ESTUARINE OCEANOGRAPHY OF THE VEMBANAD LAKE

PART III: THE REGION BETWEEN COCHIN AND THE 30M DEPTH OFF PORTMOUTH

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ABSTRACT

The time-distribution patterns of temperature, salinity and oxygen content along the shipping channel from inside the port to a distance of about 15 km out into the Arabian sea during 1981-1983 are presented and discussed in this third and last part of the estuarine oceanographic study of the Vembanad lake. The distribution patterns show that hydrologically the nearshore region up to 12 or 15 km off Cochin is more or less identical to the adjacent coastal region, without having any apparent influence of the lake, during the dry months January to May. During the wet months, however, the discharge from the lake, characterized by suspended sediments, spreads as a plume, over highly saline and cold upwelled water, turning the region into an intermittent estuary. Though the end of the plume can often be pinpointed around the 30m depthline, by a sharp change of colour and filaments formed of floating objects of land and freshwater origin, the presence of an actual plume front is doubtful because of the weak surface convergence then occurring in a broad area off Cochin.

Following the end of the S. W. monsoon, both the plume and the upwelling disappear, some time during October-November, and the hydrographic conditions of the area are reverted back to that of January-May.

INTRODUCTION

The Vembanad lake with its two perennial connections with sea forms a major estuary between Vaikom in the south and Azhikode in the north, sustaining an important fishery of its own and influencing that of the inshore region. Based on the time-distribution of salinity, temperature and flow characteristics, the southern part of the estuary between Pallipuram (Vaikom) and Thevara (Cochin) and the northern part between Cochin and Azhikode have already been treated respectively under Part I and Part II (Ramamirtham et al 1986a, 1986b). The present paper, forming Part III, is attempting to describe the region of confluence of the lake and the sea based on the observations made in a normal section along the shipping channel, from a station about a kilometer inside the port to a station in the 30 m depth zone in the inshore region (Fig. 1).

The previous studies by different authors have shown that during the greater part of the year the region is almost inshore in characteristics, with any significant mixing of the water bodies restricted to the period of S.W. monsoon. Ramamirtham and Jayaraman (1963) have observed that during the S.W. monsoon the estuary was characterized by two distinct layers, the upper one, of almost fresh water, extending like a tongue into the sea and the lower one, cold and highly saline, typically upwelled water, extending far into the backwater. Johannessen et al (1987) reported that the minimum salinity occurred at the surface during July-August in the region off Cochin and that the effect of the runoff was drastically reduced at the 10 m depth.

Methods of Study

Five stations, viz. 1, 2, 3, 4, and 5, were fixed in a normal section in an east-west direction (Fig. 1). Station 1, with a depth of 10 m was about 1 km inside the port mouth, the second, also with 10 m depth was roughly at the port mouth and 3, 4 and 5, respectively with depths 10 m, 20 m and 30 m, were in the sea, beyond the fairway buoy. The temperature and water samples for salinity and dissolved oxygen were collected during 1981-83 from all the stations using a Nansen bottle, from both surface and bottom. The data obtained are presented as time distribution patterns.

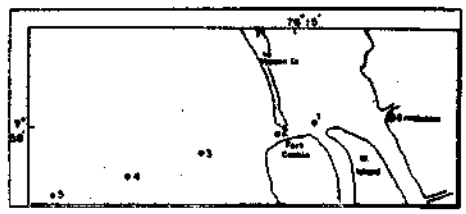

FIG. 1. Position of stations in the near shore region of Cochin.

Observation

Figs. 2-13 show the distribution of temperature and salinity at the surface and bottom layers while Figs. 14-16 show the distribution of dissolved oxygen at the bottom layers. The variations of the different parameters were more or less similar during the three years of study. Therefore an annual trend common to the three years is described here, pointing out the significant annual variations if any.

Temperature

Figs. 2-7 show that the temperature of both the surface and bottom layers rose from 28°-29°C in January to 31°-32°C in May.

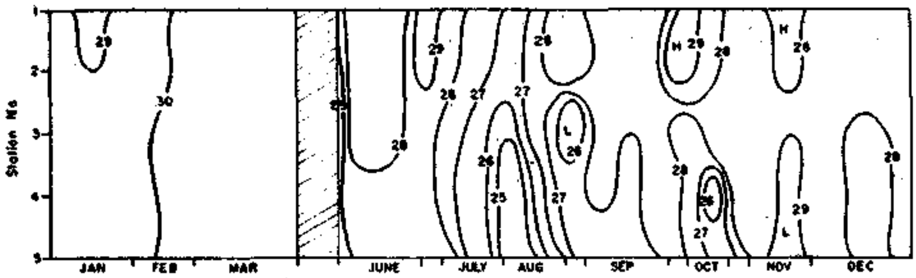

FIG. 2. Time distribution pattern of surface temperature during 1981.

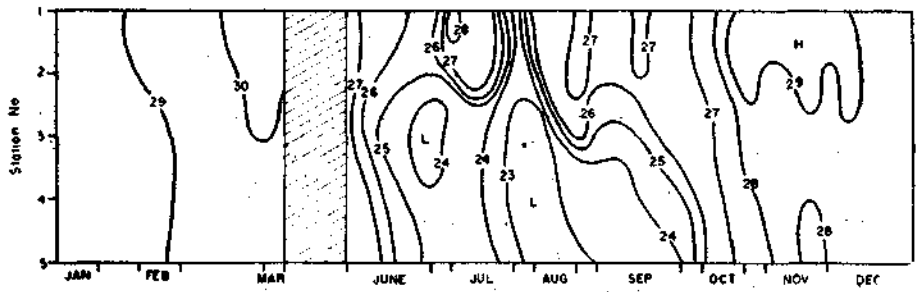

FIG. 3. Time distribution pattern of bottom temperature during 1981.

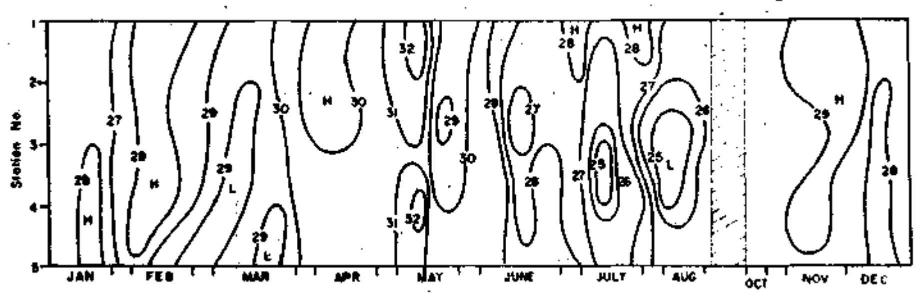

FIG. 4. Time distribution pattern of surface temperature during 1982.

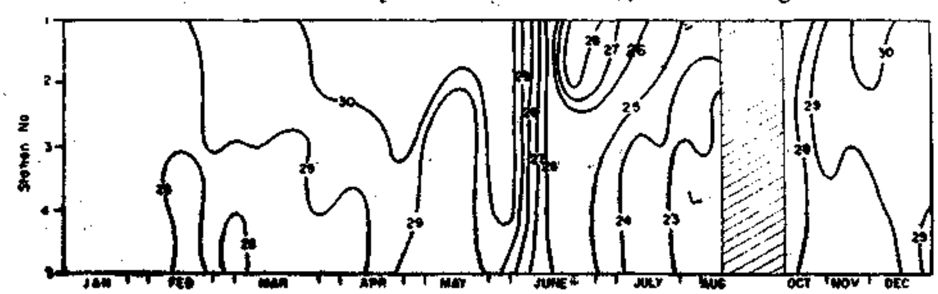

FIG. 5. Time distribution pattern of bottom temperature during 1982.

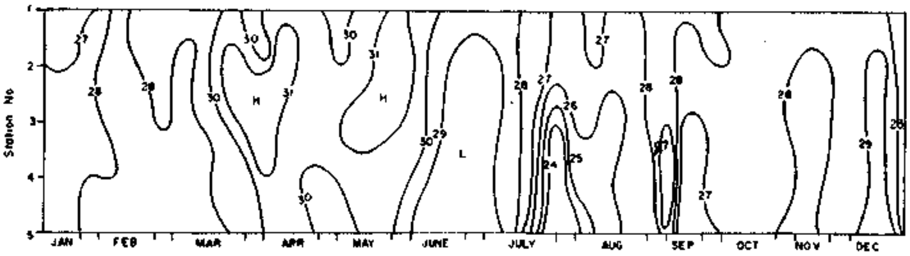

FIG. 6. Time distribution pattern of surface temperature during 1983.

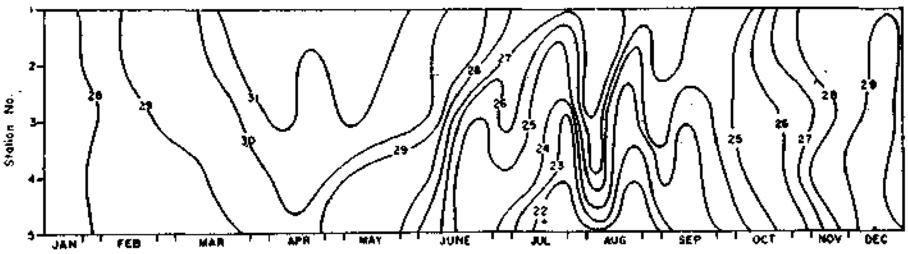

FIG. 7. Time distribution pattern of bottom temperature during 1983.

The surface temperature which was 28°-29°C in all the stations in June decreased during July-August to 27°-28°C in stations 1-2 and 24°-26°C in station 3-5 (Figs. 2, 4 and 6), but increased during September or October to 27°-28°C in all the five stations. Fig. 6 shows that the 26°C surface isotherm was interrupted in space between stations 3-5 during July-August in 1983 but showed no discontinuity in time. On the other hand, the cells in Figs. 2 and 4 show that the occurrence of 25°-26°C at the surface was at random and lacked continuity in both time and space during 1981 and 1982.

The temperature of the bottom layer that was 25°-28°C in June in stations 1-2 (Figs. 2, 5 and 7) came down to 24°-26°C for a week in July but increased to 27°-28°C in September. In stations 3-5 the temperature of the bottom layer decreased to 22°-24°C during July-August and rose to 25°-28°C in September| October. The minimum temperature of 22°C recorded in stations 4 and 5 in 1983 (Fig. 7) at the bottom layer was lower than those of the previous years.

The temperature of both the surface and bottom layers was 28°-29°C in November. Figs. 2, 4 and 6 show that in December the surface temperature between stations 3 and 5 invariably came down to 28°C while the temperature of the bottom layer remained the same as in November.

Salinity

Figs. 8-13 show that during January-May the salinity of the surface and bottom layers varied between 30 ‰ and 35 ‰ except during April-May in 1982, when the surface salinity in stations 1-2 came down to 20 ‰ - 25 ‰ . The salinity of the surface and bottom layers recorded between March and June in 1983 were uniformly high with values mostly 35 ‰ and above.

During June-September the salinity at the surface was sometimes as low as 5 ‰ up to station 3 (Fig. 8). During this period the lateral increase in salinity of the surface towards west occurred often between stations 2 and 3 and from station 2 as observed in the later half of August in 1981.

During June-September the salinity at the bottom layer in stations 1-2 appears as isolated pockets (Figs. 9, 11 and 13). The lateral increase observed

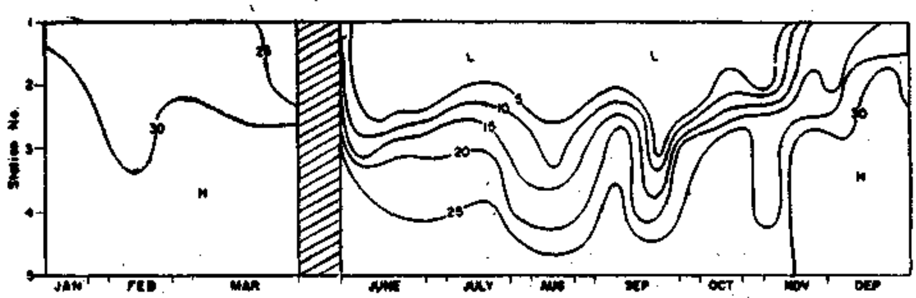

FIG. 8. Time distribution pattern of surface salinity during 1981.

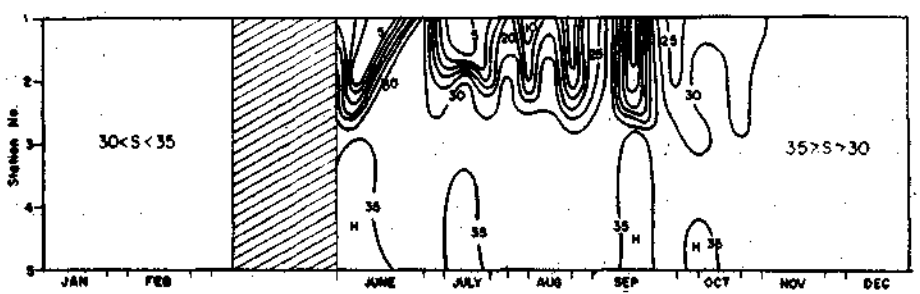

FIG. 9. Time distribution pattern of bottom salinity during 1981.

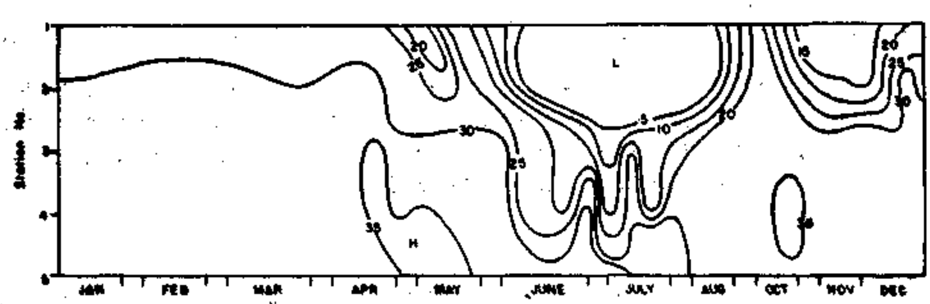

FIG. 10. Time distribution pattern of surface salinity during 1982.

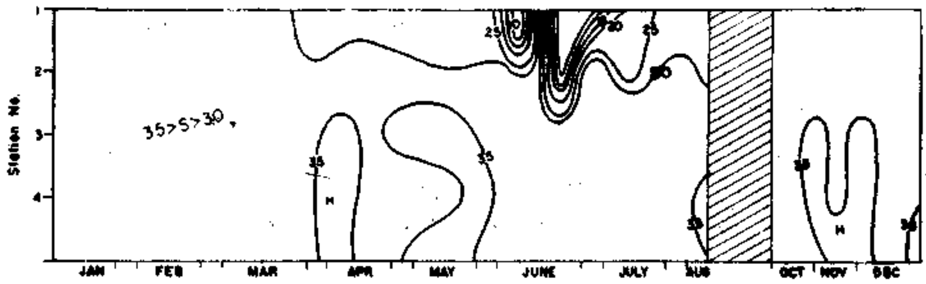

FIG. 11. Time distribution pattern of bottom salinity during 1982.

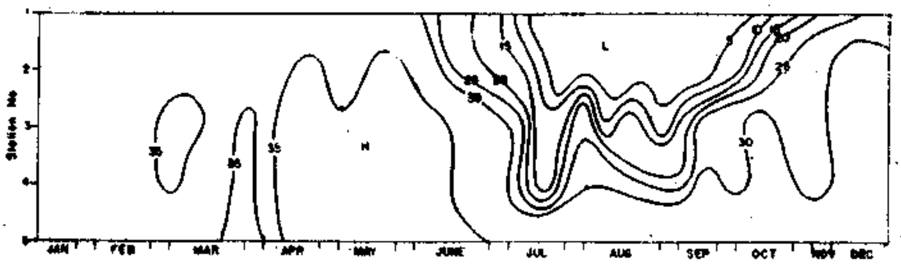

FIG. 12. Time distribution pattern of surface salinity during 1983.

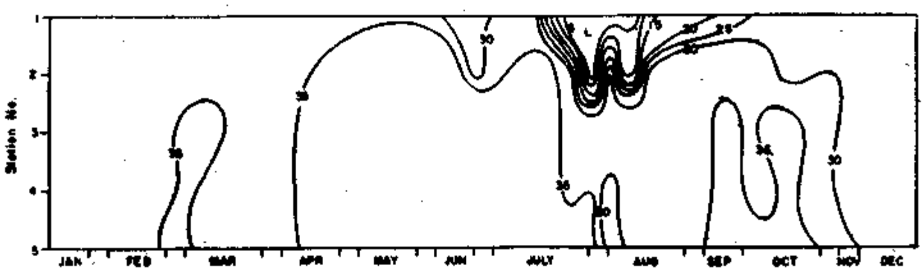

FIG. 13. Time distribution pattern of bottom salinity during 1983.

towards the west along the bottom often occurs between stations 1 and 2 and sometimes from station 2. However, the salinity of the bottom layer in stations 3-5 remained between 30 ‰ -35 ‰ during June-September.

The distance from the portmouth where he salinity was low decreased from September|October and the surface salinity in stations 1-3 rose to 30 ‰ -35 ‰ before the end of the year both in 1981 and 1983. But in 1982 the surface salinity which rose to 30 ‰ in October in stations 1 and 2 decreased to 5 ‰ -10 ‰ in November. Nevertheless, the values recorded in December were between 30 ‰ and 35 ‰.

The salinity of the bottom layer in stations 1 and 2 rose from below 20‰ in July-August to 30 ‰ in September|October and remained thereabout during the remaining part of the year. The salinity of the bottom layer in stations 3-5 remained above 30‰ during September-December.

Dissolved Oxygen

The dissolved-oxygen content of the surface layer was 3-4 ml|l and above with variations of little significance throughout the period, hence the figures showing the distribution at the surface have not been included. On the contrary Figs. 14-16 show that the oxygen content of the bottom layer varied widely from 0.5 ml|l during July-August to 5-6 ml|l in April|May.

During January-May the dissolved oxygen content of the bottom layer was 3 ml|l and above, except for a few weeks during April-May in 1982 when the values were well below 2 ml|l in stations 2-5.

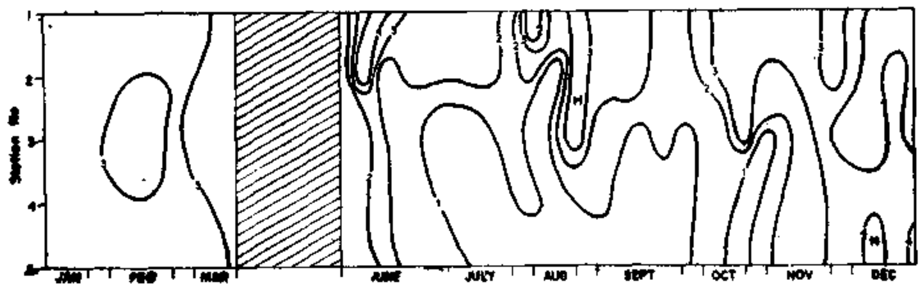

FIG. 14. Time distribution pattern of bottom dissolved oxygen content during 1981.

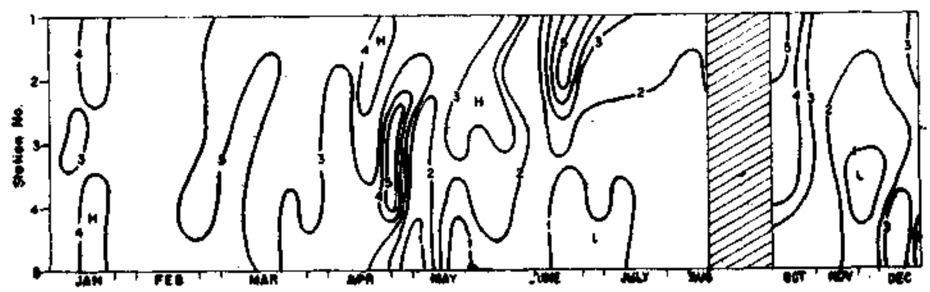

FIG. 15. Time distribution pattern of bottom dissolved oxygen content during 1982.

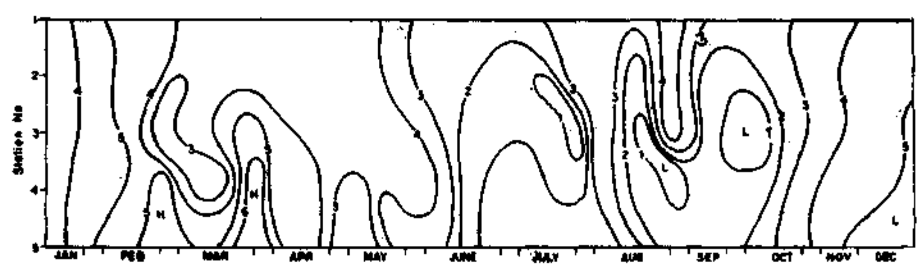

FIG. 16. Time distribution pattern of bottom dissolved oxygen content during 1983.

Between June and September|October the oxygen content came down to 1 ml|l in stations 3-5. Fig. 15 shows that the oxygen content in station at the port mouth (Station 2) was 1 ml|l for about a week in August in 1981.

Figs. 14 and 16 show that there was a steady increase in oxygen content from October to 4 m|l and 5 m|l in December respectively in 1981 and 1983. On the other hand, Fig. 15 shows that in 1982 the dissolved oxygen content rose to 5 ml|l in October but decreased to less than 1 ml|l in November in stations 3 and 4. Though the values increased to 3 ml|l and remained thereabout during a greater part of December, they decreased to 2 ml|l during the last week of the month in stations 4 and 5.

Discussion

The distribution of temperature, salinity and dissolved-oxygen content of surface and bottom shows that the region up to the 30 m depth zone is subject to a seasonal influence of Vembanad lake. During January-May temperature (28°-32°C), salinity (30-35 ‰) and oxygen content (3 ml|l and above, except in May, 1982, when it was 1-2 ml|l) varied only slightly from those of the adjacent inshore region. But, during June-September the surface salinity had a drastic fall, sometimes to 5 ‰ up to a distance of 8-10 km from the port mouth.

As can be discerned from figs. 7-12, during June-September the discharge from the lake, distinguishable by being turbid and opaque and by the presence of floating objects of land origin, spreads along the surface as a plume over more saline water. The plume extends up to 12 or 15 km, according to the intensity of monsoon, making the nearshore region almost an intermittent estuary (Zedler and Onuf 1984). Ketchum (1967) has observed a similar type of circulation in the New York Bight, where he has identified three types of waters, brackish, surface coastal and deep oceanic. The lateral spreading of the plume was over a wide area north-south, However, the spreading was considerably more toward the south. Probably the then prevailing anticyclonic circulation along the west coast causes this deflexion (Robinson 1966). The plume characterized by the turbidity and opalescence could be seen ending abruptly varyingly between 12 km and 15 km away from the port mouth and the surface immediately beyond taking a clear and bright greenish hue. At this region the floating materials of land and freshwater origin were also forming prominent filaments indicating a plume front (Bowden 1978). However, figs. 7, 9 and 11 show a broad area of weak convergence off Cochin, which makes a definite frontal zone doubtful, because the surface convergence would normally be strong and concentrated in a narrow band if a front was actually present (Boje and Tomczak 1978).

The changes in temperature and the dissolved oxygen of the bottom also were in relation to the intensity of the S.W. monsoon. As for example in 1981, when there was a lull in August before the monsoon revived in September, the temperature of the bottom layer went up by 1° or 2°C and the low oxygen content of 1 ml|l at the port mouth withdrew to 20 m depth zone, both indicating that the spreading of cold upwelled water along the bottom into the shallow nearshore region ceased, but again continued with the revival of the monsoon, switching back to the previous condition for 2-3 weeks, and reversing the oxygen content of the bottom layer in the region between 10 m and 20 m depth zones to 1 ml|l for about 4 weeks.

The decrease in bottom temperature in the S.W. monsoon varied from year to year. The bottom temperature of 22°C during July-August in 1983 was the lowest. It may therefore be deduced that the upwelling, that caused the steeper fall, during the year was of greater magnitude than those of the previous years.

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