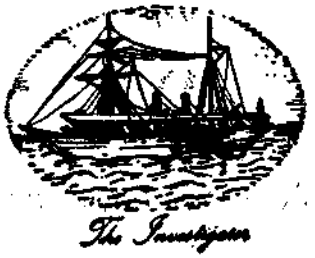
PROCEEDINGS OF THE SYMPOSIUM ON COASTAL AQUACULTURE

Held at Cochin

From January 12 to 18, 1980

PART 2 : MOLLUSCAN CULTURE

(Issued on 31st December 1983)



MARINE BIOLOGICAL ASSOCIATION OF INDIA

POST BOX NO. 1023, COCHIN 682011, INDIA

Price : Rs. 350.00

MARINE BIOLOGICAL ASSOCIATION OF INDIA

COCHIN-682 011, INDIA

SYMPOSIUM SERIES 6

Abbreviation

Proc. Symp. Coastal Aquaculture, Pt. 2

PRINTED IN INDIA BY K. G. JOHN AT THE DIOCESAN PRESS, MADRAS 7 AND PUBLISHED BY E. G. SILAS ON BEHALF OF THE MARINE BIOLOGICAL ASSOCIATION OF INDIA, COCHIN-682 011.

Proc. Symp. Coastal Aquaculture, 1983, 2: 427-435

OYSTER CULTURE AT TUTICORIN

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ABSTRACT

Oyster culture as a food producing subsystem, can be undertaken effectively and profitably in India. The success of this centure can have far reaching results in solving the demand for cheap animal protein from the sea and as an income generating avocation for fishermen.

Investigations carried out at Tuticorin to find out the feasibility of oyster farming in coastal areas were successful. Effective methods have been developed for large-scale oyster spat collection by using lime-coated country tiles. For growing the oysters to marketable size in short period 'rack culture' technique was effectively employed. Production of 119 tonnes of oysters per hectare could be achieved in 12 months time. Applicability of the technology developed in popularising oyster farming along the Indian coasts is discussed in detail.

INTRODUCTION

RICKER (1969) has stated that by the year 2000 A.D. the total marine capture fisheries yield will be of the order of 150-160 million metric tons which will supply only about 30% of the expected world human protein needs. Fish contribute to a diet from as little as 2.74 gms/day/caput (India) to as much as 76.17 gms/day/caput (Japan) according to Kaul (1978). Hanson (1974) is of the view that agriculture and fisheries are very likely nearing the limits of their practical production capacities. This combined with development in mariculture could make mariculture — a food producing subsystem — an economically important step for augmenting resources. Evaluation of the bioeconomic suitability of marine fishes and shellfishes based on trophic efficiency, reproduction in nature and in captivity, growth of biomass production and life cycle clearly shows that molluscs present fewer problems of culture. In addition to this, another factor in favour of undertaking culture of molluscs is that of all groups advanced technology has been established only for the molluscs, because considerable efforts have been expended on them for several years. Of these, culture of oysters and mussels is labour-intensive and the selection of one or the other or both for culture depends on regional and specific locational factors, micro-oceanographic features and other physical environmental facets like tidal range, state of sea etc. Regional factors are the most pragmatic ones of labour resources, market proximity, public receptivity and other socio-economic aspects.

As far as India is concerned it may be seen from the annual marine fish landing figures for the past several years that molluscan landings form an insignificant percentage (0.8%) of the total. Hornell (1909 a, b, 1910, 1914, 1917, 1922, 1949 a, b, c), Rai (1928), Rao (1941), Rao (1958, 1963, 1966), Jones (1950, 1968 a, b). Jones and Alagarswami (1973), Alagarswami and Narasimham (1973), Mahadevan and Nagappan Nayar (1973), Nagappan Nayar and Mahadevan (1973, 1974), Rao (1974) only

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to mention a selected few, have drawn our attention to the immensely rich molluscan resources, with a good variety of commercially important and economically valued species of protein food value, occurring in the coastal waters of India. Their utilisation, especially of the edible varieties, has been static and inadequately attended to till now. While capture fisheries of molluscs is no doubt under exploited a total absence of culture attempts exists in this realm. To fill this deficiency, programmes were formulated to start culture of edible molluscs by developing suitable techniques of collection, growing and farm management. Of this edible oyster culture was chosen as one of the priority areas.

For the success achieved in the development of oyster culture techniques at Tuticorin, the authors owe their debt of gratitude to Dr. E. G. Silas, Director who has been supporting our efforts by his guidance, encouragement and help. The devotion of all other members of the oyster culture team at Tuticorin is also gratefully acknowledged.

Status of Edible Oyster Culture and Resources Availability

Of the 11 species of *Crassostrea* reported from Indian waters (Awati and Rai, 1931), *C. cornucopia*, *C. glomerata*, *C. belcheri*, *C. quercina*, *C. crenulifera*, *C. bicolor* and *C. lacerata* appear to be economically unimportant. *C. cristagalli* and *C. folium* mentioned by Rao (1974) also appear to be of not much economic value. Of the remaining four *C. gryphoides* and *C. discoides* are mostly found in the north-western coast of India, the former being more important, occurring in the coastal areas of North Kanara and Maharashtra in considerable numbers. *C. madrasensis* is known to grow (Pl. I A, B) abundantly in wild state forming extensive beds in the tidal creeks and backwater areas of the east coast. In addition to this settlement of this species in the estuarine regions of many east coast rivers is not uncommon. Unfortunately nowhere in the east coast is this valuable resource commercially fished for food except on a limited scale by the Tamil Nadu Fisheries Department arranging to collect a few thousand oysters every year from the wild stock in Pulicat Lake and Ennore Estuary for supply to a few western-style hotels and westerners in Madras. The wild oysters get stunted in growth because of overcrowding in beds and pose great difficulties in harvesting. The habitat where the oysters thrive in nature, is also looked down upon by fisherfolk. Exploitation from the rugged natural beds is unremunerative considering the time spent in gathering them.

To the developed nations, oyster meat is well known for its epicurean value. Added to this, protein value of oyster meat is high comparable to other shell fishes. These factors and natural resource richness of *Crassostrea madrasensis* in the east coast of India influenced the formulation of a programme of oyster farming at Tuticorin adopting a suitable technique. The strategy was to culture oysters in the coastal area so that once the technology of growing oysters is proven a few thousand hectares in the shallow backwater areas out of an estimated 2 million hectares of such water bodies in India can be profitably utilised for developing and promoting oyster culture industry.

Selection of Farm Site

Before deciding upon the location for the oyster farm, extensive survey was taken up during the years 1975-76 to determine the areas where important oyster beds exist in the long coastal districts of Tamil Nadu. Of the 42 river mouths and backwater areas from Madras to Cape Comorin, 11 were identified as containing sizable population of oysters. The area between Madras to Point Calimere being a cyclone prone one, it was decided to consider initial culture experiments either along the Gulf of Mannar Coast or in the Palk Bay zone. Of

these two areas, the Vaigai Estuary at Attankarai is the only area with pronounced oyster bed formation in the Palk Bay side. The bar mouth here remains closed for most of the period during summer with the result that there is progressive increase in salinity due to solar evaporation and heavy oyster mortality occurs. During the north-east monsoon period following summer months freshets in the river lower the salinity to near freshwater condition which again acts as an adverse factor for oyster growing experiments. In the Gulf of Mannar, three important regions where oyster populations exist over considerable stretch were identified (1) Koothanguli Backwater region where Hanuman Nadhi, a small tributary joins it, (2) Tambaraparani Estuary at Pinnakayal near Dharangadhara Chemical Factory water pumping station and (3) Tidal inlets in the vicinity of Tuticorin. The oyster beds at Tuticorin are situated in tidal inlets leading to considerable expense of shallow water. The shallow water creeks and the adjacent areas were found suitable for conducting experiments. Another important factor was the easy availability of labour, infrastructure facilities and marketing channels. An oyster farm was therefore established at Tuticorin in one of the creeks, the Karapad Creek.

Karapad Creek

The western bank of the shallow Tuticorin bay is deeply indented in two places one at Karapad and the other at Uppar. The Karapad Creek is situated 2 km south of Tuticorin (Pl. I C). This tidal creek, 2 m deep and 30 m broad at its mouth, cuts into the land westwards as a channel for a near 750 m course after which it leads to a waterspread bathing an expansive shallow mangroved-fringed swampy area to the north and meanders further south-westwards to a distance of 2 km (Pl. II A) becoming shallower in many spots wherever sandy shoals intervene. Such areas get exposed during tidal egression.

Natural oyster beds

Extensive beds of oysters exist in the shallow areas of mangrove fringed watermass, while in the proximity of exposed flats and on either bank of the waterspread also patches of live oyster settlement are not uncommon. The oysters are densely settled in several clumps of which the top layers contain mostly dead oysters because of continued exposure during certain seasons of low tidal amplitude after settlement. The oysters in the lower strata are mostly silt-covered (Pl. II B). Both dead and live ones are met with here. The creek area is comparatively free of oyster settlement except for stray settlement in the intertidal area of a few concrete pillars of a make-shift bridge connecting the north and south banks of the channel. The salinity, temperature and other physico-chemical features of the creek water are identical to those of the open bay water since there is a free and uninterrupted ingress and egress of sea water daily in the creek throughout the year. A standing column of 1 m water depth is thus maintained even at the time of the lowest tide. At spring tides the high water level exceeds 2.5 m. The bottom in the channel is of muddy sand while the interior of the creek is muddy and slushy. For the culture experiments the channel area was preferred because of the nature of bottom, free water-flow and uniform depth.

Method of Culture

Of the several culture methods followed in different countries it was felt that in coastal areas where surf does not break, the 'rack-tray' culture method would give desired results. The creek with soft bottom would pose few problems for erecting wooden racks also. Hence this method was chosen.

a. Oyster rack

Twelve numbers of 2.4 m long wooden poles of 7.5 cm diameter, earlier coated with tar, with one end sharpened to enable them to be

easily driven into the sandy bottom 60 cm down, were planted in a line at intervals of 1 m across the creek. Two such equidistant parallel rows were driven to complete a single rack. At least 1.8 m length of these poles project above the bottom. One cut piece each of the same quality wood 1.4 m long and 6-7 cm diameter was tied parallel and across from pole to pole at a height of 0.9 m above the bottom. The finished frame structure served as the platform frame for placing the trays containing oysters. Coir rope was used for fastening the poles although nylon cord can also be used for additional strength. The height of the frame was so adjusted to enable the trays containing oysters resting on them to remain submerged in water during normal low tide periods (Pl. II D). For controlling the settlement of fouling organisms the trays were adjusted to remain exposed during low tides by manipulating the height of platform frame. A platform thus constructed will be able to hold 20 trays each.

b. Trays

The tray fabricated for this purpose was rectangular in shape of 90 × 60 × 15 cm dimensions (Pl. III A). The frame of the tray was of 6 mm welded steel to which 2 mm nylon twine netting of 20 mm mesh size was given on the sides and bottom. The frame of the tray was coated with lacaloid black paint as an anticorrosive measure. The nylon meshed trays are strong enough to bear the weight of the oysters, at the same time allowing free water flow.

Each rack was designed to give an area of 25 sq.m allowing space on all sides for farm work to be carried out using 2.75 m long flat bottomed fibreglass dinghy. The rectangular trays were fashioned to hold 150-200 oysters each. Thus provision was made to accommodate 20 trays to grow 3000-4000 oysters in a 25 sq.m area. By erecting a panel of such racks parallel to the previous ones it was possible to increase the area of cultivation. 30 such racks for experiments were put up.

c. Oyster spat collection

Preparation of lime-coated tiles : Of the several experiments tried with different spat collection materials (details of which form the matter for publication elsewhere), country roofing tiles of 24 × 15 cm were found to be the best suited for collecting large quantities of oyster spat from nature. The tiles were first coated with a layer of lime by dipping them individually in a vat containing sufficient quantity of slaked lime. The tiles were then spread out in shaded area to dry for 24 hours. After this the tiles were again dipped in slaked lime with a mixrure of sand to obtain a second coating with rough surface. The tiles were dried as before and kept stocked for use during collection season (Pl. II C). Setting properly prepared tiles in the right season was considered very important to achieve maximum success.

Gonadial maturity of oysters and spawning season

Regular sampling of oysters from natural bed for a 12 month period to determine the gonadial maturity stages enabled the determination of the right time of spawning. It was noticed that in the natural beds majority of oysters attained maturity in April and August. Ripe female and male oysters discharged the reproductive elements in the first fortnight of April when the temperature was 28.8°C, salinity 34.8‰ and oxygen content 4.5 ml/l (Fig. 1). Spat collectors laid in the natural bed area (during April first week) on low submerged wooden platforms enabled large scale settlement of oyster spat on the tiles. At the time of laying spat collectors the following precautions were taken :

i. The platform on which tiles were arranged always remained submerged in water so that the tiles would not get exposed at any time till they are finally removed for scraping the oyster spat.

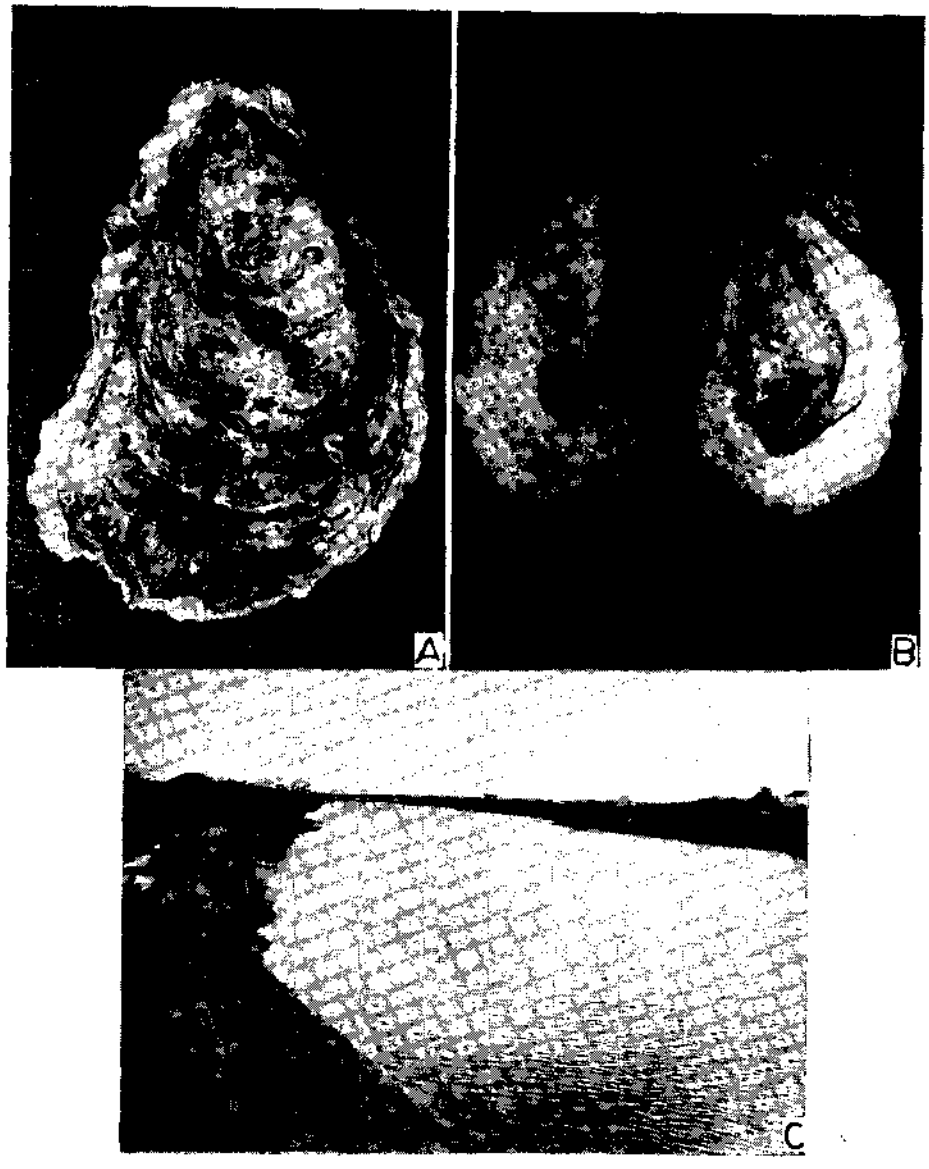

PLATE I. A. The edible oyster *Crassostrea madrasensis*, B. Shell valves of *C. madrasensis* opened to expose the body of the oyster and C. A view of the Karapad Creek at Tuticorin.

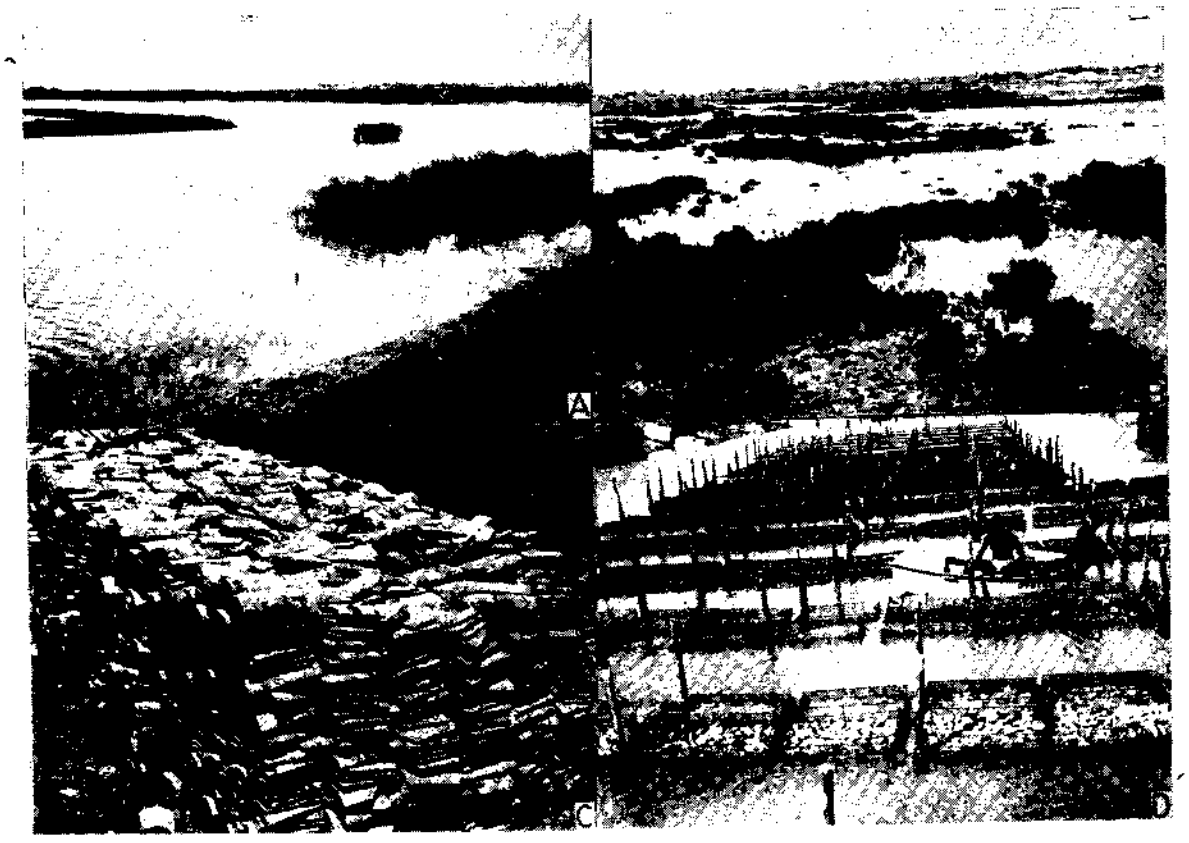

PLATE II. A. A view of the Karapad Creek spreading over mangrove fringed area to the right and continuing southwestward, B. Natural beds of edible oyster exposed partially during low tide, C. Lime-coated tiles used for spat collection and D. The oyster growing racks in the creek (Note the oysters kept in the rectangular trays).

PLATE III. A. Rectangular tray used for growing oysters, B. Box-type cages used for initial growth of scraped oyster spat, C. Oyster spat settled on tiles and D. Scraping of spat in progress.

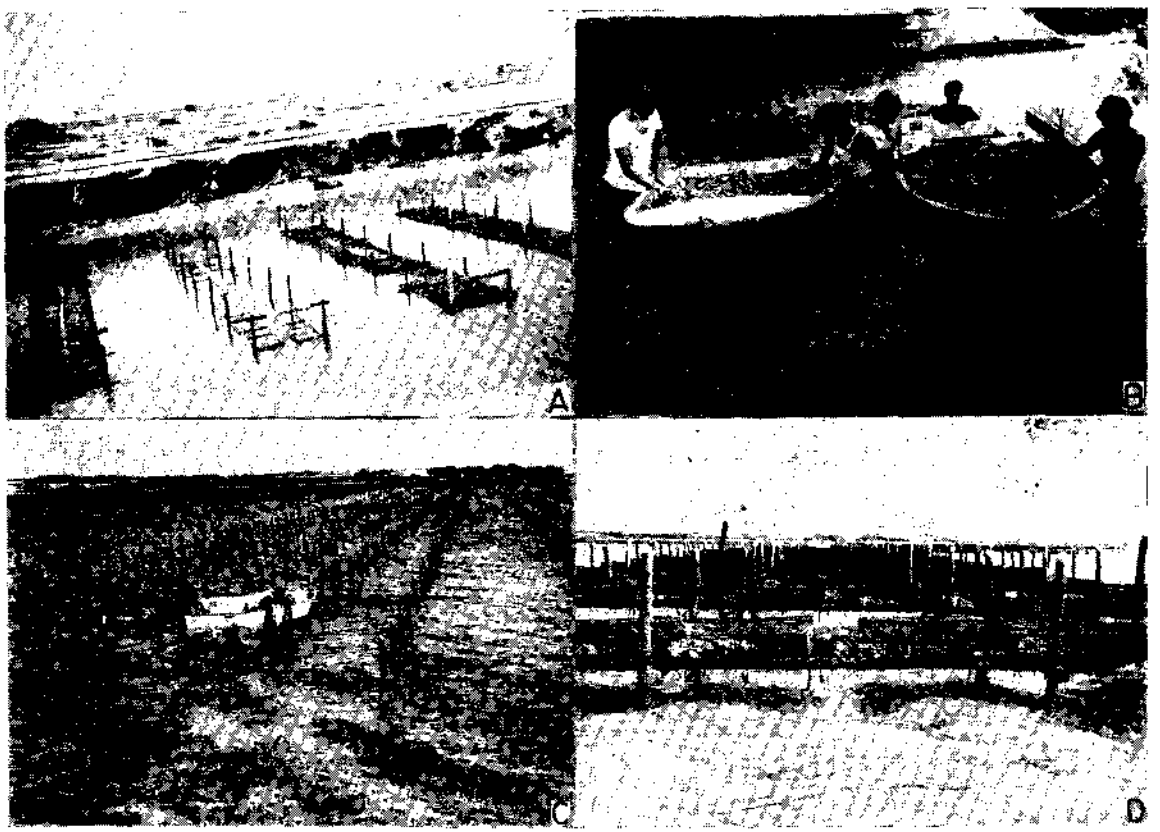

PLATE IV. A. The erosion of the bank of the creek, B. Harvested oysters being taken in fibreglass dinghies, C. A view of the oyster farm in open sea coast and D. A view of the open sea oyster farm at very low neap tide.

ii. The selection of site where spat collectors were laid was free of currents and was a calm area. Spat collectors were laid in different places in the vicinity of natural oyster beds.

iii. The concave side of tiles was kept facing down while being positioned on collection racks since it is this darker side that oyster larvae prefer for attachment.

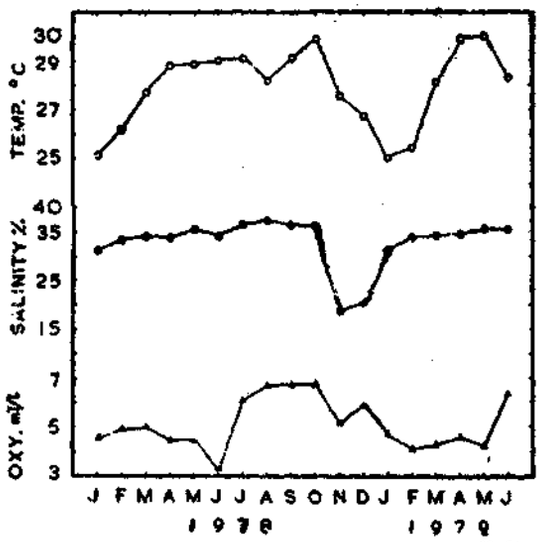

Fig. 1. Seasonal variations in temperature, salinity and dissolved oxygen in oyster culture area at Tuticorin during 1978-79.

iv. Since the time taken for oyster larvae to settle down after fertilisation may vary from 15-20 days or even more depending on environmental conditions, spat collectors were laid only after satisfying about the ripe condition of the gonads. This gave maximum results as otherwise fouling community settlement on tiles effectively reduces or prevents good spat settlement.

Periodically the spat collectors were examined to see the progress of spatfall. Spat settlement ceased by April end. In August when water temperature was similar to that in April, 28.1°C, and salinity and oxygen higher, 37.08 ‰ and 6.7 ml/l respectively spatfall was very less as compared to that in April. On many tiles as many as 100 spat could be collected in April although the average was about 40 per tile (Pl. III C). The spat were allowed to grow on tiles till they attained a size of 30 mm in about 45 days. After this, scraping of spat was done (Pl. III D). Very little force is needed to dislodge the spat from the tiles. During the first season it was possible to collect a total of 600,000 spat by the above method. The spat were then transferred to box type nylon meshed cages for initial growth since the oyster seeds at this size were light and small.

The box type cages were of identical material as the rectangular trays except that these were much smaller of 40 × 40 × 10 cm size with 12 × 12 mm meshed nylon netting and provided with a lid (Pl. III B). The lid ensured that the oysterlings were not thrown out and lost because of wind and wave action. 400-5000 oysterlings were put in each cage and suspended using nylon ropes from the cross poles of the rack, below the surface of water. The cages were often examined and algal filaments clogging the meshes were removed and gentle scrubbing was resorted to for removing barnacles and other foulers. Monitoring of physico-chemical properties of the creek water was done as also the collection and analysis of the planktonic food available. Phytoplankters were found to be present throughout the year with blooms of *Rhizosolenia* spp. and *Chaetoceros* spp. occurring from June to October.

Growth of oysters and production

The study on the growth of the oyster spat in the cages revealed that there was rapid growth in the first three months and a size of 38 mm was attained in 60 days by July, 1978 giving an average of 12.6 mm growth per month. At this stage oysters were transplanted to open rectangular trays for further growth. Manage-

ment of the farm stock after this needed only the examination of oysters once in a month, cleaning of oysters and trays and removal of predators. The monthly rate of growth was less in later months with very poor growth from December to March. At the end of the first year the average growth recorded was 84 mm (Fig. 2) with a total shell and meat weight of 120-130 g per oyster of which the meat weight alone was 8 gm. Mortality out. The deflection of water current by the rack panels caused erosion of the raised channel banks damaging nearby structures on either bank (Pl. IV A). The creek water being the main source of supply of sea water to adjacent salt pans the creek entrance had to be temporarily closed whenever large-scale maintenance and repair works were undertaken by the salt pan owners. This happened once towards the end of the present initial experiments by

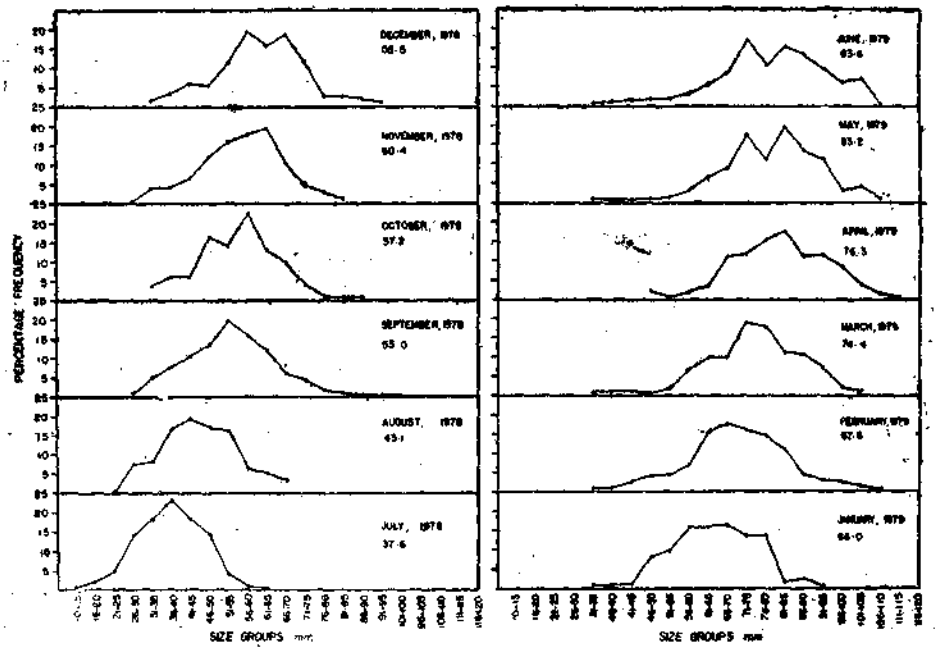

Fig. 2. Size frequency composition and average sizes of cultured *Crassostrea madrasensis* at Tuticorin during 1978-79.

noticed in the farm was very little (5%). The production per rack containing 4,000 oysters (Pl. IV B) at the end of one year was 425 kg (shell on) indicating a production rate of 119 t/ha with a meat yield of 9 t/ha.

Difficulties experienced in farming in the creek

Because of the obstruction to the free flow of water by erecting racks and placing trays silting occurred in the area covered by racks. Desilting operations had to be constantly carried which time we had obtained necessary basic data and information for planning large-scale confirmatory farming work. Because of the problems in the creek the farm site was shifted in 1979 to the shallow Tuticorin Bay on the southern side of the Karapad Creek.

Farm site at Tuticorin Bay

The shore of Tuticorin Bay is shallow with depth ranging from 1.5 to 2.5 m. The nature of bottom is sandy with a shoreward approach

through a flat of inter-tidal mud and sand (Pl. IV C). Roughly 100 hectares of such shallow area available is not subjected to high waves or wind action normally and therefore was considered suitable for establishing the oyster farm. The oysters in the natural bed in the Karapad Creek and the stock held in the oyster farm would produce seeds needed for eventual large-scale farming venture. 80 racks were constructed and 2,50,000 oyster spat collected from the natural bed in April 1978 were grown in the farm at the rate of 3,000 spat per rack (Pl. IV D). The growth rate was very satisfactory although mortality of transplanted stock of size 45-65 mm was noticed in June-August due to predation by one species of gastropod entering the trays. This gastropod was identified as *Cymatium cingulatum* (details of this are reported elsewhere by Thangavelu and Muthiah). The problem was tackled by periodical examination of trays and removing the gastropods daily during this period. The estimated production of oysters from rack and tray system of culture was less in the Tuticorin Bay as compared to that in Karapad Creek and amounted to 90 t (shell on)/ha with a meat production of 7.5 t/ha.

Further intensification of farm work was taken up by the end of 1979 and an additional 90 racks had been put up where the work of oyster growing was entrusted to 15 small-scale fishermen. Orientation training in all aspects of oyster culture was given to them. Spat collected in April, 1979 by using country tile technique enabled to keep a stock of 5,00,000 which were utilised by the fishermen for farming. This new venture is being watched keenly and if successful would add a new dimension in establishing oyster farming as an additional income generating venture.

Discussion

The foregoing account of experimental culture of edible oyster carried out at Tuticorin has shown the feasibility of growing oysters in shallow coastal areas and tidal creeks to marketable size with a production of 90—119 tonnes of oysters/ha with a meat yield of 7.5 9.0 t/ha. This much of production cannot be expected from natural beds due to obvious reasons. In Australia where *rack* system of culture is followed in many areas, 2,000 kg of oyster meat has been produced per hectare (Bardach *et al.*, 1972). In the same country *tray* culture is reported to yield 5,400 kg of oyster meat per hectare. In this context the results achieved at Tuticorin appear to be significant. Although culturists in Japan are able to produce 26 tons of oyster meat by longline system and 20 tons by *raft* culture such attempts do not appear to be immediately possible in the deeper areas of our coast because of the non-existence of sheltered bays. The 'lines' or 'rafts' positioned in the open sea will not only hamper navigation, but also clash with the interests of the traditional fishermen exploiting these areas.

It was Hornell (1910) who first suggested taking up oyster culture in Tamil Nadu and after seven decades we are seriously implementing that idea along with similar attempts in the field of mussel culture, etc. The results achieved are very encouraging and it is hoped that this will find favour with culturists.

Although the present culture experiments at Tuticorin have shown the possibility of a reasonably high output by the 'rack-tray culture' method, ample scope exists to achieve higher production values per hectare by raising the number of oysters in a rack increasing the number of trays per rack and keeping them in a two tier arrangement of 20 trays per tier, the two tiers being one below the other but well above the bottom. Predator problem does not appear to pose difficulties at Tuticorin since vigilence during the period of predator abundance will help to eradicate the gastropod which occurs in the area. It cannot be said that throughout the east coast the same problem alone would confront the farmers. Problems

might differ from region to region and by experience these can be identified, documented and remedial action taken as otherwise mortality of farm stock would result in the venture becoming unproductive and unremunerative.

Keeping the future perspectives in mind it appears necessary that in our effort to establish a permanent oyster industry attention has to be paid to the development of hatchery system for seed production which will reduce our total dependance on nature for seed requirements for the large-scale expansion of this industry. This has been identified, therefore, as a priority area of research.

It is too early to work out the economics of the culture attempted based on the data available. But there is every hope that the margin of profit will be sufficiently attractive to provide necessary incentive to the farmers to come forward to take up oyster farming. Consumer preference and market demand are no doubt the deciding factors, for which systematic extension work is necessary. Although the paper does not deal with the steps proposed to be taken to find marketing avenues, it may be mentioned here that some years ago people never thought much of the potentialities of market for prawns and lobsters, but found themselves in a world wide demand trade for prawn meat which has resulted in keen interest in prawn farming in India. In this context oyster culture should be taken up as a long range development programme initially to cater to local market demands and later for export market.

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