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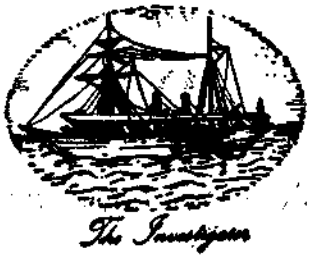

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OBSERVATIONS ON THE SETTING OF SPAT AND GROWTH OF *CRASSOSTREA MADRASENSIS* IN VAIGAI ESTUARY AT ATHANKARAI

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ABSTRACT

The setting of spat of the edible oyster *Crassostrea madrasensis* on different kinds of spat collectors like oyster shells, wooden pieces, concrete pieces, concrete slabs, tiles, bamboo frames and coconut shells kept in Vaigai Estuary at Athankarai was studied. It was observed that there was spatfall on concrete pieces with irregular surfaces given lime coating, on oyster shells given a coating of cement or lime and lime-coated curved tiles. Oyster spat set in stray numbers on bamboo frames, Mangalore tiles and coconut shells, spatfall took place between January and April and generally only small numbers of spat were seen to set on spat collectors in the other periods of the year. Oysters attained an average size of 86.7 mm and a maximum of 110 mm at the end of one year. Average and maximum sizes of 89.6 mm and 130 mm were attained at the end of 14 months and growth of oysters was very much retarded later.

INTRODUCTION

THE BACKWATER OYSTER *Crassostrea madrasensis* is widely distributed in India and occurs in the estuaries and backwaters along the east coast in Orissa, Andhra Pradesh and Tamil Nadu and on the south-west coast in Karnataka and Kerala. For successful culture of oysters, oyster spat have to be collected in large numbers by using appropriate spat collectors and the spat and growing oysters have to be reared to marketable size by spreading them on the bottom or keeping them in trays on racks in unpolluted brackish or sheltered coastal waters.

In Vaigai Estuary at Athankarai about 30 km from Mandapam camp on the south-east coast of India, there are beds of *Crassostrea madrasensis* extending over an area of 1.5 ha (Rao *et al.*, MS). Efforts have been made to collect spat of oysters in the estuary and a preliminary report was given by Rao (1976). Detailed observations on the spatfall on collectors and growth of the oyster are presented in this paper.

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MATERIAL AND METHODS

Spat collectors of nine different types were used to determine their relative efficiency for collection of oyster spat : oyster shells given a coating of cement and fine sand in the ratio 2 : 1 mixed with water, oyster shells given a coating of lime, sand and mud in the ratio 2 : 1 : 1, wood plates 10 × 10 × 2.5 cm in size given lime-coating, lime-coated concrete pieces with irregular surfaces 12.5 × 12.5 × 12.5 cm in size, concrete slabs 30 × 15 × 2.5 cm in size, lime-coated curved tiles 23 × 15 × 2 cm in size, lime-coated Mangalore tiles 33 × 25 × 2.5 cm in size, lime-coated coconut shell halves,

frames of the sizes 1 × 1 m and 1.8 × 1 m made of bamboo strips.

Oyster shells, five each, were tied to bamboo strips and fixed in the estuary. Shell strings were hung from horizontal poles. Shells were also kept in bags of synthetic twine netting or in trays which were placed on racks erected in the estuary. Tiles, curved ones and Mangalore type were kept in trays on racks. Curved tiles were also kept spread on racks. The concrete pieces, concrete slabs and coconut shell halves were hung from horizontal poles. The bamboo frame spat collectors were filed vertically.

The spat collectors were placed in Vaigai Estuary at Athankarai in the vicinity of oyster beds. They were laid in the months December-January every year and replaced by fresh ones if there was fouling. The spat collectors were set about 0.5 m above the bottom. At weekly intervals the spat collectors were cleaned with wirebrush and fouling organisms like algae, barnacles and polychaetes removed. When the juvenile oysters grew to a size of 25-30 mm, they were removed from the spat collectors. The same collectors were used again to study the seasonal variations in spatfall. The dislodged oysterlings were reared in trays kept over the racks. The spat collectors were examined once every week and the number of fresh spat which had set was noted. Growth of spat was studied by their size frequency. Water temperature and salinity data were collected during 1973-78.

Results

It was observed that oyster spat set a minimum of two weeks after laying the spat collectors. A slimy layer on the collector appeared to be favoured by the oyster larva for setting.

Spatfall on various kinds of spat collectors

A. *On oyster shells given cement coating*

Of the 400 shells tied to bamboo strips and placed in December 1972, many of them did not collect any spat. A total of 156 spat and 89 spat were collected in January and February 1973 respectively. Very few spat settled in March, May and June. The mean spatfall was 0.7 spat/shell. Among the 180 shells on strings, 19 spat were observed in January and stray ones during February-May. The mean spatfall was 0.2 spat/shell (Pl. I A).

B. *On oyster shells given lime coating*

On this kind of spat collector tied to 30 synthetic ropes, each with six shells, 166 spat had set in the period January-March, 1974 and 12 in June and July, 1974 with a maximum of 3 spat and an average of 1 spat per shell in the season. On shells tied to 40 ropes the spatfall was low in the first quarter of 1975 being 32 and another 45 spat had set on a total of 50 ropes in July 1975 indicating setting on an average 0.3 spat per shell in the season. In January 1976 a total of forty spat had set and January 1978 only two spat were seen on this type of spat collectors tied to 50 ropes. The poor spatfall in January 1976 is attributed to failure of spawning of oysters. On 480 oyster shells given lime coating and kept in 16 bags of synthetic twine netting only 29 spat had set in January, 1978 and 16 in February, 1978 with an average of 0.1 spat per shell.

On keeping 2,000 oyster shells given lime coating in ten trays placed on a rack in December 1977, 279 spat set in February, 191 in March and 16 in July 1978 with a maximum of 3 spat and average of 0.2 spat per shell.

C. *On wooden pieces given lime coating*

72 ropes with 4 wooden pieces tied to each were kept in the estuary in 1974 and 1975 but only stray oyster spat had set on this spat collector in February and April 1974 and January and February 1975.

D. *On concrete pieces with irregular surfaces given lime coating*

When 30 ropes with a total of 150 concrete pieces were kept, 405 spat had set in the first

quarter of 1974. A maximum of 24 spat with an average of 2.7 spat had set on each concrete piece, setting not taking place on some of the pieces. In 1975, 1976 and 1978 spatfall was very poor in the first quarter but it was better in September and November 1976 when 238 and 125 had set on keeping a total of 30 ropes with 150 concrete pieces with an average of 1.6 spat and 0.8 spat per concrete piece in the two months respectively.

E. *On concrete slabs given lime coating*

34 ropes each tied with three concrete slabs were kept in the estuary from the first quarter of 1975 but only stray spat had set in March 1976.

F. *On curved tiles given lime coating*

1,720 curved tiles were kept in 48 trays on three racks each tray containing 40 tiles in December 1977 (Pl. II B). 158 oyster spat had set in February 1978 and 787 spat in March 1978 with a maximum of 32 spat setting per tile on the concave surface of tiles (Pl. II A). On many tiles spat fall did not take place. In May and June 185 and 162 spat had set and the spatfall was much lower, 15 and 48 in July and August 1978. The average spat which had set per tile was 0.8 in the season.

1,200 curved tiles were kept in six bamboo frames in February 1978 and another 1,200 curved tiles were kept on six additional frames in July 1978. There was good spatfall on tiles kept on bamboo frames, 1,970 spat had set on the spat collectors in March 1978. In May, June, July and August 1978 the numbers of spat which had set were 439, 289, 31 and 76 respectively. A maximum of thirty spat had set on a tile and the average number of spat set on each tile was only 1.2 per tile there being no spatfall on a large number of tiles.

G. *Lime coated Mangalore tiles kept in trays*

100 Mangalore tiles were kept in 10 trays on a rack in January 1978, each tray containing ten tiles. Only stray numbers of spat had set on these tiles in March, July and August 1978. In March 3 spat had set and a total of 25 and 47 spat had set in July and August 1978. A maximum of 4 spat had set on this type of collector per tile with an average of 0.8 spat per tile.

H. *Lime coated coconut shell halves*

500 lime coated coconut shell halves were suspended from 100 synthetic ropes with 5 shells per rope which was weighted with a stone at the bottom. On this kind of spat collector also only small numbers of spat had set. One or two stray spat had set on the inner side of a few shell halves and on an average 0.1 spat had set per shell half(Pl.I B). In April, May and June 1978, 30, 4 and 2 spat had set. The spat adhered firmly to the coconut shells and it was difficult to remove them without injuring.

I. *Frames made of bamboo strips*

Ten frames 1 × 1 m in size were kept fixed vertically in the estuary in November 1973 and ten bigger frames 1.8 × 1.8 m in size in February 1978. In 1974 there was no spatfall and a few stray spat had set on the spat collectors in February 1978.

Growth of spat and oysters

The size range of oyster spat which had set on oyster shell spat collectors was 8.5 to 33.0 mm in March, 1973 with a mode at 15.5 mm (Fig. 1). This mode shifted to 35.5 mm in April, 1973 and 45.3 mm in May, 1973 showing a rapid growth of 20 mm in March. Between April and May the growth of modal size group is only 9.8 mm but the mode at 45.3 mm in May shifted to 65.0 mm in June with a growth of 19.7 mm and the maximum size was 83.0 mm. In July, 1973 the mode was at the same position and it increased to 75.2 mm in August and 75.4 mm in September. A few spat had set in May and June. The modal sizes were 84.8 mm and

PLATE I A. Spat of *Crassostrea madrasensis* set on oyster shell spat collector tied to synthetic rope and B. Oyster spat set on coconut shell halves.

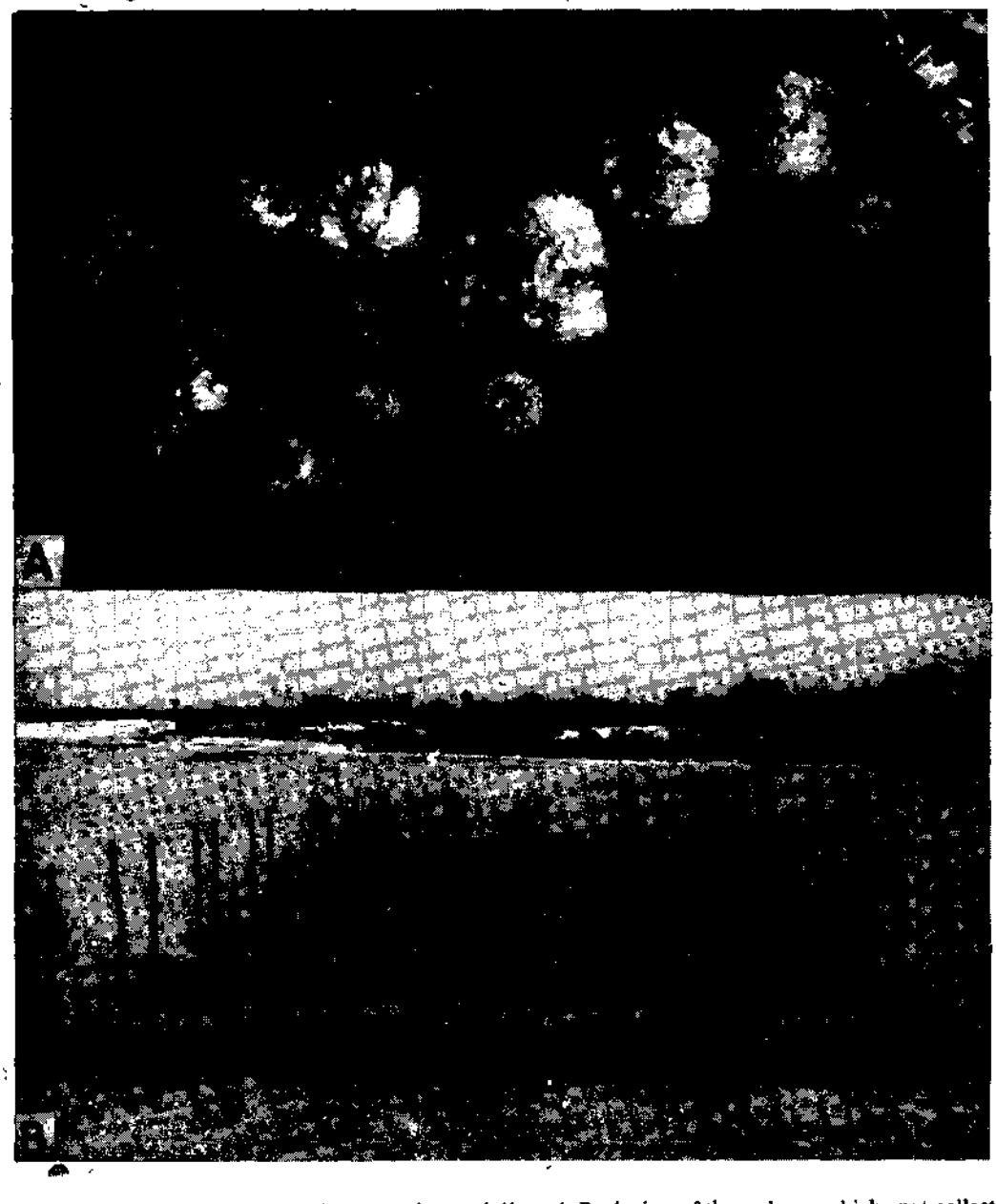

PLATE II A. Oyster spat set on a lime-coated curved tile and B. A view of the racks on which spat-collectors and growing oysters were kept in trays in Vaigai Estuary at Athankarai.

84.0 mm and maximum sizes 107 mm and 111 mm in October and November, 1973 respectively. In January, 1974 the modal size was at 96 mm and the maximum size 110 mm. This mode attained a size of 106.3 mm in October, 1974 126.2 mm in July, 1975 and 129.6 mm in March 1976. The maximum size was 111 mm in November 1973, 119 mm in February 1974, 130 mm in March 1974, 133 mm in July 1975, and 150 mm in March, 1976. It could be considered that the spat 8.5-33.0 mm in size seen in March, 1973 had set in the period January-March. An average size of 86.7 mm and maximum size of 110.0 mm are reached at the

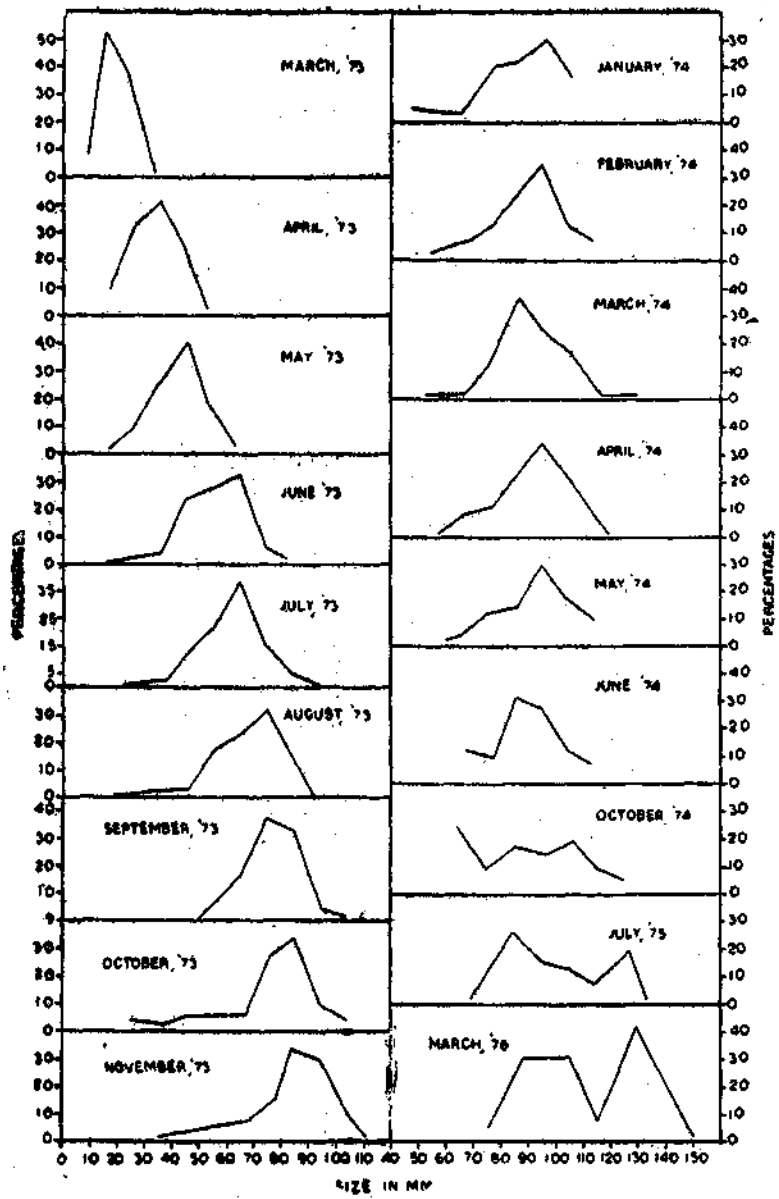

Fig. 1. Size frequency of *C. madrasensis* cultured in Vaigai Estuary at Athankarai.

end of one year in January, 1974. The cultured oysters showed further growth and attained an average size of 89.6 mm and maximum size of 130 mm in March, 1974. Even after another two years the average size attained is only 112.5 mm and maximum size is 150 mm in March, 1976.

Crassostrea madrasensis which set in December - January 1974 showed a mode at 25 mm in January 1974 which shifted to 35 mm in February 1974 and 55 mm in April 1974. A mode at 35 mm in May shifted to 55 mm in August. A single mode was seen at 65 mm in October which increased to 75 mm in December 1974. The maximum size reached at the end of December 1974 was 100 mm.

Oyster spat which had set in November 1975 showed a mode at 25 mm in January 1976 which increased to 35 mm in February, 45 mm in April and 55 mm in May. It was stationary at 55 mm in July and September but increased to 65 mm in October, 85 mm in November and 95 mm in December. The maximum size reached at the end of 1976 was 135 mm.

The 1978 year class showed a mode at 5 mm in February and March and at 10 mm in April and May. In June two modes were seen at 15 mm and 65 mm and these shifted to 25 mm and 75 mm in September.

The 1975 year class oysters grew to an average size and weight of 82 mm and 112 gm and had an average meat weight of 9.3 gm at the end of one year. The 1978 year class oysters which had set in February reached an average size and weight of 76 mm and 48.3 gm and had an average meat weight of 6.2 gm at the end of seven months in September 1978.

Survival

The survival rate of oysters from spat which had set on shell spat collectors with cement coating was 36-41 %, that from shells with lime coating 46-56%, that from concrete pieces with irregular surfaces 76-79%, that from curved tiles 67% and that from Mangalore tiles 70%. The survival rates of oysters set on concrete pieces may be seen to be highest followed by that on Mangalore tiles and curved tiles. Surviavl rates of spat on oytser shells was low.

Hydrological characteristics of Vaigai Estuary at Athankarai

Data on water temperature and salinity in Vaigai Estuary at Athankarai for a typical year, 1973 are given in Table 1. The temperature increased over a limited range from 27.4°C in January to 32.7°C in April after which there was a decrease in the succeeding months. In the other years 1974-78 the pattern was similar

TABLE 1. *Seasonal variations in water temperature and salinity of Vaigai Estuary at Athankarai during* 1973

Months		Temperature °C	Salinity ‰
January	..	27.4	29.98
February	..	28.0	27.98
March	..	30.7	29.82
April	..	32.7	33.66
May	..	32.4	34.81
June	..	31.0	32.46
July	..	30.0	35.53
August	..	29.5	34.98
September	..	29.0	34.07
October	..	28.0	6.94
November	..	27.5	7.20
December	..	data not available	

with lowest temperature of 26°C in January 1976 and a maximum of 33.3°C in April 1974. Unlike temperature, salinity of the estuary varied markedly during the course of a year. It was 29.98‰ in January, 1973 and rose to values ranging from 32.46 to 35.53‰ in the months of April-September. The salinity declined to 6.94-7.2‰ during October-November 1973. Due to rains of north-east monsoon and freshets from the upper reaches of River Vaigai. In the periods July-September and

October-November 1973 when the salinity was high and very low respectively, there was retardation of growth of oysters indicating that high as well as very low salinity conditions are not favourable for growth of the oysters. Rao and Nayar (1956) also observed that constantly high and low salinities slackened the growth of *C. madrasensis* of Adyar Estuary. In Vaigai Estuary at Athankarai very high salinities of 52.35‰, 62.39‰ and 47.41‰ were recorded in August and September 1976 and September 1977 due to evaporation of estuarine water when the estuary was cut off from the sea by the formation of a sand bar.

Pests and Predators

The green alga *Enteromorpha* sp. and the red alga *Polysiphonia* sp. grew over the outer surface of the valves of cultured oysters and formed a covering over them but they did not cause any significant damage. The barnacle *Balanus amphitrite communis* was a serious pest being competitor for space to oyster spat on spat collectors and they were scraped with chisel. The whelks *Thais* and the crabs *Scylla serrata* and *Pagurus* sp. were the predators which occurred in small numbers.

Discussion

It has been observed by Rao (1974) that sexually ripe *Crassostrea madrasensis* are found in Vaigai Estuary at Athankarai almost throughout the year in greater or lesser percentages. The results obtained in the present work indicate that successful oyster spatfall takes place in the estuary following breeding of oysters in the period January to April and on a small scale from June to December. The main spatting season in Vaigai Estuary is January-March. Spatfall takes place when the salinity ranges between 20.96‰ and 27.0‰ and the estuary is connected with the sea. Spatfall continues to take place on a small scale in the later months when the salinity is higher. Hopkins (1931) had considered that in *Crassostrea virginica* of Galveston Bay the salinity should be about 20‰ while Gaarder (1932, 1933) and Gaarder and Bjerkan (1934) have observed that a salinity of 24.0‰ and over with 31-35‰ was optimum for successful growth of larvae of *O. edulis*. Rao (1951) has observed that when Adyar Estuary was connected with the sea and the salinity of the estuary was 27‰ and above spatfall of *C. madrasensis* takes place.

The present work shows that concrete pieces with irregular surfaces given lime coating, oyster shells given lime or cement coating and curved tiles given lime coating are suitable for collecting spat of *Crassostrea madrasensis* in Vaigai Estuary at Athankarai. Among the three kinds of spat collectors the average number of spat setting is highest on concrete pieces given lime coating and the number of spat setting on lime-coated oyster shells and curved tiles is less. The kind of spat collector which is most efficient resulting in setting of large number of spat differs in various areas. Lime-coated curved roofing tiles have been effectively used in Arcachon, Southern France (Hornell, 1910 ; Yonge, 1960). Hornell (1910) pointed out the possibilities for culturing *Ostrea* (=*Crassostrea*) *madrasensis* along the east coast of India by collection of spat by laying lime-coated tiles. Sundararaj and Devanesan achieved limited success in effecting setting of spat of *C. madrasensis* using this type of spat collector. Recently in Tuticorin Bay, Mahadevan and Nayar (1980) obtained a maximum of 97 and average of 34 spat of *C. madrasensis* per lime-coated tile. On the southwest coast, Dhulkhed and Ramamurthy (personal communication) found a maximum of 30 to 40 oyster spat setting on Mangalore tiles kept in Sambhavi Estuary, Mulki.

Varying types of spat collectors are used for oyster culture in various parts of the world. Rens of oyster shells hung from horizontal poles or rafts are used in Japan (Cahn, 1950)

and British Columbia, Canada (Quayle, 1969; 1971). Stick culture is prevalent in British Columbia and Australia (Qualye, 1969; Glude 1976). Wooden veneer rings dipped in cement slurry are used successfully for spat collection in British Columbia (Quayle, 1969). In United States of America oyster culture is largely carried out by the bottom culture method and spat are collected on shells (Bardach *et al.*, 1972). In U.S.A., with the development of hatchery method of production of spat a number of oyster hatcheries have been established which produce and supply spat to oyster farmers (Glude, 1976).

The average growth of 86.7 mm attained by *Crassostrea madrasensis* in Vaigai Estuary at Athankarai is similar to that of 85-90 mm observed by Mahadevan and Nayar (1980) in the same species in Tuticorin Bay. The maximum sizes of 100-110 mm reached by *C. madrasensis* at the end of one year at Athankarai is higher as compared to 84 mm recorded by Rao and Nayar (1956) for the species in Adyar Estuary, Madras. The American oyster *Crassostrea virginica* has been found by Ingle (1950) to grow to a size of 104 mm in seven months itself in the warm Apalachicola Bay in Florida while Menzel (1951) has reported that the *C. virginica* reaches a size of 100 mm only in nine months on Louisiana Coast. A very rapid growth to a size of 80 - 95 mm has been observed by Dhulkhed and Ramamurthy (1980) in *C. madrasensis* in Sambhavi Estuary, Mulki and the authors attributed it to higher productivity of waters on west coast of India than on the east coast. The growth of the above species of *Crassostrea* is very rapid as compared to that of the European oyster *Ostrea edulis* which grows to a maximum size of only 35 mm (Orton, 1937) at the end of one year.

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