SPAT SETTLEMENT AND GROWTH OF THE EDIBLE OYSTER, *CRASSOSTREA MADRASENSIS* (PRESTON) IN THE VELLAR ESTUARY, PARANGIPETTAI, INDIA

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ABSTRACT

The settlement of spat on different types of spat collectors (oyster shells, asbestos, lime coated tiles, and used cycle tyres) was studied from August 1995 to July 1996. Lime coated tile suspended at 80 and 100 cm depth was the most efficient substratum for spat settling. The mean spat per tile was 21.4 and 54.2 individuals respectively. Two peaks of spat settlement were noticed (August-September and April-May). Oysters grew fast in culture trays and the mean shell length was 8.2 cm at the end of one year. The present study shows that the Vellar estuary is an ideal locality for spat collection and culture of this oyster species.

INTRODUCTION

The edible oyster, *Crassostrea madrasensis* Preston, 1916, is distributed in estuaries and backwaters along the east and south west coast of India (Alagarswami & Narasimham 1973). Because oysters are sessile and have a comparatively low position in the food web, the edible oyster is one of the marine animals best suited for large scale culture. At present several species of oysters of the genera *Ostrea* and *Crassostrea* are profitably mass cultured along the coasts of maritime countries of the world (Korringa 1976). In India the edible oysters, *Crassostrea madrasensis* and *Crassostrea gryphoides* have great potential as cultivable species and the Central Marine Fisheries Research Institute (CMFRI) has developed a viable technology for oyster farming including hatchery production of seeds.

In the Vellar estuary, heavy encrustations of *C. madrasensis* are found throughout the year but they dominate during pre-monsoon and post-monsoon seasons. They are much exploited by people of the area for food and to feed cultured prawns. In order to avoid over exploitation of this species, and to meet the growing demand for food, oyster assumes significance in aquaculture. Moreover, the presence of sizeable populations of oysters in nature is prompting for the establishment of experimental oyster farms. A precise knowledge on the intensity of the spat settling season and growth in relation to ecological conditions is necessary to plan and conduct large scale culture activities in this region. This prompted us to make detailed observations of spat fall and growth of *C. madrasensis*, for a period of one year.

MATERIALS AND METHODS

The spat fall in the Vellar estuary was monitored from the settlement data gathered from cultch materials suspended in the estuary. Four different types of material were used to ascertain their relative efficiency for collection of oyster spat. The collectors of cultch materials were tied to casuarina poles for the collection of spat.

a. Dead oyster shells, 18 x 10 cm, were thoroughly cleaned and dried. A hole was drilled in the middle of each shell. Shells were hung in batches of 10 with 10 cm spacing. Heavy pieces of discarded metal were used as anchors to position each collector and to prevent it from floating or drifting.

b. Rectangular asbestos plates, 25 x 10 cm, had holes bored at the centre. A total of 10 asbestos plates were rigged by knots on a nylon rope passing through the central holes. Weights were mounted as in (a).

c. Earthenware country roofing tiles, 11 x 3.8 cm, were initially washed thoroughly to facilitate efficient attachment of lime. The washed tiles were dipped in lime and dried in sunlight. Holes were drilled at the centre and 10 tiles were strung together using nylon ropes with an interspace of 10 cm. No additional weights were attached.
d. Used cycle tyres were cut into small pieces, of 18 x 8 cm size, and a hole was made at the centre. Ten pieces of tyre were hung with nylon ropes in batches with 10 cm spacing. Heavy weights were mounted as in (a)
All the collectors were suspended vertically between 10 and 100 cm depth at the vicinity of oyster beds. After 30 days, all collectors were examined and number of settled spat recorded.
Based on encouraging results obtained from a pilot experiment, seasonal variations in spat fall was monitored using lime coated tiles from August 1995 - July 1996. Every month 10 tiles were suspended in 100 cm depth in the vicinity of an oyster bed. After 30 days these collectors were removed and number of spat attached per tile was recorded. The used tiles were thoroughly cleaned and used again for spat collection in subsequent months.
The spat which had settled on lime coated tiles were removed carefully, using a scalpel blade. The spat, 1-2 cm length, were used for rearing in two plastic trays (42 x 42 x 32 cm) during the study period. In each tray 100 oyster spat were placed and covered with nylon net to avoid entry of predators. Measurements of growth and survival were carried out monthly. The growth in terms of shell length and shell width were measured from 10 randomly chosen animals from each tray using a Vernier calliper. Possible predators were also recorded. Throughout the experimental period, rainfall, water temperature, salinity, dissolved oxygen, and nutrient data were recorded. All data obtained during this study were analysed using one way and two way analysis of variance.

Table 1. Hydrological characteristics of the bottom water of the Vellar estuary during the study period.

	Rainfall (mm)	Temp. (°C)	Salinity (‰)	Dissolved Oxygen (ml l^{-1})
1995				
August	115	28.7	33.17	4.24
September	240	29.5	28.25	5.29
October	165	29.4	31.74	5.31
November	250	27.6	19.13	6.01
December	-	28.1	26.17	6.41
1996				
January	-	28.4	26.74	4.59
February	-	28.5	31.08	4.82
March	-	28.2	33.43	3.82
April	-	28.2	32.28	3.77
May	-	28.9	34.56	3.09
June	240	28.6	31.07	3.76
July	-	28.9	34.06	3.09

Table 2. One way analysis of variance of nutrients between seasons.

Nutrients	F	P
Ammonia	16.117	< 0.005
Nitrate	9.972	< 0.005
Nitrate	5.387	< 0.005
Inorganic phosphate	4.214	< 0.005
Total phosphate	0.468	N.S
Silicate	3.031	N.S

RESULTS

Environmental variables

Tab. 1 shows environmental variables of bottom water of the Vellar estuary during the study period. The values of nutrients fluctuated between months. A one way analysis of variance between nutrients and seasons (Tab. 2) showed significance for ammonia, nitrite nitrate ($P < 0.005$) and inorganic phosphate ($P < 0.05$) whereas no significance was observed for total phosphates and silicate (August - September and April - May).

Settlement on spat collectors

Fig. 1 shows that intensity of spat settlement on different types of collectors varied considerably. The intensity of spat fall was very low on oyster shells. No spat was observed

Table 3. Two way analysis of variance of shell length and shell width between months.

Tray no.	Variables	Shell length		Shell width	
		F	P	F	P
1	Months	110.719	< 0.005	78.885	< 0.005
2	Months	174.185	< 0.005	35.336	< 0.005

on shells suspended at 20 cm depth. The number of spat had increased on shells in 100 cm depth and mean spat fall was 3.9 spat per shell. Very few spat attached in 40, 60, and 80 cm depths. No spat was observed on asbestos in 20 and 40 cm depths. Large numbers of spat were found in 80 and 100 cm depths and mean spat fall was 2.5 and 6.4 spat per plate respectively. No spat attached to tiles in 20 cm depth. A maximum number of spat was recorded on tiles in 80 and 100 cm depths, and mean spat fall per tile was 21.4 and 54.2 respectively. The intensity of spat settlement on cycle tyre was very low. At all depths stray numbers of larvae had settled and mean spat fall was 0.5, 1.3, 1.9, and 2.2 per piece of tyre in 40, 60, 80, and, 100 cm depths respectively. Of the four spat collectors, lime-coated tiles were most attractive followed by asbestos. The oyster shells and used cycle tyres were found unsuitable as very few spat settled.

The pattern of spat fall on lime coated tiles was observed from August 1995 to July 1996 and mean spat fall per tile. Two periods of peak spat settlement were noticed during August-September (maximum spat fall) and April-May (secondary peak). The average spat fall per tile was 83.1 and 94.2 during August-September, and 74.6 and 50.1 during April-May respectively. The mean spat fall was very low in other months.

Growth and survival

The mean growth rate of oysters reared in two trays for a period of 12 months is presented in Fig. 2. The mean shell length showed a gradual increase from the first month towards the 12th month. At the end of the 12th month oysters obtained a mean shell length of 8.2 cm and it appeared that growth rate of *C. madrasensis* was high. The growth in terms of shell length and shell width varied significantly (P < 0.005) between months in both trays (Tab. 3). The survival of oysters decreased gradually over time in both types of tray. From the second month to the end of one year, 34 and 38 % survival was observed in trays 1 and 2.

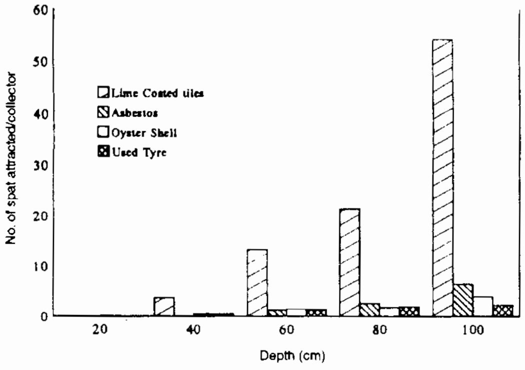

Figure 1. Settlement of spat of *C. madrasensis* on collectors suspended for 30 days.

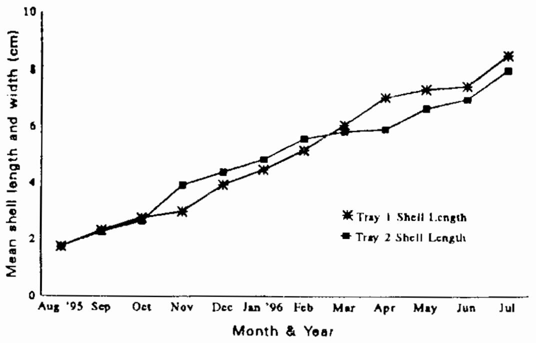

Figure 2. The mean shell length and width of oysters reared for a period of one year.

Fouling

A large number of fouling organisms settled on spat collectors, cultured oysters, trays, and supporting wooden poles. The barnacle *Balanus amphitrite* Darwin, 1854 was most numerous among fouling organisms. Borers such as *Teredo* sp. and *Martesia striata* (Linnaeus, 1758) caused serious damage to the wooden poles. Predators were the gastropod, *Cymatium cingulatum* (Lamarck, 1822) and the crabs *Scylla serrata* Forskål, 1755, and *Portunus pelagicus* Linnaeus, 1766.

DISCUSSION

The present study shows that lime-coated tiles are suitable for collecting spat of *C. madrasensis* in the Vellar estuary, Parangipettai. The kind of spat collector which is most efficient for settling of large numbers of spat differ in various areas. Lime coated curved roofing tiles have been effectively used in Arcachon, Southern France (Yonge 1960). Nair (1975) reported the suitability of cement-coated oyster shells at Athankarai estuary. Mahadevan & Nayar (1980) obtained maximum spat on lime-coated tiles in Tuticorin Bay. Rao *et al.* (1983) have reported that lime-coated concrete pieces with irregular surfaces, oyster shell with a coating of cement or lime, and lime-coated curved tiles were the best spat collectors in Vaigai estuary, South India. Asbestos and wood were best collectors of *Crassostrea rivularis* (Gould, 1861) and *Ostrea folium* Linnaeus, 1758 (syn. of *Dendrostrea frons* (Oliver 1992)) spat in west coast of Karachi (Moazzam & Rizvi 1983). Joseph & Joseph (1983) found that oyster shell, used automobile tyre, rigid PVC, lime-coated tiles, and asbestos were good spat collectors in Mulki estuary. They also reported that collectors smeared with crude extracts of oyster tissue supported more spat per unit area than untreated panels. Ajana (1979) found hardwood as the best collector of mangrove oyster *Crassostrea gasar* Adanson, 1757. The author further found optimum settlement on collectors placed between 70 and 120 cm below the water surface. In the present study, large numbers of spat settled on tiles suspended in 80 and 100 cm depths. Nelson (1921) found that the "eyed" larvae of *Crassostrea virginica* (Gmelin, 1791) are stimulated by light and continue to move until they reach a shaded place where they become quiescent. Walne & Helm (1974) reported that light is an important factor affecting settlement of larvae of *Crassostrea gigas* (Thunberg, 1793) and *Ostrea edulis* L., 1758. The present investigation also reveals that tiles suspended in 20 cm depth did not collect any spat and this can be attributed to the influence of direct sunlight.

The peak settlement varies with spawning season of oysters in various coastal waters. In the present study area, settlement occurred in two seasons, August-September and April-May. In Tuticorin Bay, two periods of peak settlement were March-April and September-October (Thangavelu & Muthiah 1983). Reuben *et al.* (1983) reported peak settling of oyster spat during March and October in Bheemunipatnam backwater, while it was from November-January and March-May in the Mulki estuary (Joseph & Joseph 1983).

Mean shell length of *C. madrasensis* was 8.2 cm after one year. This growth rate was similar to records of the same species reared in Tuticorin Bay (Nayar & Mahadevan 1983), Vaigai estuary (Rao *et al.* 1983), and Mulki estuary (Joseph & Joseph 1983, 1985). The growth rate of *C. madrasensis* is very rapid compared to that of *Crassostrea rhizophorae* (Guilding, 1828) from Brazil (Ramos *et al.* 1986) and *C. belcheri* (Sowerby, 1871) from Malaysia (Tan & Wong 1994). However, comparing the results from different areas are difficult because the rate of growth of oysters are known to be affected by a variety of ecological and environmental factors, such as nutrition, temperature, salinity, and water quality (Kinne 1971). Rao & Nayar (1956) noticed that prolonged immersion of spat or yearlings in high or low salinity has an adverse effect on the growth of oysters. Chanley

(1958) reported that juveniles of *C. virginica* survived salinities as low as 5 ‰ but failed to grow below 5 ‰. In the present study, fall or raise in the bottom water salinity was between 19.13 and 34.56 ‰. This salinity variation did not have noticeable effect on the growth of oysters.

Adverse effect of fouling organisms, *Balanus amphitrite* was noticed during spat collection and culture of the oysters. In Vellar estuary breeding of *B. amphitrite* is continuous except during monsoon when the salinity is as low as 3.4 ‰ (Fernando 1978).

Predators, the gastropod *C. cingulatum* and crabs *S. serrata* and *P. pelagicus* were also found in the culture trays. Muthiah *et al.* (1987) found spat on tiles destroyed by *S. serrata* but the loss was negligible. Thangavelu & Muthiah (1983) reported 13 % of mortality in farm oysters due to *C. cingulatum*. In the present study 34-38 % survival was observed but the cause is not known, though fouling organisms seem to be the major problem. They can be controlled by frequent check and cleaning. In general, the Vellar estuary is an ideal environment for spat collection and culture of *C. madrasensis*.

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