ESTUARINE OCEANOGRAPHY OF THE VEMBANAD LAKE

PART II: THE REGION BETWEEN COCHIN AND AZHIKODE

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ABSTRACT

Some aspects of the estuarine oceanography of the Vembanad lake between Cochin and Azhikode are discussed. Since this part of the lake is in confluence with the Arabian sea at its southern and northern ends, at Cochin and Azhikode, its circulation pattern and other characteristics are different from what they are between Cochin and Vaikom. Because of the position of these two mouths, which are exposed to the same tidal cycles, the high tides and low tides each producing two opposite flows respectively converge and diverge leaving a null zone, almost free of the tidal effect, around Kadakara, situated midway between Cochin and Azhikode. Another significant feature of this part of the estuary is an extreme low-salinity region between Karthedam and Cherai during monsoon and early postmonsoon, brought about by the deflected waters of the Periyar, opening at the northern end of the estuary.

INTRODUCTION

The topography of the Vembanad lake, as well as describing how the lake is divisible into two arms, viz., the southern and the northern, has been discussed in detail by Ramamirtham et al (1986) in the part I of this paper, dealing with the characteristics of the southern arm. The northern arm is in confluence with the Arabian sea at two places, namely Cochin and Azhikode, about 16 miles apart. These estuarine mouths, though subject to the same tidal variations, are of different width and physiography. The presence of a number of islets and shoals in the Cochin inlet considerably modifies the circulation pattern of this part of the Vembanad lake. Further, the proximity of the Azhikode mouth to the Periyar mouth adds to the changes in the hydrographic features. Thus, the estuary in the northern arm is hydrographically different from that in the southern arm. Hence, the study pertaining to this region, though forms part of the overall study of the Vembanad lake, is treated seperately.

METHOD OF STUDY

The temperature, salinity and dissolved-oxygen content at the surface and bottom between Cochin and Azhikode were measured at six stations, namely Cochin mouth, Karthedam, Manjanakad, Kadakara, Cherai and Azhikode

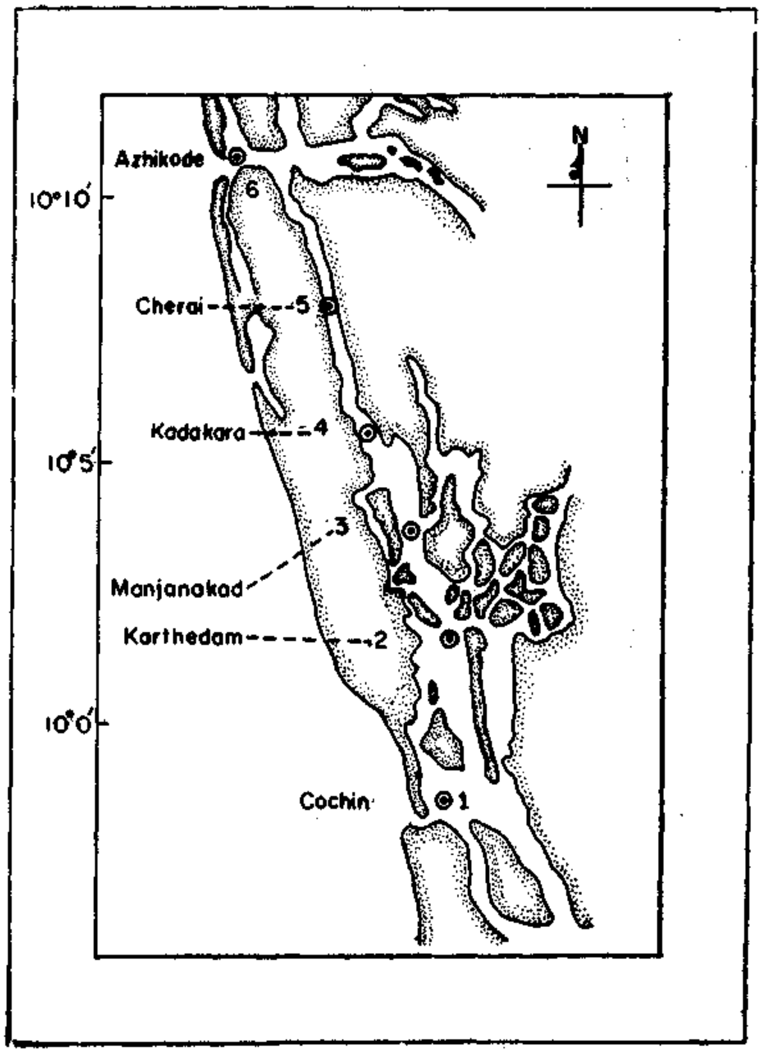

FIG. 1. Location of hydrographic stations between Cochin and Azhikode in the northern arm of Vembanad lake.

mouth (Fig. 1), at fortnightly intervals from June 1983 to October 1984. The distribution pattern of properties are presented as contour diagrams as has been done by Ramamirtham et al (1986).

Observation

Temperature

The surface temperature of the Cochin-Azhikode stretch of the estuary, denoted here as the northern arm, varying between 24.5° and 30.5°C, had an annual maximum in April and a minimum in July-August (Fig. 2). During the S.W. monsoon the decrease in the surface temperature of the northern arm was

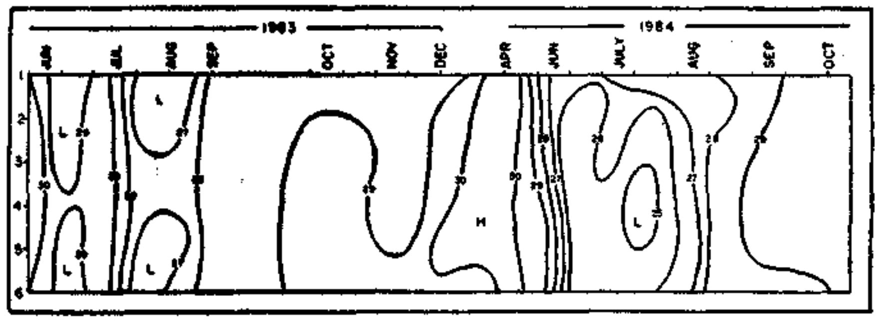

FIG. 2. Distribution of surface temperature.

less and more gradual than that observed in the southern arm (Ramamirtham et al 1986). Figure 3 shows that the decrease in the bottom temperature was highly conspicuous at the estuarine mouths during the monsoon, especially in 1984. But this markedly low temperature, not extending north of Karthedam

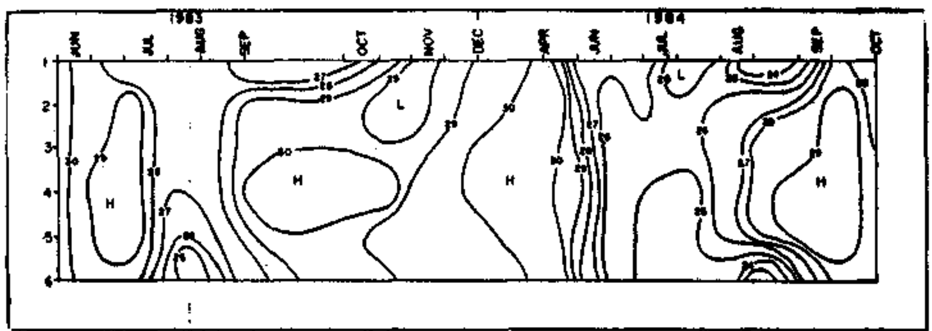

FIG. 3. Distribution of bottom temperature.

near Cochin and south of Cherai near Azhikode, did not affect a large central zone, which retained a higher temperature. This bottom thermal difference between the central zone and estuarine mouths, however, disappeared immediately after the monsoon, causing an almost equidistribution in the estuary. But this equidistribution was only for a short while, because the temperature of the central area of the estuary (whose extent had varied between the two years) rising further, the difference between the central zone and the estuarine mouths once again became conspicuous (Fig. 3). For the rest of the period the distribution of bottom temperature was more or less uniform.

The difference in temperature between the surface and bottom shows that, except at the mouths, the downward gradients were weak in this part of the lake. Also, the occurrence of the estuarine thermocline — metalimnion — unlike in the southern arm (Ramamirtham et al 1986), was highly restricted (2 or 3 miles from the mouths). Consequently, during the S.W. monsoon vertically homogeneous water predominated in the major part of the northern arm, indicating good vertical mixing.

Salinity

The variations in salinity with seasons were more drastic than those of temperature. There was a gradual decrease in surface salinity (Fig. 4) as the monsoon advanced, though the decrease was not very conspicuous in 1984. Except near the mouths very low salinity was observed all over the estuary both at the surface and at the bottom during July-October in both the years of study (Figs. 4 and 5). The halocline at the mouths were strong and the one at the Cochin mouth was more stratified. In the premonsoon season moderately high salinity prevailed all over the northern arm, including the central area, around Kadakara.

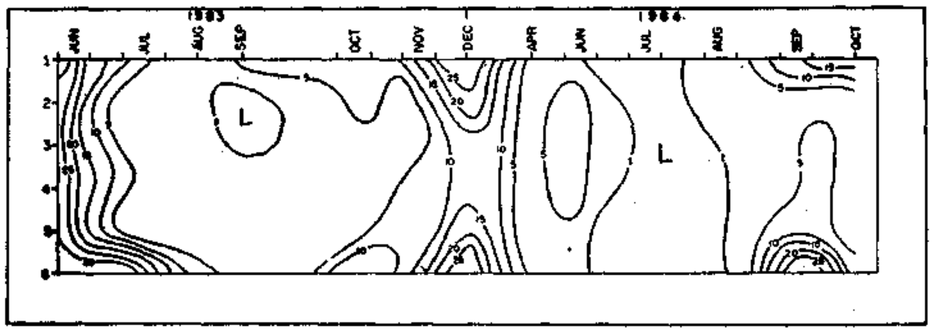

FIG. 4. Distribution of surface salinity.

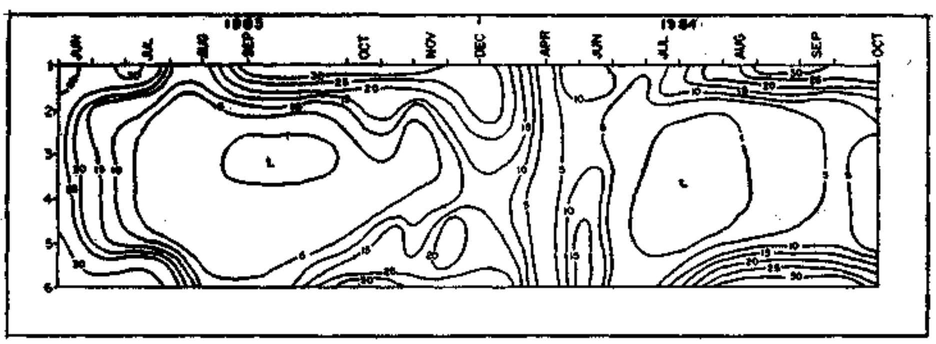

FIG. 5. Distribution of bottom salinity.

The distribution of dissolved oxygen at the surface and at the bottom are given in Figures 6 and 7, respectively. The surface in general was rich in oxygen almost throughout the period of study, except for some low values, around 3 ml|1, occurring particularly near the Cochin mouth. The bottom distribution showed areas well-distinguishable with low values ranging from 3 ml|1. However, during peak monsoon high values were observed in the area around Kadakara.

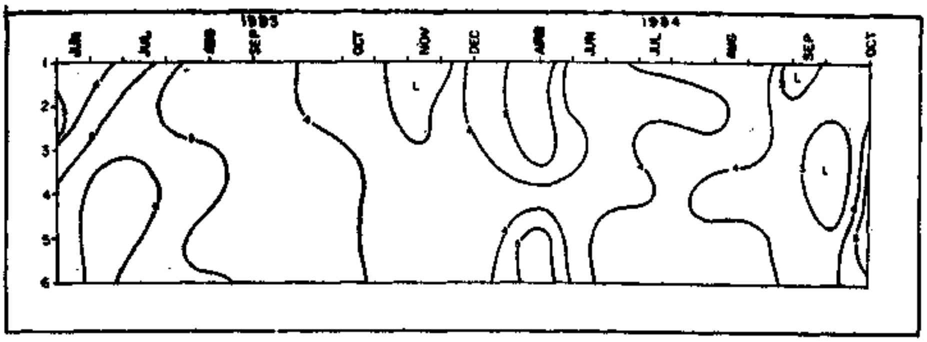

FIG. 6. Distribution of surface dissolved oxygen.

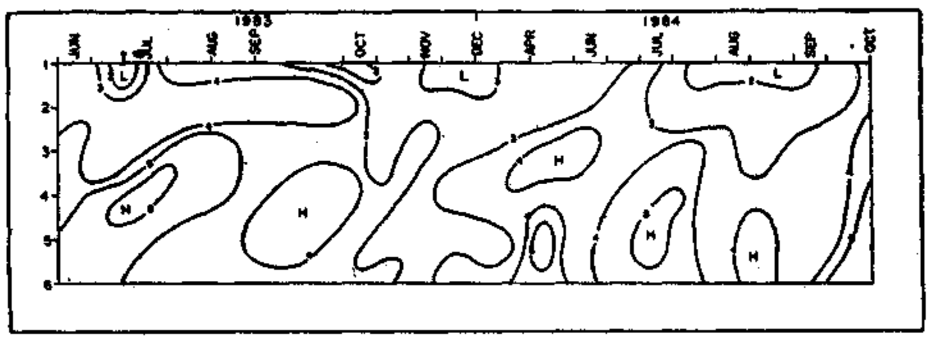

FIG. 7. Distribution of bottom dissolved oxygen.

Discussion

As the northern arm of the Vembanad lake is connected with the shelf waters by two openings subject to the same tidal variations, one at either end, it would not be possible to assign it to any known classification, even on a seasonal basis. Since the Azhikode mouth is shallower than the Cochin mouth, the influence of the Arabian sea on the northern half of this part of the estuary is less, both in magnitude and in extent, than on the southern half. The rising and ebbing tides, entering and exiting through the two mouths, each creates two opposite flows in the estuary: two face-to-face flows and two diverging. The face-to-face flows, caused by the rising tide, converge and the corresponding ebb-tide flows diverge around Kadakara, where as a result a null zone, almost free of the tidal force, is formed. Nevertheless, these flow characteristics are not keeping any visible pattern, owing mainly to the islets and shoals between stations 2 and 5 making them more complex and modified.

The salinity of both surface and bottom was extremely low in a large central area between Karthedam and Cherai during July-October (Figs. 4 and 5). As the Azhikode estuarine mouth is near the Periyar river mouth, the tidal impact of the coastal water, pressing shoreward, particularly in the monsoon season, deflects a large portion of the river discharge southward and, resisted by the tidal impact from Cochin, this deflected flow accumulates in this area eroding the salinity there, which causes the consistent low salinity observed for a period of nearly four months in the region between Karthedam and Cherai.

It may be pointed out that vertically homogeneous water of low salinity of less than 1 ‰ was observed from July to October and 5-15 ‰ from January to May in the region between Karthedam and Cherai. This well-mixed water, occupying a greater part of the estuary, seems to indicate that the uneven bottom of the central zone, which can offer much resistance to the tidal flows, cause greater turbulance and turbulant mixing.

Since the tidal flows are in opposite directions as is mentioned above, that part of the northern arm where a particular ebb or flood tide can dominate is limited to half way between the mouths and the centre. The islets and shoals, preventing horizontal flows in the Cochin inlet, together with the shallow bottom of the Azhikode inlet, offering much resistance to the tidal flows, can considerably weaken the formation of a strong halocline, which is essential for entrainment to take place according to Tully (1958), who also stated that spatially weak flows could restrict mixing due to entrainment. Therefore, in the northern arm mixing due to entrainment in the monsoon season appears to be more or less negligible.

A gradient in salinity observed in the S.W. and post-monsoon seasons from the mouths to Karthedam was prominent. This lateral gradient was absent during the rest of the period. However, it is not possible to infer a smooth longitudinal variation in the northern arm as a whole because of the presence of two mouths and opposing tidal flows. But it is well known that there are estuaries which are vertically homogeneous but show variations in the longitudinal direction.

The salinity ascendant observed near the mouths is conspicuous, more so near the Cochin mouth. Hence, it may be suggested that a salt wedge appears to form for a distance of 3 or 4 miles from the mouths in the monsoon season. However, because of more or less vertically homogeneous water in the central area during July-October and again from January to May, the northern arm as a whole cannot be categorized as a saltwedge estuary, in which as defined by Pritchard (1955), water of less salinity flowed over that of greater salinity.

The northern arm, having a mouth at its either end, can be treated as a two-channel system where the tidal flows are in opposite directions and hence cannot be classified as a coastal plain type of estuary, since, for classifying an estuary as the coastal plain one, only one major channel with uniform flow direction inward or outward is considered.

A number of islets and shoals on the Cochin side of the inlet, two arms of the same tidal flow moving in opposite directions with reference to a central null zone, the heavy discharge of the Periyar at one end in the monsoon season, the persistent difference between the characters of the mouth region and the central area, all these characters contributing to the peculiar dynamics of the northern arm of the Vembanad lake, it is well neigh impossible to make a justifiable classification of this estuary. At this juncture it would be appropriate to refer to Fischer et al (1979), who had stated that estuaries, possessing several characters and each one differring greatly from one estuary to the other, have individual personalities and, therefore, no one scheme of classification can define more than a simgle estuary in common.

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References

Hugo Fischer, B., E. John List, C. Y. Robert Kor, Jorg Imberger and H. Norman Brooks. 1979. mixing in estuaries. In *'Mixing in inland and coastal waters'* 229-278. Academic Press, New York.

Ramamirtham, C. P., S. Murhusamy and L. R. Khambadkar. 1986. Estuarine oceanography of the Vembanad lake - Part I: The region between Pallipuram (Vaikom) and Thevara (Cochin) *Indian J. Fish.* 33: 85-94.

Pritchard, D. W. 1955. Estaurine Circulation patterns. *Proc. Americ. Soc. Civil Engg.* 81 No. 717.

Tully, J. P. 1958. On structure, entrainment and transport in estuarine embayments. *J. Mar. Res.* 17: 523-535.