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OBSERVATIONS ON THE ENVIRONMENTAL CHARACTERISTICS OF PULICAT LAKE

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ABSTRACT

Observations made during the years 1968 through 1970 on the spatial and temporal variations in temperature, salinity, dissolved oxygen and pH in Pulicat Lake are presented. Water temperature showed double oscillation in its seasonal changes, whereas salinity had a single peak during May/June. From the mouth to the upper reaches of the lake there was a decreasing salinity gradient during monsoon and postmonsoon, which got more or less reversed during premonsoon and summer. Higher values of dissolved oxygen were observed during monsoon and postmonsoon when compared to summer and premonsoon. Hydrogen ion concentration showed an inverse relationship with oxygen. Wider fluctuations in the environmental parameters were observed in the northern sector of the lake and the probable reasons for this are discussed. An attempt has been made to correlate the variations in salinity with the fish production of the lake.

INTRODUCTION

PULICAT Lake is a large brackishwater lagoon, on the east coast of India and its annual fish yield is about 1,000 tonnes. Detailed accounts on the topography and physical features of the lake have been given by Chacko *et al.* (1953) and Rao (1971).

It is well known that fluctuations in the environmental parameters are responsible for the nature and distribution of fauna and flora in an estuary. Though much work has been done on the environmental features of Pulicat Lake (Hornell, 1908 ; Chacko *et al.*, 1953 ; Michael, 1970 ; Rao, 1971 ; Kaliyamurthy, 1972, 1973 ; Rao and Rao, 1972), no information is available regarding their probable effect on its fish production. In the present account an attempt has been made to correlate the fluctuations in the fish yield of the lake with the environmental features, particularly with salinity.

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MATERIAL AND METHODS

From 8 selected stations in the lake (Fig. 1) water samples were collected at the subsurface level, fortnightly from stations 1-3 and monthly once from the rest,

during January 1968 to December 1970. Data from stations 4 to 8 could not be collected during November and December 1970, due to inclement weather. Salinity was determined by Mohr's method and dissolved oxygen by Winkler's method. With a Lovibond colour comparator pH estimations were made. The values of each parameter for both fortnights were averaged to find the monthly means for

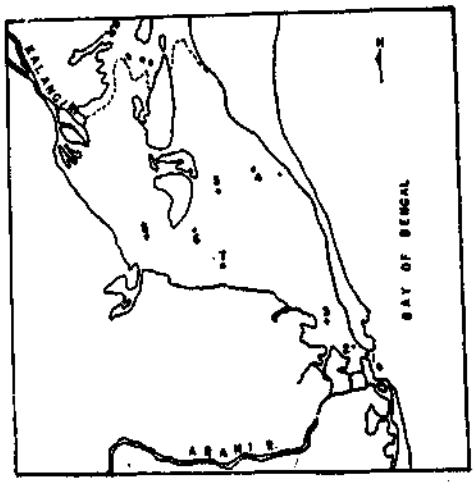

Fig. 1. Map of Pulicat Lake showing the collection stations.

stations 1 to 3. The monthly values for stations 1 to 3 and 4 to 8 were grouped separately to represent the southern sector (tidal zone) and northern sector (nearly a tidal zone) respectively, for easy comparison. Rainfall data were obtained from the Revenue Department, Government of Tamil Nadu, Ponneri.

Results

Temperature : Seasonal changes in the water temperature showed double oscillation with peaks during April-June and August-October (Fig. 2a). Generally, the values were lower at the southern sector than that of the northern sector, fluctuations being comparatively wider in the latter (25.0 - 32.8°C) than in the former zone (25.2 - 30.8°C) (Fig. 3a).

Salinity : Fig. 2b shows the monthly variations in salinity at the southern and northern sectors. Unlike temperature, salinity showed a single peak during May/June. Very low values were recorded during late monsoon (November/ December) or early postmonsoon (January). Salinity also showed wide fluctuations at the northern sector (0.5 - 51.5 ppt.) than that of the southern sector (7.3 - 40.0 ppt). An inverse relationship was observed between salinity and rainfall (Fig. 2b). In Fig. 3b season-wise grouped data for different stations are given, from which it can be seen that there was a horizontal gradient showing general decrease in values from the mouth region to the upper reaches of the lake during monsoon (Oct.-Dec.)

and postmonsoon (Jan.-Mar.). The same horizontal gradient got more or less reversed during summer (Apr.-June) and premonsoon (July-Sep.) with higher values at the upper reaches of the lake and lower values at the southern sector.

Dissolved oxygen : The values of dissolved oxygen content also showed pronounced seasonal fluctuations like temperature and salinity (Fig. 2c). Generally,

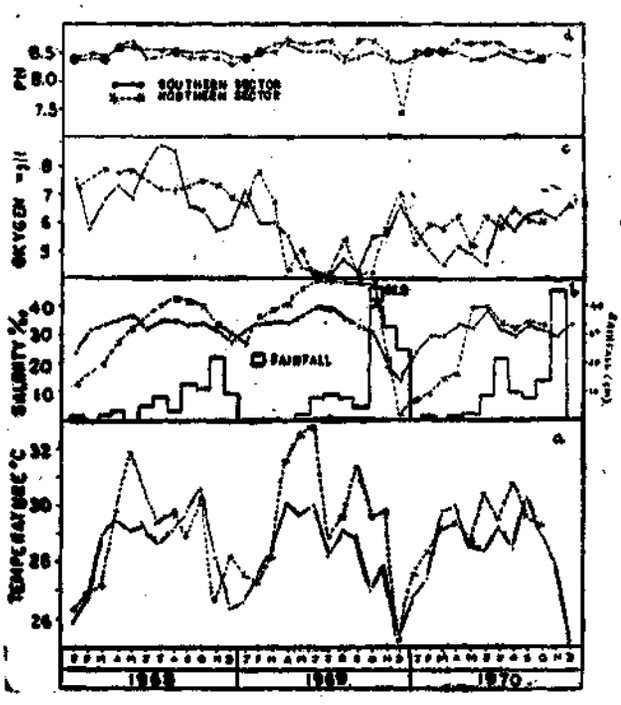

Fig. 2. Sector-wise seasonal changes in : a. temperature, b. Salinity, c. dissolved oxygen and d. pH.

higher values were observed during monsoon and postmonsoon and lower values during summer and premonsoon (Fig. 3c). Dissolved oxygen values showed a marked inverse relationship with temperature and salinity. No definite pattern of horizontal gradient could be observed (Fig. 3c).

Hydrogen ion concentration : The pH values showed considerable seasonal fluctuations (Fig. 2d). Maximum pH values were recorded during summer and premonsoon while minimum values were encountered during monsoon and postmonsoon (Fig. 3d). The seasonal changes in pH were smaller at the southern sector (8.3 - 8.7) than at the northern sector (7.4 - 8.8) (Fig. 3d).

Salinity in relation to fish production : Monthly values of salinity and fish catch data pooled for the whole lake were used to find out the relationship between them. In Fig. 4 the relationship between salinity variations and production of important groups like prawns, mullets, perches, clupeoids and catfishes are given.

Prawns (r = —0.381) and clupeoids (r = —0.465) showed negative correlation with salinity while mullets (r = 0.457) and perches (r = 0.594) showed positive cor-

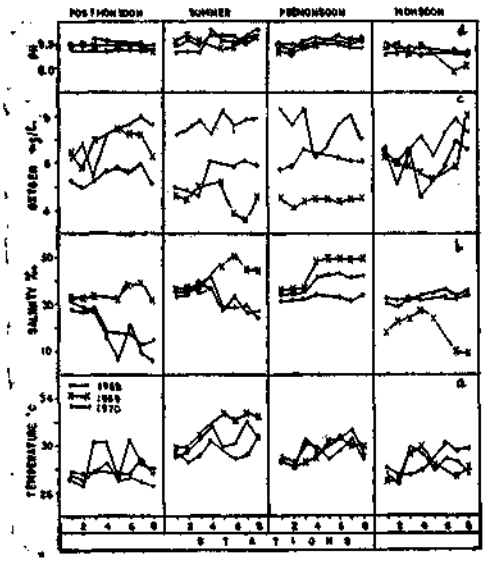

Fig. 3. Season-wise horizontal distribution of a. temperature, b. salinity, c. dissolved oxygen and d. pH.

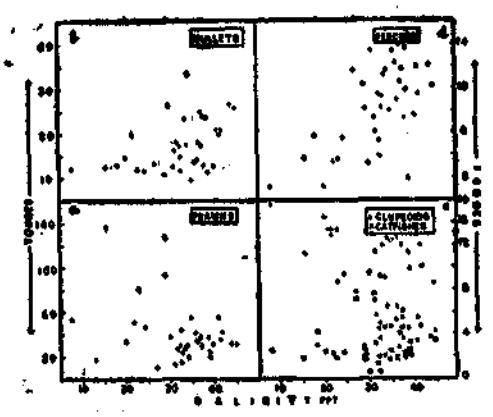

Fig. 4. Relationship between a. prawns, b. mullets, c. clupeoids and catfishes, d. perches and salinity.

relation. No definite correlation could be observed between salinity and catfishes (r = 0.051).

Discussion

The present studies showed that the water temperature in Lake Pulicat had two peaks annually, which is comparable to the observations made by Banerjee and Roychowdhury (1966) in Lake Chilka. Generally, waters of the northern sector were found to be warmer than that of the southern sector with wider fluctuations in the former. Higher water temperature coupled with wider fluctuations observed in the northern sector seems to be due to the shallowness of the area (average depth *ca*<1m). A similar case was reported from Marmugao Bay (Dehadrai, 1970a). Since the stations of the southern sector are situated in the tidal zone of the lake, it appears that lower water temperature with relatively narrow fluctuations observed in this zone may be due to the cooling effect of the neritic waters brought in by the incoming tide (Jacob and Rangarajan, 1959 ; Qasim and Gopinathan, 1969).

The salinity condition of the waters of the northern sector was observed to fluctuate from nearly fresh to hypersaline state, which confirms the earlier records (Hornell, 1908 ; Chacko *et al.*, 1953 ; Michael, 1970 ; Rao, 1971 ; Rao and Rao, 1972). Decreasing salinity gradient from the mouth to the upper reaches of the lake observed in the present study during wet seasons, seems to be a common feature among positive estuaries (Jacob and Rangarajan, 1959 ; Sankaranarayanan and Qasim, 1969). However, the reversal of this gradient during the dry seasons

(summer and premonsoon) is comparable to the situation in some of the negative estuaries (Collier and Hedgpeth, 1950 ; Ewing, 1950). Hornell (1908) reported that as distance from the mouth of Lake Pulicat increases, the specific gravity mounts higher with marked regularity, which is in conformity with the present observations. Very low salinity encountered during wet seasons might be due to dilution by fresh water. Conversely, during dry seasons when there was no fresh water influx, the water of the northern sector attained hypersaline state mainly due to evaporation. Rao (1971) opined that seepage of ground waters from brine aquifers and disposition of the mouth of the lake in relation to the direction of wave travel in the sea are also responsible for the hypersaline condition. According to Emery and Stevenson (1957) an estuary or lagoon presents positive characteristics in regions of low evaporation and high rainfall and runoff but negative characteristics in regions of high evaporation and low rainfall and discharge. Thus the different types of salinity distribution observed during various seasons clearly indicate the Lake Pulicat has the characteristics of a mixed environment (Rao, 1971). Comparatively narrow salinity variations in the southern sector may be due to tidal flushing, as the stations are situated in a fairly strong tidal zone.

Dissolved oxygen changes generally followed that of the salinity and temperature of the waters in Lake Pulicat. Similar relationship has been observed in Zuari and Mandovi estuaries in Goa (Dehadrai, 1970b). During summer and premonsoon, values of dissolved oxygen were lower, especially in the northern sector, while postmonsoon and monsoon recorded higher values. Higher values observed during wet seasons may partly be due to lower temperature and salinity (Dehadrai, 1970b), and partly due to photosynthetic activity of macrophytes that are abundant in these areas (Radhakrishnan, personal communication). Lower values recorded during dry seasons may be due to greater oxygen demand on account of decomposition of plant detritus and prevailing conditions of higher salinity and temperature. A similar situation has been reported from Lake Chilka (Banerjee and Roychowdhury, 1966).

Lower values of pH were observed during monsoon and postmonsoon while relatively higher values were encountered during summer and premonsoon which are comparable to the condition in Lake Chilka (Banerjee and Roychowdhury, 1966). Wider fluctuations observed at the northern sector can be attributed to the dense algal growths, as suggested by Banerjee and Roychowdhury (1966).

The salinity fluctuations of the lake showed an inverse correlation with prawns and clupeoids, while mullets and perches showed direct relationship. No definite correlation could be established between salinity and catfish landings of the lake. The present observations regarding mullets and prawns only agree with the previous work done in Chilka lake (Banerjee and Roychowdhury, 1966). However, these relationships should be taken with caution, as the fluctuations in fish populations and commercial stocks depend also on other factors like biological characteristics of the individual species (Murty and Edelman, 1966) and fishing intensity in the lake.

Nearly 57 to 66% of the total fish landings of the lake come from the tidal zone (southern sector), though it is much smaller than the northern sector in area. Similarly in Hooghly estuarine system also 70-80% of the total landings are obtained from the marine zone (Gopalakrishnan, 1971). The southern sector, by virtue of its proximity to the neritic waters, show comparatively narrow fluctuations in the environmental features, which may be the reason for its higher fish production.

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