trend of bottom temperature and dissolved oxygen was a decrease with increase in depth and salinity increased with increase in depth along the southwest and southeast coasts.

Along southwest coast, variation of bottom temperature at different depth ranges shows an increase from 30m to 100m depth range and then decreased to 200m. In the 30m depth range, the bottom temperature along the southwest coast transects shows minimum variations. In the 30m and 100m depth range, temperature was high off Kozhikode. In the 50m depth range, comparatively higher temperature was observed off Kannur transect. The central part of the Arabian Sea is warmer than the southern part because of the influence of Persian Gulf waters (Wyrtki, 1971). This may be the reason of the higher values of temperature towards north. In the 200m depth range temperature was high off Kollam. So, higher temperature observed along northern transects compared to south from
30m to 50m depth ranges. Joydas and Damodaran (2009) also reported same trend along southwest continental shelf of India.

Along southeast coast, bottom temperature variations were irregular along transects and at different depth ranges. In the 30m and 200m depth ranges, temperature was high off Krishnapatnam compared to other transects. In the 50m depth range, temperature was higher off Cuddalore and off Chennai. In the 100m depth range, comparatively higher temperature was observed off Nagapatnam transect. The temperature values of the bottom waters along the outer shelf of the east coast were low compared to the inner shelf (Jacob et al., 2008).

Salinity shows least variation along transects as well as in different depth ranges. Though the variation was small, a general trend shows an increase in salinity from near shore waters to the shelf edge along both the coasts. In the southwest coast at 30m depth range, bottom salinity shows high values recorded at northern region and was highest off Vadanapilly. In the 50m depth range, salinity was high at off Kannur transect. Off Kozhikode recorded high salinity in the 100m and 200m depth ranges. Generally higher salinity observed to northern transects. Similar trend was observed in the west coast shelf waters by Joydas & Damodaran, (2009). During the northeast monsoon season, low saline water from the Bay of Bengal joins the northward flowing equatorial Indian Ocean water and flows as a northward surface current along the west coast of India (Pankajakshan & Ramaraju, 1987). The lower salinity of southern region can be due to this incursion of low saline waters from the Bay of Bengal to the west coast (Darbyshire, 1967; Wyrtki, 1971).

In the southeast coast, highest salinity at 30m, 50m, 100m and 200m depth ranges was observed at off Cuddalore compared to other transects.
Comparing both the coasts, southwest coast was more saline than the southeast coast. But the highest salinity was recorded at Cuddallore, 200m depth, in southeast coast. In the southeast coast the salinity in the near shore waters is less compared to Arabian Sea may be because of the large amount of river water input to the Bay of Bengal.

Dissolved oxygen content of the bottom waters shows a decrease with increase in depth, like bottom temperature variation along both the coasts. The dissolved oxygen concentrations of the bottom waters along the outer shelf of the east coast were low compared to the inner shelf (Jacob et al., 2008).

In the southwest coast, at 30m depth range, bottom dissolved oxygen shows high values along southern region and was highest at off Kochi and off Kollam. In the 50m depth range, high DO was observed off Vadanapilly compared to other transects. In the 100m depth range, DO was highest off Kozhikode and in the 200m depth range, it was at off Kochi.

Along southeast coast bottom dissolved oxygen was varied irregularly at different depth ranges and along transects. In the 30m and 100m depth ranges dissolved oxygen level was high at off Nagapatnam. In the 50m depth range, high DO value observed off Krishnapatnam. In the 200m depth range off Nagapatnam and off Cuddalore was recorded high dissolved oxygen.

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