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ENVIRONMENTAL CHARACTERISTICS OF EDIBLE OYSTER BEDS IN AND AROUND TUTICORIN*

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ABSTRACT

The investigations on various hydro-biological parameters which influence the condition factor, spawning and the resource characteristics of the edible oyster *Crassostrea madrasensis* around Tuticorin have been conducted in three habitats of oyster beds, namely coastal (Tuticorin Bay), mangrove (Korampallam Creek) and estuarine (Punnakayal) areas. Observations on the stages of maturity, spawning and condition of oysters in the three habitats have been made and a correlation of the above biological aspects of the oysters with the environmental factors have been attempted. A direct correlation has been observed between the biological aspects of oysters and the productivity parameters of the habitat. The water temperature also showed a direct relationship with the condition factor of the oysters. The mean value of the condition factor of the oysters were found to be at the optimum level during April when productivity parameters were observed to be at higher level. The chemical factors especially the nutrients such as nitrates and phosphates showed an indirect relationship with maturity and condition of the oysters. Among the different habitats, the mangrove area registered higher productivity rates which has a well defined relation with the condition of oysters.

INTRODUCTION

DURING the course of investigations on the biological history of oyster population of different habitats in the vicinities of Tuticorin, it was found that the biological features of oyster population such as condition of meat and maturity stages have been observed to exhibit changes in a uniform pattern. But the degree of the condition of the meat and maturity stages differ from habitat to habitat. Hence, in order to assess the factors which influence and govern the existence of the oyster population at the various habitats, a detailed investigation on the prevailing productivity and hydro-biological parameters of the oyster beds spread in the coastal, estuarine and mangrove areas of this region has been studied and the results presented in this paper.

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MATERIAL AND METHODS

The present studies were conducted at the three different habitats, *i.e.* western part of the Tuticorin Bay (St. 1), mangrove creeks on the southern part of the Tuticorin Bay (St. 2) and Punnakayal Estuary (St. 3) (Fig. 1).

Station 1 : The Tuticorin Bay lies in 08° 45'N and 78°12' E enclosing a water area of

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56 sq. km. The Hare Island (Pandian Thivu) forms the eastern boundary of the bay and the shore of island is sandy along the northern and middle zones and muddy along the southern zone. The western bank of the bay is deeply indented in two places and these creeks lead to expansive water bodies, harbouring sizable oyster populations. Of this, the northern creek and its water spread houses some mangrove vegetation. The depth of the creek ranges from 0.5 to 2.0 m and bottom is of sand and mud.

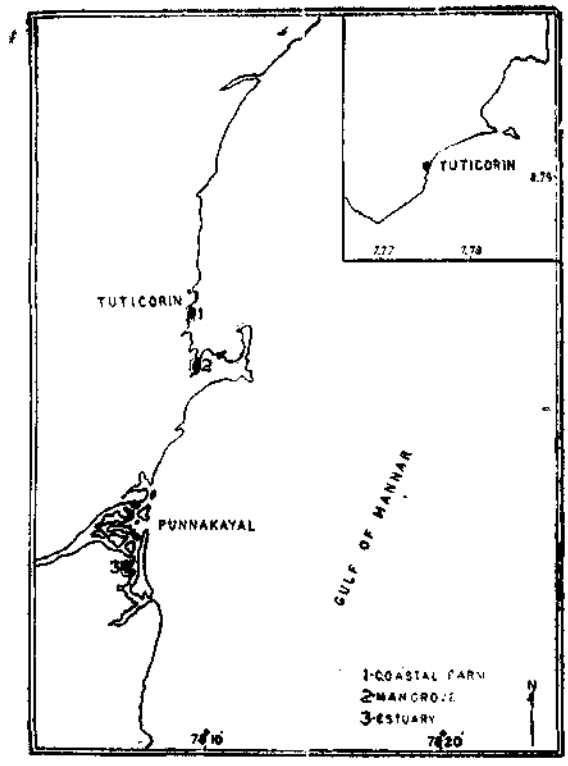

Fig. 1. Sampling stations of oyster beds in and around Tuticorin.

Station 2 : The southern point of Tuticorin Bay extends to a creek which expands into a wide mangrove area and merges with a freshwater channel in which surplus water from the nearby irrigation tank flows into the sea. This creek is relatively deeper than the other due to the heavy flow of freshwater during monsoon months. The mangrove vegetation (chiefly *Avicinnia* sp.) is found to be lush and dense in this area. On the banks of the creek, the boulders and on tide washed shoals or flats, live oyster settlement are prominently noticed. The depth ranges from 0.5 to 3.5 m. The banks and the slopes of the creek is muddy sand and the interior of the creek is muddy or slushy.

Station 3 : The Punnakayal Estuary is in the north of river Thambirabarni, about 25 km south of Tuticorin. The place of observation lies at the southern part of the estuary and is about 2 km from the bar mouth of the estuary. This part of the estuary extends as creek southwards to about 3 km and harbours sizable oyster population. The depth of the water in this area ranges from 0.5 to 3 m. The banks and bottom of the creek is of sandy mud.

Fortnightly samples of oysters and water were collected from all the habitats between 0600-0830 hrs from May 1986 to April 1987. Atmospheric and water temperatures were recorded. Light and dark bottle oxygen technique (Gaarder and Gran, 1927) was employed for measuring the primary production. Uniform time was given for the samples and Winkler's method was followed for the estimation of oxygen and converted the same for carbon equivalent using a PQ of 1.25 for obtaining the gross production.

The estimation of chlorophyll *a* was made by filtering one litre of water from each habitat using millipore HA filters and dissolved in 90% acetone and the optical wavelength (665) was measured using a Spectrophotometer. Hydrological factors studied simultaneously with primary production and chlorophyll *a*, temperature, salinity, pH, dissolved oxygen content and nutrients such as nitrite, nitrate, phosphates and silicates. Estimation of the schemical properties of the water was followed

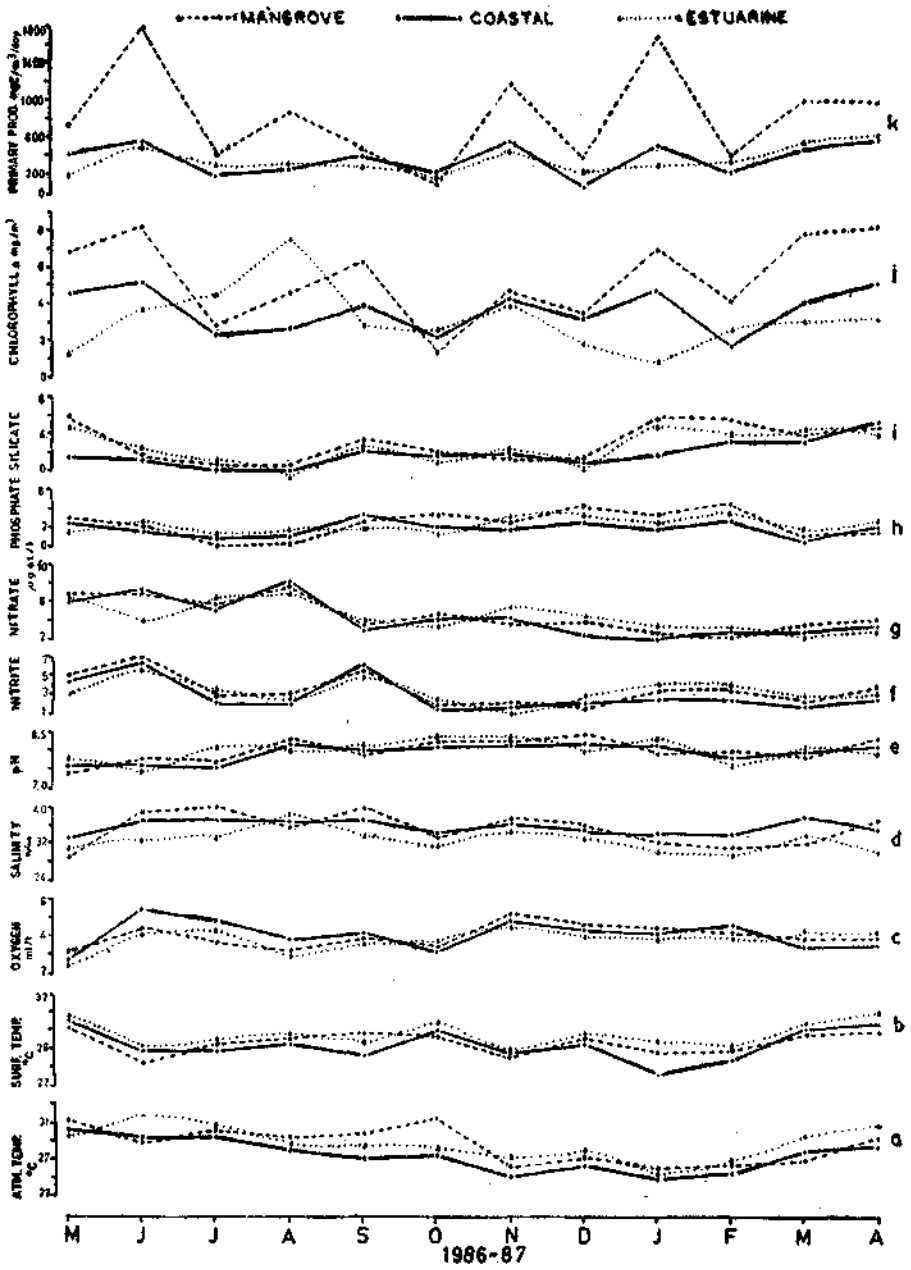

Fig. 2. Seasonal variations of hydro-biological parameters of oyster beds.

as suggested by Strickland and Parsons (1968). The fluctuations in the productivity parameters and the physico-chemical conditions are discussed in terms of monthly averages.

Random samples of 50 oysters from each habitat have been collected and the size, weight, sex, stages of maturity were recorded. The condition factor have been estimated by dry

weight method and sex and maturity stages have been assessed by smear studies.

Observations and Results

Temperature

The atmospheric temperature was recorded regularly along with the water temperature and the monthly variations represented in Fig. 2 a, b indicated a direct relation. The close similarity in the curves reveal that the water temperature of the three environments are basically influenced by the atmospheric temperature. It has been observed that the atmospheric temperature in the estuarine environment of Punnakayal was slightly higher when compared to the coastal and mangrove areas. Both the atmospheric and water temperature of all the habitats showed maximum values during the summer months (March-May) and lower values during November-January. A secondary rise in temperature was noticed in September-October, revealing a bimodal oscillation of temperature in these ecosystems.

Salinity

The monthly average values of salinity showed the variations ranging from 24 - 38 ‰ during the period of observation (Fig. 2 d). However, there were marked variations in the values of salinity for the coastal and mangrove ecosystem whereas the estuarine environment at Punnakayal showed very low values during December-February. In the coastal and mangrove ecosystems, high salinities recorded in March-April, June-July and September months, showing 3 peaks during the period of study.

The pronounced fall in the salinity at Punnakayal region during December-February resulted in relatively low values of the condition factor and poor representation of matured stages among oyster population. While in the other habitats, the values of condition factor and percentages of matured stages were moderate. During the peak period of salinity, the condition and maturity stages of oysters have been observed to be high, especially during March-April and September months.

Oxygen

The dissolved oxygen content showed less fluctuations among the environments when compared to temperature and salinity (Fig. 2 e). Two peak of oxygen content noticed in all the habitats, first during June-July and the second during November. Exceptionally high values of oxygen observed during June in the estuarine area of Punnakayal. Very low oxygen content noticed during May, October and March-April periods.

pH

The pH indicated steady level in all the habitats of oyster growing areas (Fig. 2 e) and ranged from 7.3 to 8.2, revealing that all the environments are suitable for the growth of oysters.

Nitrite

The monthly nitrite content of the water indicated 2 peak periods, first during June and the second during September (Fig. 2 f). The rest of the period showed no fluctuations in all the habitats, indicating that nitrite nitrogen has been utilized by the phytoplankton substantially.

Nitrate

The monthly values of nitrate (Fig. 2 g) for 3 habitats showed slight fluctuations when compared to the nitrite values. The nitrates were found to be in increased rates during the period May-August and steady level during the rest of the year. The values ranged from 1.8 to 8.2 μg at N/l. The low or negligible value of nitrogenous products in the waters revealed that the compounds have been used fully for the production of phytoplankton.

Phosphate

Compared to nitrates, the phosphate showed steady level in all the habitats of oyster growing areas (Fig. 2 h). The phosphate ranged from 1-5 μg at P/l during the period of observation. High values were noted during May, September and December-February and low values during March-April and July-August. The low values indicated that the inorganic phosphate has been completely utilized by the primary producers, thus showing an inverse relationship with primary production.

Silicate

The silicate showed two distinct peaks with a small inter-peak during September, during the period of observation (Fig. 2 i). The first peak was observed during March-May and the second during December-February similar to the high values noticed in the case of phosphate. However, higher values of silicate observed at the mangrove and estuarine habitats when compared to the coastal bed of oysters.

Chlorophyll a

Since chlorophyll *a* forms one of the indices of the standing crop of phytoplankton, the estimation of this pigment along with the primary production will indicate a general idea of these habitats of oyster beds. The Fig. 2 j shows wide fluctuations in all the habitats. High values of chlorophyll *a* could be observed during January, March-June and August-September months at the mangrove and coastal ecosystems when compared to the Punnakayal estuarine oyster bed. During October, the chlorophyll *a* values were low at all these habitats.

Primary production

It is seen from Fig. 2 k a wide range of fluctuations in primary production among different ecosystems. However, the values showed that the mangrove ecosystem was having high values compared to the coastal and estuarine areas. The primary production at the coastal and estuarine areas were somewhat similar throughout the period of study. High primary production noticed at the mangrove during January, June, August and November. The data reveal that there is a close relationship with the values of chlorophyll *a* indicating the expected positive correlation between these two indices of standing crop.

Condition factor of oysters

The oysters in the mangrove ecosystem showed a maximum condition value of 222.6 with a mean of 98.34; the estuarine oysters a maximum of 196.6 and a mean of 85.79; the coastal oysters, a maximum of 180.5 and a mean of 77.16. In general, the condition value was uniformly high in all the ecosystems during April. In the mangrove ecosystem, the oyster population was moderate to high without significant fluctuations.

Stages of maturation of oysters

The maturity stages of oyster population of the three habitats showed distinctively different patterns.

Spent stages of male and female oysters were dominant in the coastal and estuarine habitats during May and June whereas in the mangrove ecosystem, these stages were less dominant when compared to other areas.

Maturing stages of male and female were dominant during July in the coastal area while this feature was observed in the mangrove areas during September. In the estuarine system, the above feature was noticed during September and October.

Fully matured males occurred in low percentages in the coastal area when compared to other ecosystems. However, this feature is noticed in the coastal region during February-March. Fully matured females were dominant during March-April in all the ecosystems. A secondary rise of this stage is noticed during August, September and October in coastal, mangrove and estuarine areas respectively.

Discussion

In all the habitats, the water temperature showed higher values during March-May and September-August months. This bimodal oscillation has a well defined relation to the condition of meat in oysters as well as stages of development of maturity. Among the three

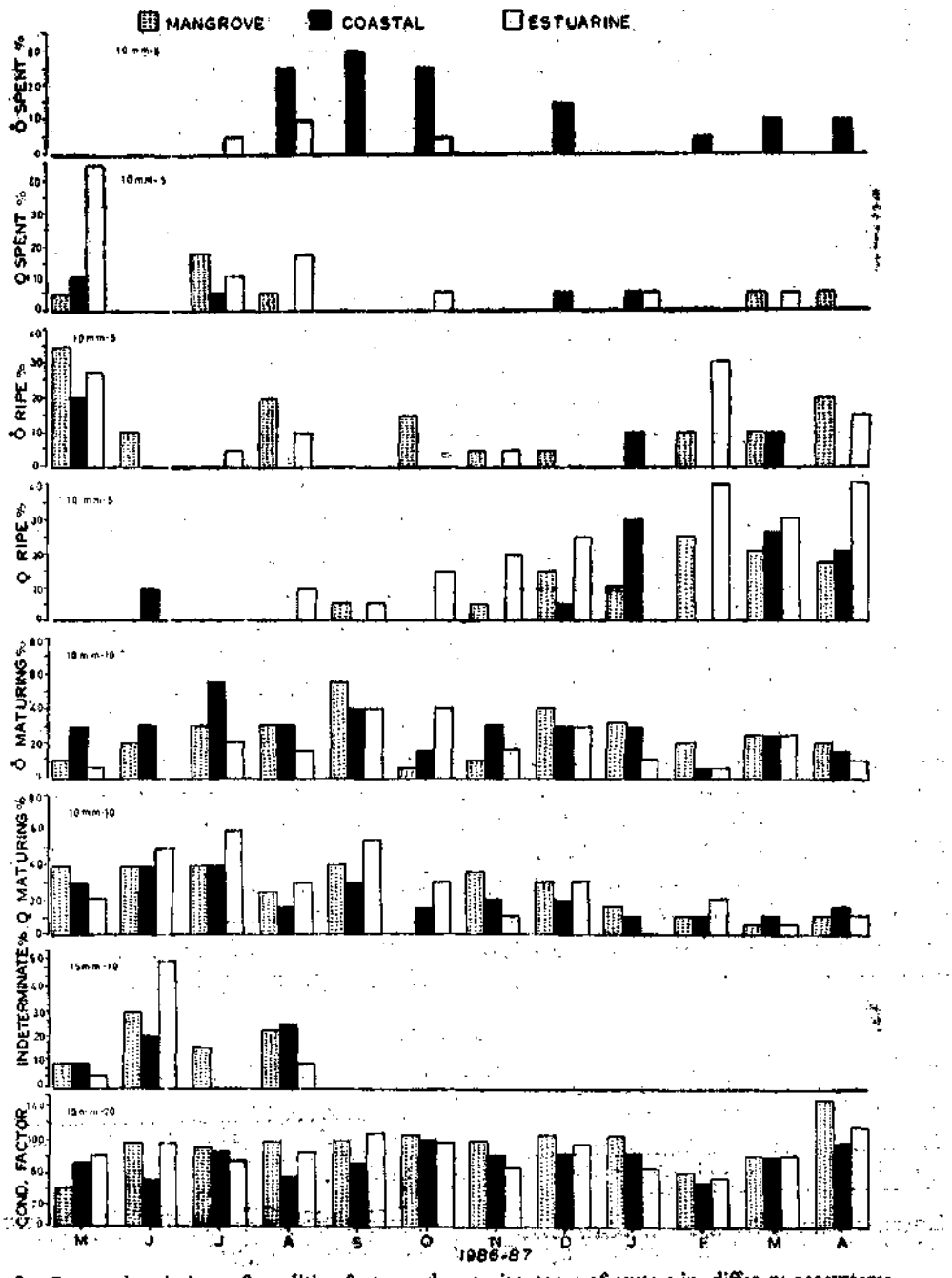

Fig. 3. Seasonal variations of condition factor and maturity stages of oysters in different ecosystems.

habitats, mangrove ecosystem registers high values of condition factor and greater percentages of sexually matured individual. Nayar and Mahadevan (1980), Rajapandian and Rajan (1980) and Mahadevan (1987) have stated that these periods have been ideal for large scale collection of oyster spat at Tuticorin Bay.

Salinity in Punnakayal Estuary has a sudden fall during December-February, resulting in low values of condition factor and poor representation of mature stages among oyster population. While in other habitats, the condition factor and percentages of mature stages were moderate. The condition and maturity stages of oysters were high, especially during March-April and September months, when the salinity remained high. The salinity of these habitats during this period of the year remained static, because of the prevailing shoreward winds. Further, the oxygen content in the water remained low in March, May and October. During this period, the primary production was very high in these calm and semi-enclosed areas. Hence, this feature may be attributed to the low oxygen content during early morning hours.

Subsequent to this period, an increased trend of nitrate content of water in all the habitats have been noticed. This reflects the low values of productivity rates which correspondingly reduces the condition factor of the oysters. Similarly, an inverse relation has been arrived with the availability of phosphate content in the waters.

During the post-monsoon months (December-February), the silicate in the waters of mangrove and estuarine habitats showed a marked increase resulting in the improvement of the condition of the oyster meat. The relatively high abundance of chlorophyll *a* during March-June and August-September months, have shown a close relationship with the development of the condition of meat and gonads in oysters.

The exceptionally high values of primary production (887-2250 mgC/m³/day) durine March-August evidently showed the positivg correlation in the maturation of gonads and condition of meat of oysters in the mangrove ecosystem.

Based on the present investigations, the diffyrent oyster beds of this region are influenced by fairly ideal to very ideal environmental conditions. The temperature and salinity regimes of these areas remain steady almost throughout the year. The southwest and northeast monsoon greatly influence the productivity which in turn has a significant impact on the oyster population. The impact of the monsoon on coastal and estuarine ecosystems are more direct than on the mangrove ecosystem which is considerably protected on the western and eastern boundaries by land-masses. This topographic feature provides relatively stable environmental conditions, in the mangrove areas, resulting in the optimum growth of the oyster population.

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