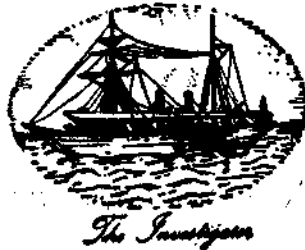


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ECOLOGICAL CONDITIONS OF THE PEARL CULTURE FARM AT VEPPALODAI IN THE GULF OF MANNAR

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ABSTRACT

The seasonal changes in atmospheric temperature, surface water temperature, salinity, dissolved oxygen, pH, turbidity and silt deposition at and in the vicinity of the pearl culture farm located off Veppalodai in the Gulf of Mannar were studied during the period from January, 1974 to December 1978. The surface temperature exhibited a clear double oscillation every year and the atmospheric temperature which was invariably higher, also registered two maxima and two minima. The salinity was high during the period of the south-west monsoon and low during the north-east monsoon. There was not much variation in pH values and dissolved oxygen content. The water was turbid during most part of the year, with higher dissolved oxygen content. Silt deposition was observed to be high during December. The values of primary production were high in September.

INTRODUCTION

FOR the survival and optimum growth of pearl oysters, the ecological conditions should be most conducive, inasmuch as growth is strongly influenced by the chemical substances and trace elements present in the sea water and the quality and quantity of the plankton. Matsui (1958) emphasized this fact and pointed out that the resultant variations in the width of pearl oyster shells influence the size, colour and lustre of the cultured pearl. Besides, spawning of the oyster and settlement of spat depend greatly on the quality of the water and the currents prevailing from time to time. Alagarswami (1970) has drawn attention to the necessity of hanging pearl oyster cages at such depths where optimum temperature conditions prevail and also the desirability of shifting the depth of suspension when the hydrographical conditions change from season to

season. Also a moderate current is found necessary not only as a source of oxygen but also to bring in planktonic organisms on which the pearl oyster feeds.

Observations on the physico-chemical conditions of the pearl and chank beds in the Gulf of Mannar were studied earlier by Pillai (1962 a, b) and Chandraseharan *et al.* (1967). Prasad and Nair (1963) have reported that the waters off Tuticorin at 10 metres was found to be very productive. As an integral part of the pearl culture experiments off Veppalodai in the Gulf of Mannar, the basic ecological conditions prevailing in the locality were studied. Since pearl production has been successful at Veppalodai (Alagarswami, 1974), a knowledge of the environmental conditions of the area would be useful in extending the operations to other areas.

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work. He is indebted to Dr. K. Alagarwami of this Institute for his constant encouragement, invaluable guidance, critical perusal of the manuscript and valuable comments. His sincere thanks are due to Shri S. Dharmaraj for the data on silt.

MATERIAL AND METHODS

The pearl culture farm is located in the Gulf of Mannar off Veppalodai (08°57' N and 78°14' E) about 25 km north of Tuticorin. Observations were made at three stations — the farm (station 1), near the shore (station 2) and near Karai-challi Island (station 3) as shown in Fig. 1. The depth range at these stations are 3.75-4.25 m, 2.50-3.00 m and 4.25-4.75 m respectively. Sea water samples were collected once a week

capacity glass bottle with a diameter of 2.54 cm at the mouth, at a depth of two meters. Gaarder and Gran (1927) light and dark bottle oxygen technique was employed to estimate the primary productivity. Sets of light and dark glass bottles of 125 ml capacity were filled with sea water collected from the Veppalodai pier and suspended in the same area. The incubation period lasted for 12 hours from 0600 hours to 1800 hours. The initial and final oxygen content of both the bottles were determined by Winkler method. It was observed that the temperature, salinity, dissolved oxygen and pH of the surface waters of all the three stations did not show any marked variations and hence, the data collected from the stations were pooled together. Data on rainfall were obtained from the records of the Port Trust, Tuticorin. The

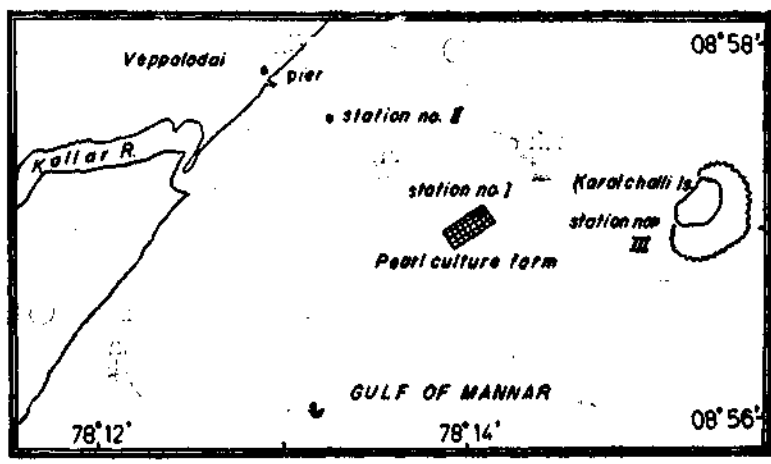


FIG. 1. Veppalodai pearl culture farm in the Gulf of Mannar and sampling stations.

from each station between 0830 and 0930 hours. The atmospheric and surface water temperatures were recorded. Water samples were collected for the estimation of salinity and dissolved oxygen by standard titration methods. Hydrogen-ion concentration was determined with a pH meter. The transparency of the water was measured using a secchi disc. Silt deposition was estimated by suspending a 270 ml

observations relate to a period of five years from 1974 to 1978.

OBSERVATIONS

Atmospheric temperature

The monthly mean atmospheric temperature varied between 25.2°C (January) and 31.6°C (March) in 1974, 26.1°C (December) and 30.9°C

(May) in 1975, 27.2°C (December) and 31.6°C (May) in 1976, 25.8°C (January) and 31.4°C (April-May) in 1977 and 26.2°C (December) and 31.3°C (May) in 1978 (Fig. 2). Except in 1978, two distinct temperature maxima were

in 1978. Judging from the general trend of atmospheric temperature, there appears to be a strong maximum during April-May, a weak minimum during June-July, a weak maximum during September-October and a strong mini-

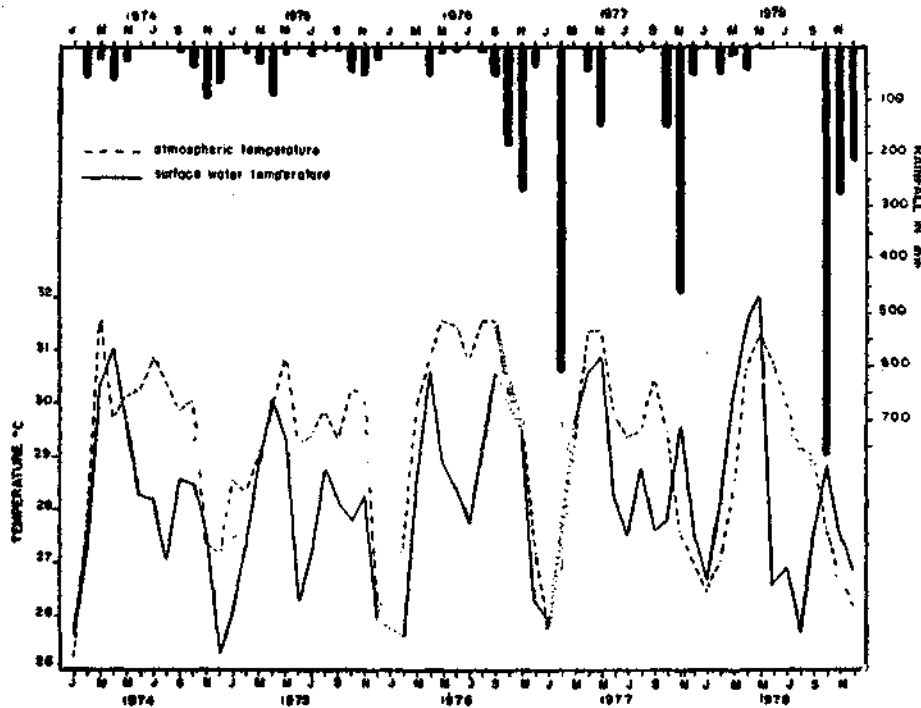


FIG. 2. Seasonal variations in atmospheric temperature, surface water temperature and rainfall (Months in which no observations were made are shown in dotted lines).

observed in each year — March (31.6°C) and July (30.9°C) in 1974, May (30.9°C) and October (30.3°C) in 1975, May (31.6°C) and August-September (31.6°C) in 1976 and April-May (31.4°C) and September (30.5°C) in 1977. In 1978 only one temperature maximum was observed in May (31.3°C). In contrast, only one temperature minimum was observed in each year, January (25.2°C) in 1974, December (26.1°C) in 1975, December (27.2°C) in 1976, January (25.8°C) in 1977 and December (26.2°C)

in 1978. Judging from the general trend of atmospheric temperature, there appears to be a strong maximum during April-May, a weak minimum during June-July, a weak maximum during September-October and a strong mini-

Surface water temperature

The monthly mean surface water temperature varied between 25.5°C (December) and 31.1°C (April) in 1974 ; 26.0°C (December) and 30.1°C (April) in 1975, 25.6°C (February) and 30.6°C (April) in 1976 ; 25.9°C (January) and 30.9°C

(May) in 1977 and 25.7°C (August) and 32.1°C (May) in 1978 (Fig. 2). Two temperature maxima were observed in each year — April (31.1°C) and September (28.6°C) in 1974, April (30.1°C) and November (28.3°C) in 1975, April (30.6°C) and September (30.6°C) in 1976, May (30.9°C) and November (29.6°C) in 1977 and May (32.1°C) and October (28.8°C) in 1978. The two minima were observed in August (27.1°C) and December (25.5°C) in 1974, June (26.3°C) and December (26.0°C) in 1975, July (27.7°C) and December (26.3°C) in 1976, July (27.5°C) and December (27.6°C) in 1977 and August (25.7°C) and December (26.9°C) in 1978. Data are not available for the month of January 1976. However, February 1976, recorded lower temperature as compared to the corresponding month of preceding years.

Rainfall

The annual rainfall was 368 mm, 282 mm, 615 mm, 1489 mm and 1370 mm during 1974 through 1978 respectively. The maximum monthly rainfall was 95.6 mm in November 1974, 50.6 mm in November 1975, 269.9 mm in November 1976, 616.4 mm in February 1977 and 770.0 mm in October 1978 (Fig. 2). The period June-August is the period of least or no rainfall. September-May period is the rainy period with main peak in October-November. A secondary peak of rainfall is noticeable during February-April also. The air and sea temperatures appear to be correlated with rainfall. The air temperature is as low as that of the surface temperature during peak rainfall periods. During non-rainy or least rainy periods in June-July the air temperature is much higher than that of sea surface.

Salinity

The monthly mean salinity values varied from 32.15‰ (January) to 35.26‰ (August) in 1974, 32.38‰ (December) to 35.13‰ (August) in 1975, 32.79‰ (February) to 35.58‰ (July) in

1976, 28.48‰ (November) to 34.78‰ (July) in 1977 and 28.95‰ (January) to 34.28‰ (July) in 1978 (Fig. 3). In contrast with the temperature, the salinity showed a single peak in July/August preceded by a gradual rise from January and followed by a gradual decline to December. The peak salinity period corresponds with the no rainfall period. Salinity becomes the lowest during January/February, followed by peak rainfall in October-November. But such a decline in salinity is not noticeable after the secondary rainfall peak in February-April.

Dissolved oxygen

The monthly mean dissolved oxygen values ranged from 4.6 ml/l (November) to 5.6 ml/l (January) in 1974, 4.8 ml/l (December) to 5.9 ml/l (April) in 1975, 4.4 ml/l (April) to 6.0 ml/l (March) in 1976, 4.4 ml/l (September) to 6.0 ml/l (May) in 1977 and 4.4 ml/l (November) to 6.4 ml/l (August) in 1978 (Fig. 3).

pH

The pH values were recorded from January 1974 to November 1975. The monthly mean pH values varied from 7.96 (February) to 8.42 (November) in 1974 and 8.03 (June) to 8.29 (February) in 1975 (Fig. 3).

Water transparency

The monthly mean transparency of water varied from 0.69 m (May) to 1.73 m (September) during 1974, 1.12 m (September) to 2.60 m (November) during 1975 and 1.44 m (August) to 2.29 m (July) during 1976 (Fig. 3).

Silt

Data were collected from October 1975 to April 1976 only. The average rate of silt deposition per day was calculated. The maximum of 3.13 ml/day was recorded in the month of December 1975 and the minimum 0.87 ml/day during March 1976.

Primary production

Table 1 illustrates the mean monthly values of gross and net productivity expressed as mg C/m³/12 hours day for the year 1978. The

(September) in 1978. There are two peaks of production one in May (345.2 mg C/m³/12 hours day) and another in September (377.0 mg C/m³/12 hours day). The two depressions

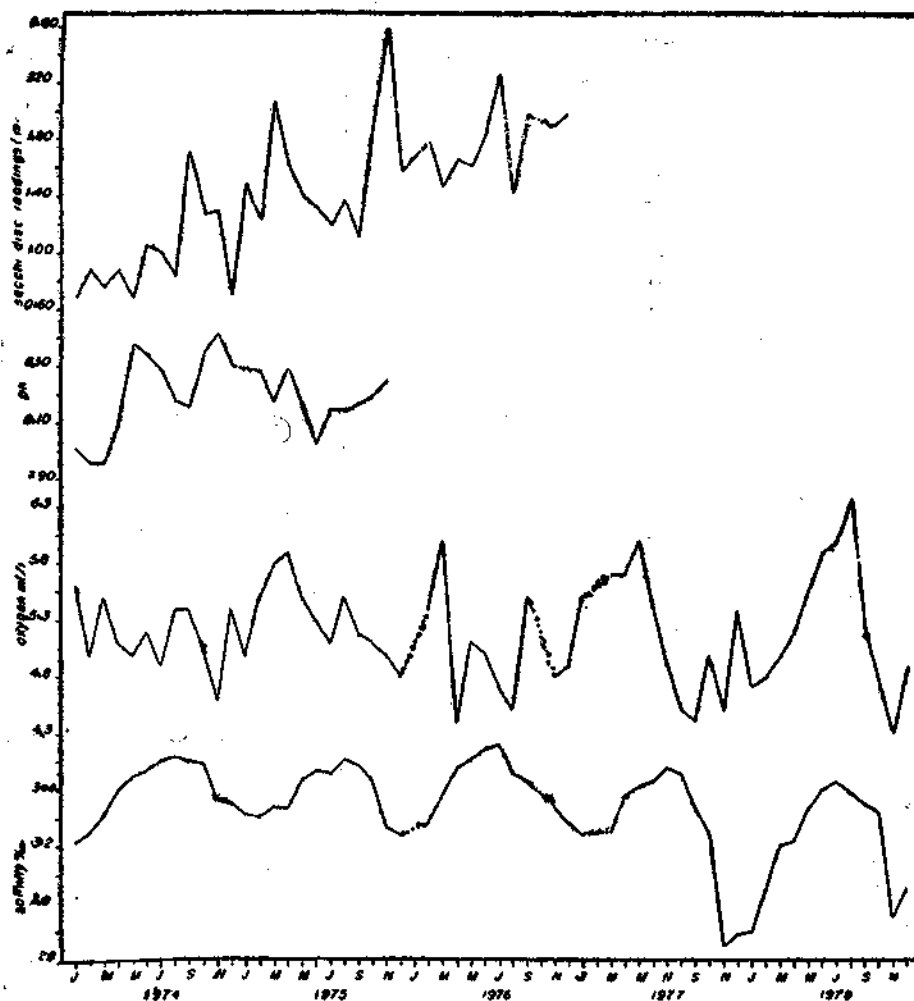


FIG. 3. Seasonal variations of salinity, dissolved oxygen, pH and clarity (Months in which no observations were made are shown in dotted lines).

mean monthly values of gross production are one in March (195.8 mg C/m³/12 hours day) and the other in October (211.9 mg C/m³/12 hours day) (March) and 377.0 mg C/m³/12 hours day (September).

TABLE 1. Values of mean monthly primary productivity and Respiration at Veppalodai Pearl Culture Farm during 1978

Month	Primary productivity (mg C/m ² /12 h day)		Respiration (mg C/m ² 12 hrs)	% of gross
	Gross	Net		
January	278.5	181.6	96.9	34.8
February	202.8	96.9	105.9	52.2
March	195.8	109.0	85.9	44.3
April	278.6	181.7	96.9	34.8
May	345.2	212.0	133.2	38.6
June	295.6	167.2	128.4	43.4
July	369.5	243.8	125.7	34.0
August	355.8	286.2	69.6	19.6
September	377.0	255.6	121.4	32.2
October	211.9	149.9	62.1	29.3
November	294.8	244.3	50.5	17.1
December	339.2	269.9	70.3	20.7

DISCUSSION

The fluctuations in the monthly mean atmospheric temperature followed the same pattern during the five years of study from 1974 to 1978. In general the atmospheric temperature exhibited three distinct periods of change; rising temperature from January to May, high temperature from June to October and decreasing temperature from early November to late December. The decrease in temperature to the lowest levels in December is due to the effect of an active north-east monsoon. The monthly mean surface temperature also exhibited a similar trend; temperature rise from January to April, temperature fluctuations during June-October with minimum during July-August and temperature decrease from early November to late December. During July-August the strong winds associated with the south-west monsoon caused a high rate of evaporation resulting in the lowering of temperature (Prasad, 1957). The steep fall in the surface temperature during November-December was primarily due to the onset of the rain-bearing north-east monsoon. In all the five

years of study the coincidence between atmospheric and the surface water temperature was not continuous. Except in January and April 1974, January, March, November and December 1977, January to May and October to December 1978, the atmospheric temperature was found to be higher than the surface water temperature. Prasad (1957) observed that the average atmospheric temperatures were above the mean surface temperatures mostly in the months of May, June and July at Mandapam and that the atmospheric temperature was never above the surface temperature continuously for more than four months.

The variations in salinity followed the same pattern during the five consecutive years of study. Unlike temperature, salinity appears to be monocyclic in its annual variation. High salinity values prevailed over a period of about six months from May to October and the low salinity values from November to April in 1970. The period of very high values and very low values coincide with south-west monsoon and north-east monsoon respectively. Jayaraman (1954) recorded high salinity values from

November to April in the Gulf of Mannar and Palk Bay which is in agreement with the present observations. During the present study, the highest individual salinity value of 36.68‰ was recorded on June 29, 1976. The highest salinity value recorded by Chandraseharan *et al.* (1967) in the pearl and chank beds off Tuticorin was 36.12‰ on September 1, 1961. The lowest individual salinity value obtained during the present study was 9.27‰ on November 25, 1978. Chandraseharan *et al.* (1967) recorded a low salinity of 29.13‰ on December 5, 1962 and Chacko and Sambandamurthy (1969) recorded the lowest value of 11.2‰ during 1962-63 on the pearl banks of the Gulf of Mannar. The effects of heavy rainfall in the coastal and interior areas and the influx of fresh water into the sea from the numerous rivers and rivulets including the major river Tambraparni and the two small rivers Kallar and Vaippar in the vicinity of Veppalodai considerably lowers the salinity. Alagarwami and Victor (1977) have shown that salinity conditions reached the low level of 15.59‰ on November 8, 1977 in the Veppalodai pearl culture farm. However, there was no mortality of pearl oysters mainly because the low saline conditions prevailed only for a short while.

There is no perceptible seasonal variation in dissolved oxygen. However, during certain months the values were pronouncedly high as well as low. The range of 4.4 - 6.4 ml/l observed in the present study area agrees with the observations of Jayaraman (1954) on the surface waters off Mandapam. The hydrogen ion concentration ranged from 7.96 to 8.42 and there was no marked seasonal variation.

The south-west and north-east monsoons cause the presence of large quantities of suspended matter in the water. The monthly

mean transparency of water was never high, and the values ranged from 0.69 m to 2.60 m in the depth range of 2.50 - 4.75 m. Turbidity and dissolved oxygen showed good correspondence; more turbid the water, more was the oxygen content. The rate of silt deposition per day varied from 0.87 ml (March 1976) to 3.13 ml (December 1975). The highest silt deposition observed in the month of December 1975 coincides with low salinity and temperature conditions.

There were two peaks of primary production one in May (345.2 mg C/m³/12 hours day) and another in September (377.0 mg C/m³/12 hour day). Prasad and Nair (1963) reported that the waters off Tuticorin were remarkably productive and showed a rate of 252.6 mg C/m³/day at 10 metres. The range of 195.8 - 377.0 mg C/m³/12 hour day observed in the present study area is relatively higher than the above values.

The present study deals with only a few ecological parameters of the pearl culture farm. Investigations on other factors such as nutrients and energy content of suspended organic matter which are relevant have been started only recently. Compared to the environmental conditions of pearl culture farms in Japan (Matsui, 1958; Alagarwami, 1970) and Australia (Hancock, 1973) those at the Veppalodai farm are far different in regard to at least three factors — protection from winds and waves, depth and turbidity — and the latter would seem apparently unfavourable. The difference is so with regard to the conditions of the natural pearl oyster beds in the Gulf of Mannar. However, the initial successful development of pearl culture technology at Veppalodai for producing high percentage of good quality cultured pearls would show that shallow open coastal areas may be considered for establishing pearl culture farms in the absence of more ideal sites.

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