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SOME ASPECTS OF EXPERIMENTAL CULTURE OF THE OYSTER *CRASSOSTREA MADRASENSIS* (PRESTON)

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ABSTRACT

Settlement and rate of growth of the oyster *Crassostrea madrasensis* (Preston) were studied at the Mulki Estuary, Dakshina Kannada. The breeding season extends from October to May. Peak Settlement of spat takes place during November-December and March-April. Of the several cultch materials tried, oyster shell, used automobile tyres, rigid PVC, lime-coated tiles and asbestos were found to be suitable. Cultch smeared with crude extracts of oyster tissue supported more spat per unit area than the untreated panels. The spat grew initially at the rate of 2-3 cm per month. Spat transferred to suspended wire bag grew faster than the feral ones. The oysters attained ≥7.0 cm shell-height in about 7 months. The size at first maturity was 12-14 mm for males and 24-26 mm for females. Study of the condition and edibility indices showed that the best season for harvest is May-September.

INTRODUCTION

BECAUSE of their sessile habit and comparatively low position in the food web, the edible oysters form one of the best suited marine animals for large-scale culture. The history of oyster culture dates back to the times of the ancient Romans. However, the high degree of technological proficiency attained in the fields of hybridization, seed production, field culture and disease control is the result of meticulous work carried out during the past few decades. At present several species of oysters belonging to the genera *Ostrea* and *Crassostrea* are profitably mass cultured along the coasts of maritime countries of the world (Korringa, 1976 a, b). Although many species of edible oysters occur in the Indian waters and at least two of these *viz.*, *Crassostrea madrasensis* and *C. gryphoides* have great potential as culturable species, no extensive farming is practised in India due to the very limited demand. In the Kelwa Backwaters near Bombay and Ennur near Madras, small sized oysters are collected and maintained in the field till they attain marketable size (Jones, 1970). Even now, work on the farming of Indian edible oysters is limited to experimental scale and is restricted to a few research institutions and universities. The biology of the species involved is fairly well known and there is considerable scope for undertaking culture of oysters in the backwaters and estuaries of both coasts of India.

The present paper incorporates the findings of a study on the experimental culture of *C. madrasensis* carried out in the Mulki Estuary during 1976-79.

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CHARACTERISTICS OF HABITAT

The Mulki Estuary (Lat. 13°5'N and Long. 74°46'E) is formed by the confluence of the Shambhavi river and the Pavanje rivers near Mulki town, in the district of Dakshina Kannada, Karnataka. The estuary has a waterspread area of *Ca.* 5 km² and an average

depth of 3 m. The tidal range is about 2 m. The bottom consists mainly of a mixture of silt and sand. The southwest monsoon contributes significantly to the total rainfall in this region. During this season the Dakshina Kannada Coast receives about 3000 mm of total rainfall. The ambient water temperature fluctuates from 25.5° (September) to 32.7°C (March) during the course of one year. During the southeast monsoon months (June-September) the salinity of the water decreases from about 36.0‰ to very low levels (< 1.0‰) while turbidity increases up to 95.5 ppm. The estuarine water does not show wide fluctuations in dissolved oxygen content and pH.

Breeding Season

Our knowledge of the biology of *C. madrasensis* from the west coast of India is meagre. Balasubramanyan and Nair (1970) observed that in the Port of Cochin, the breeding of this species is seasonal, restricted to the periods of high salinity. Menon *et al.* (1977) recognised two peaks for the settlement of oyster larvae in the Netravathi-Gurupur Estuary, *viz.*, March and May. Rao and Menon (1978) reported heavy settlement of *C. madrasensis* spat in the above estuary during March-June. Joseph (1979) observed that in the Mulki Estuary the spawning season is rather prolonged, extending from October to May, with two peaks: December-January and April-May.

Spatfall

The spatfall in the Mulki Estuary was monitored from the settlement data gathered from cultch materials suspended in the estuary. Shells of the green mussel (*Perna viridis*), oyster (*C. madrasensis*), uncoated roof tiles, lime-coated roof tiles, asbestos plates, asbestos plates coated with crude extract of oyster meat, coconut shells, used automobile tyre pieces and rigid PVC pieces were the cultch materials tried in the present study (Pl. I). Of these, shells of *Perna viridis*, uncoated tiles and coconut shells were found to be not suitable, as settlement of spat was negligible. Lime-coated roof tiles were good spat collectors, but the loss of spat due to pealing up of the coating was considerably high, especially during the initial stages after settlement. Both untreated and treated asbestos panels attracted appreciable number of larvae resulting in heavy settlement. Asbestos panels smeared with an extract of oyster meat (prepared by blending the meat of ten mature oysters in 500 ml of sea water) and dried in the sun for two days appeared to support higher spat density than untreated panels. Settlement of spat was poor on freshly laid panels prepared from used automobile tyre. However, moderate to high settlement resulted when these panels were kept after being subjected to about ten days of leaching in sea water. Rigid PVC panels were also found suitable as the fouling intensity on them by barnacles and polychaetes was considerably low. However, the spat of oysters fall off the substratum at the slightest pressure. Compared to all the above materials tried, the oyster shells (upper valves of *C. madrasensis*) appeared to be the best spat collector because of their easy availability, convenient size, good spat density, neglegible market value and reusability (Pl. II). An interesting feature observed during the present study was the effect of spacing of the cultch materials on the settlement density. When cultch was strung close together with very litte (< 2 cm) space in between, the settlement was high. However, when the same cultch materials were suspended at intervals greater than 4-5 cm, the intensity of space settlement was considerably reduced. Polyethylene tubings cut into the required sizes were used as spacers. Probably, as Korringa (1970) opined, prolonged periods of low current velocities are required for good settlement.

Two periods of peak spat settlement were noticed in the Mulki Estuary, the first from November to January and the second from

PLATE I. Different types of culch materials used for collecting spat of *C. madrasensis* : A. Used automobile tyre pieces, B. Oyster shell and C. Lime-coated tiles.

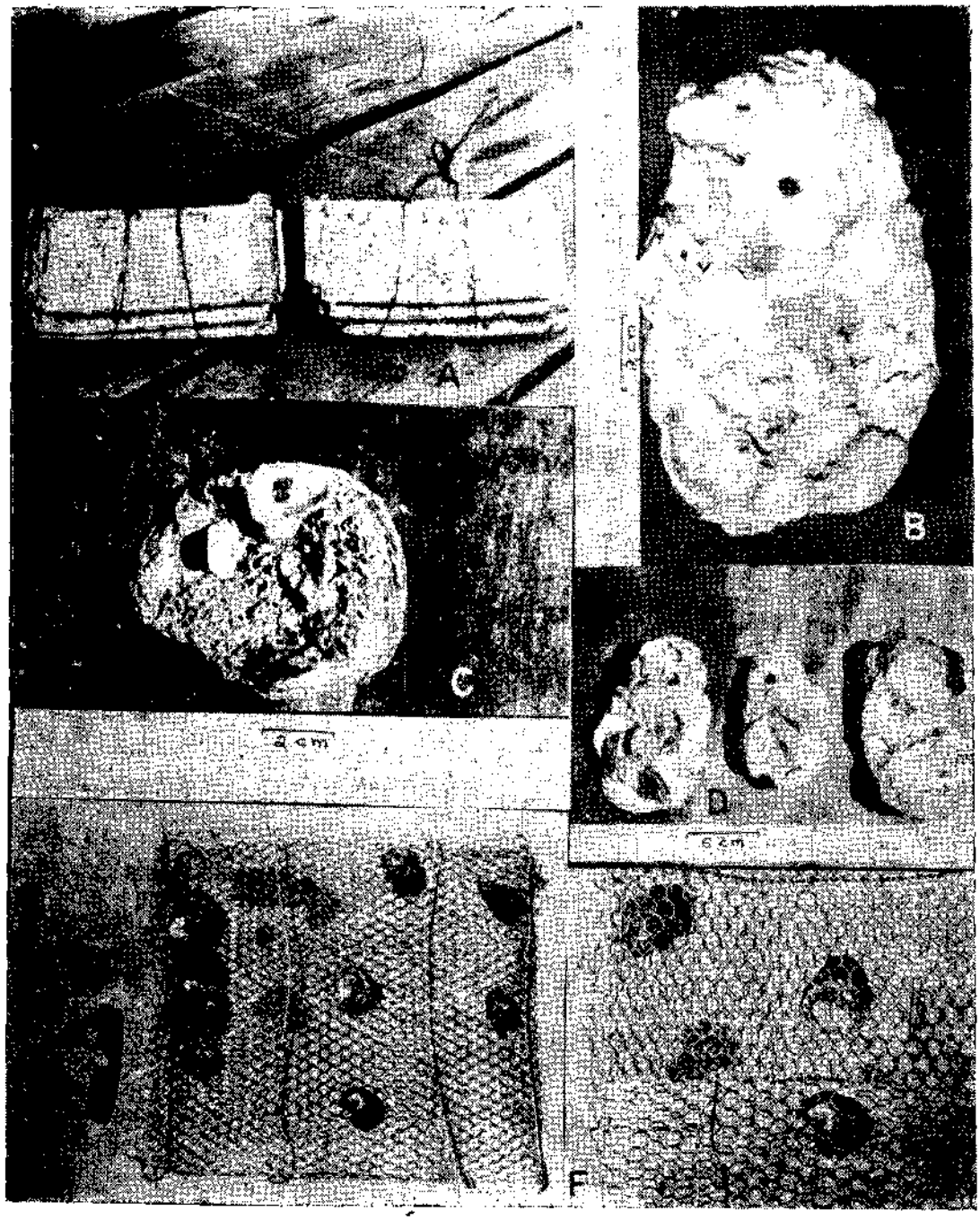

PLATE II. Spat collectors and cultured oysters : A. Lime-coated tiles with oyster spat, B. Oyster shell with heavily settled spat, C. A spat collector heavily fouled by tube-dwelling polychaetes, D. Oyster shell with growing spat and oysterling. Arrows indicate oysters of five months' growth, E. A cage used for suspending culchless spat in the estuary and F. Culchless oysters grown in cages. Age about 3 months.

March to May. There was no settlement of spat during the period extending from August to September. However, the spat of the rock oyster *C. cucullata* settles heavily almost throughout the year in the Mulki Estuary except during July and August and probably forms the toughest competitor to *C. madrasensis* for settlement space, especially at those regions of the estuary where depth is comparatively less.

Growth of spat

When the spat was about 2-3 cm in size (shell-height), the oyster shells used as cultch were removed and polyethylene spacers were introduced in between, so that the interval between the shell pieces was about 6-7 cm. A few of the spat were removed from automobile tyre and rigid PVC cultch materials, placed inside wire cages (size 40 × 40 cm) made out of galvanised iron chicken-wiremesh (Pl. II E) and suspended in the estuary. Rate of growth in length (shell-height) was followed by making periodical measurements with the aid of a vernier calipers. The mean shell-heights from the time of settlement were as follows: 2.10 cm at 1 month; 3.5 cm at 2 months; 4.5 cm at 3 months; 5.5. cm at 5 months; 6.2 cm at 6 months and 7.2 cm at 7 months. From the foregoing it appears that the rate of growth of *C. madrasensis* in the Mulki Estuary is considerably faster than that reported for the same species from the Madras Coast by Hornell (1910), Paul (1942) and Rao and Nayar (1956) and for *C. gryphoides* from the Kelwa Backwaters by Durve and Bal (1962). Joseph (1979) has reported that the feral population of *C. madrasensis* inhabiting the Mulki Estuary grow to a marketable size of *Ca.* 7 cm in 9 months time (mean sizes: 4.70 cm at 3 months; 6.33 cm at 6 months; 7.66 cm at 9 months). In the Netravathi-Gurupur Estuary the maximum recorded size of *C. madrasensis* on glass panels immersed for 20 weeks duration is 7.6 cm shell-height (R. J. Katti, unpublished data). All these evidences suggest that *C. madrasensis* can be grown to marketable size in the Mulki Estuary or similar estuaries of this region within a maximum period of 7 months from the time of settlement. This unusually high rate of growth might be the result of the abundant food supply in the estuary, coupled with other favourable environmental factors experienced during the post and pre-monsson periods. Thus, if cultch is laid in October and quality spat collected, the oysters will be ready for harvest by next April or latest by May before the commencement of the southwest monsoon (Fig. 3).

Condition

Studies conducted on the variations in the condition and edibility indices have shown that in the Mulki Estuary the oysters are in their best condition from late May to September. Condition indices as high as 63.3 have been recorded during this period (Joseph, 1979). Further, during this period, the oysters are in a sexually indeterminate stage and have large quantities of carbohydrates (for example, 68.93% dry weight in the indeterminate gonad) (Joseph, 1979).

Harvesting

Analyses of the data on the annual gonadial cycle, variations in the length-weight relationships, condition and edibility indices and biochemical composition of feral oysters (Joseph, 1979) suggest that the ideal time for harvest is the period extending from late May to September. Along the Dakshina Kannada Coast, the southwest monsoon rains commence by the second fortnight of May. However, intense rainfall is experienced from June onwards only, resulting in heavy flooding of the estuaries. Hence, the harvesting operations can be completed by the end of May. This will result not only in the production of oysters with higher meat content and nutritive value, but also in preventing loss of culture rafts and poles.

Associates, parasites and mortality

A large number of fouling organisms settle on spat collectors and cultured oysters. The most numerous of these are the barnacles (*Balanus amphitrite* var. *variegatus*, *B. amphitrite* var. *communis*, *B. amphitrite* var. *denticulata* and *B. amphitrite* var. *cocgiensis*), tube-dwelling polychaetes (*Hydroides norwegica*, *Pomatoceros triquetor*, *Spirorbis* sp. and *Polydora ciliata*) and the spat of the rock oyster (*C. cucullata* = *S. tuberculata*). Heavy fouling by barnacles and polychaetes results in poor settlement of oyster larvae. Further, fouling impairs the growth of already settled spat. This problem is important as the breeding season of most of the fouling organisms of this region coincides with that of *C. madrasensis*, resulting in intense competition for settlement space (Menon *et al.*, 1977). Further studies are required to overcome the problem created by such heavy fouling on spat collectors. *Polydora cilata* causes extensive mud blisters on the shells of *C. madrasensis* in the Mulki Estuary (Stephen, 1978). The larval trematode *Bucephalus* sp. also infests oysters, leading to parasitic castration of the host (Joseph, 1978). However, both these species do not seem to pose any serious threat to the cultured oysters which live in the estuary only for about 7 months. During the southwest monsoon, large scale natural mortality of oysters has been noticed in the feral population. This probably is the result of the unfavourable environmental conditions especially very low salinity and high turbidity existing in the estuary.

Conclusion

One of the essential prerequisites for successful culture of oysters is a thorough knowledge of aspects of biology such as breeding season, time and area of spatfall, substrate preferences of spat, rate of growth and eco-physiological requirements of oysters for survival, growth and fattening. The present study has conclusively proved that the Mulki Estuary is an ideal locality for spat collection and growth of *C. madrasensis*. The spat is plentiful in the estuary all through the breeding season of the oyster. The rate of growth of spat and juveniles reported in the present study is perhaps the highest reported from the Indian coasts.

Considering the very poor demand for oysters in the Indian market, it is necessary to popularise the use of oyster meat as an item of protein and carbohydrate-rich sea food. Further, exploring the possibilities of preparation of frozen or canned oyster meat on a large scale may prove to be highly rewarding. The market value of whole oysters along the Dakshina Kannada Coast ranges from Rs. 7 to Rs. 8 per hundred. Small quantities of shucked oysters are bought by some local freezing factories at Rs. 10 per hundred. Large scale farming might prove to be a lucrative business as the demand for raw or processed oyster meat increases.

A scheme of farming operations suitable for the Dakshina Kannada region is given below. The farming operations are divided into three phases of 15 days duration each. The first phase is spat collection. Oyster shells (upper valves of *C. madrasensis*) are suspended at intervals of < 2 cm on wire rope in areas where the current velocity is moderate. This operation must be completed in October. The second phase involves relaying of the settled spat. Here the oyster shells are removed from the strings and the oyster spat adhering to the shell cultch are scraped and reared in trays provided with nylon netting kept on racks set up in the shallow parts of the estuary. Low current velocities are conducive to fast growth of oysters and hence care should be taken to avoid areas of rapid currents while erecting the stakes. During December-January, fouling organisms have to be removed and if the oysters are over-crowded, they

should be separated. The third phase is harvesting. This should be commenced by the end of May and completed before the onset of heavy rains. The farming technique outlined here is quite simple so that even an unskilled fisherman will be able to follow. This simple and less expensive method might be the most suitable one for Indian conditions.

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