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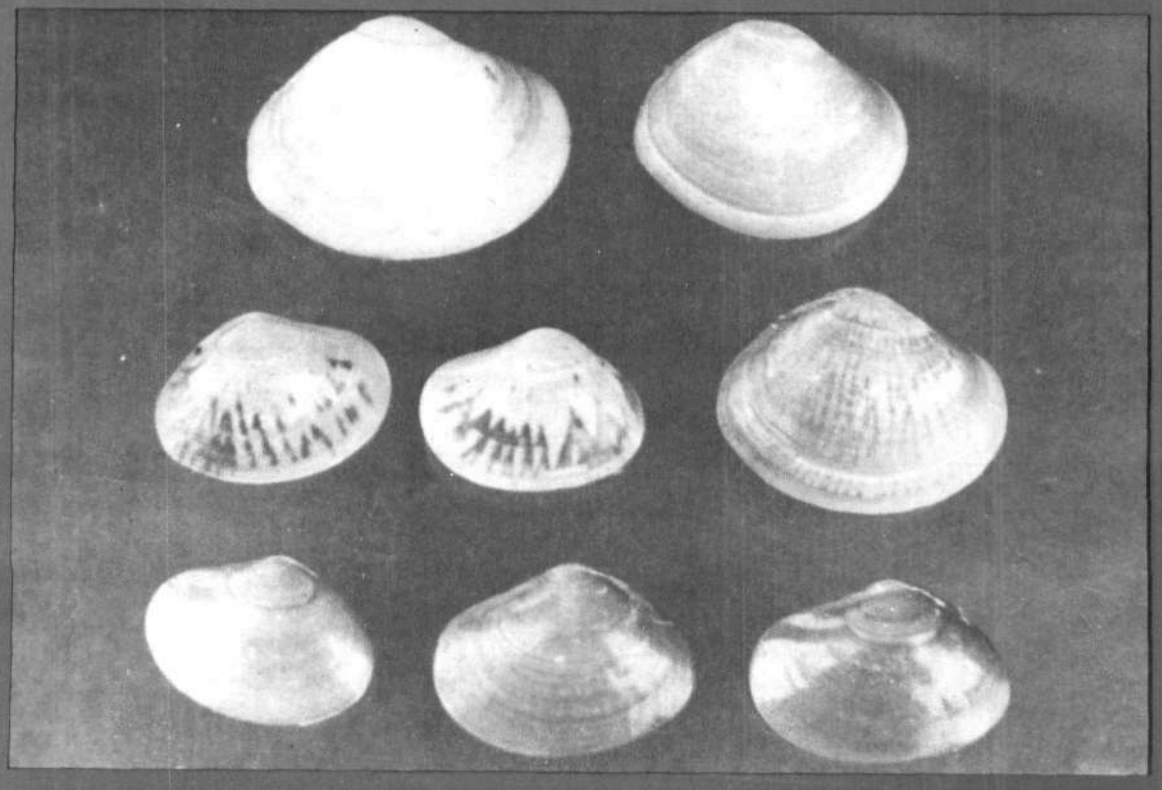

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

SEA RANCHING OF PEARL OYSTER*

Introduction

Sea ranching of laboratory/ captive reared organisms/animals is a technique which aims at rebuilding the wild population from its destruction/catastrophe by man-made and natural causes. The main aim of sea ranching pearl oysters in their natural habitat is to revive the pearl oyster population from extinction and create new beds. The main difference between land-rancher and sea-rancher is that the land-rancher retains ownership of his animals whereas the sea rancher cannot possess the ownership of the animals since they are ranched in the sea. The ranched animals became part of the wealth of the sea which can be harvested by anybody.

Sea ranching of commercially important molluscs dates back 1977. Japan is the first country to sea ranch molluscs. They produced abalones in the hatchery and transplanted in the sea, a practice to increase the production (Imai, 1977). Till the beginning of 1985, no attempt has been made to sea ranch the hatchery produced pearl oyster seed in the natural pearl oyster beds. The development of hatchery technology for mass production of pearl oyster spat under controlled condition in 1981 (Alagarswami. *et al* 1983) has opened the possibility of sea ranching pearl oysters. An experimental sea ranching was commenced in December, 1985 in the pearl oyster beds of Tuticorin waters.

Fluctuation of pearl oyster in natural beds

The wide spread mortality of young and old pearl oysters in the pearl banks may be due to certain physical causes such as shifting of sand, strong currents, destruction by natural enemies etc. Factors like overfishing, over crowding of oysters and diseases may also be responsible for the depletion of pearl oyster population (Hornell, 1903). Hornell (1922) found that the predatory fishes such as *Balistes* sp. and *Serranus* sp. destroy the oyster population. Chacko (1956) considered the starfish *Pentaceros linckl* as the greatest enemy of pearl oysters and suggested for their removal from the beds. Salvadori (1962) considered moray seals and octopi as the destructive agents of pearl oysters. Covering the spat by the weaving mussel *Modiolus* sp. in the form of a mat (Mahadevan and Nayar, 1976) and predation by gastropod molluscs *Cymatium* sp. (Chellam *et el*, 1983) are also some of the agents responsible for the destruction of oysters.

Replenishment of natural stock on the beds is possible, if only mass settlement of spat takes place every year. Devanesan and Chidambaram (1956) are of the opinion that the water drift and current over the pearl banks of Ceylon and India may carry the larvae of pearl oysters from one coast to the other. Alagarswami (1977) observed good spat settlement in the inshore area and incursion of multi species *Pinctada* population in

* This article is based on the work carried out by A. C. C. Victor, A. Chellam, S. Dharmaraj, T. S. Velayudhan, K. Srinivasagan, A. Dasman Fernando, F. Soosai V. Rajan, N. Jesuraj and K. Shanmugasundaram. The article was prepared and presented by A. C. C. Victor.

the paars which he had attributed to coastal larval drift.

Conservation of pearl oyster in the natural bed

Herdman(1906) suggested transplantation of young 'strides' or brood of oysters from unproductive paars to productive paars where better growing conditions prevail. Devanesan and Chidambaram (1956) recommended for the creation of a sanctuary of 1 sq. km in the pearl oyster beds which should not be fished at all, and creation of a 'Breeding Reserve' to resuscitate the population. Salvadori (1962) suggested 'stock improvement' by development of 'hallows' in the oyster beds by dumping rocks to provide better anchorage for oysters.

Sea ranching

Subsequent to the success achieved in the large-scale production of pearl oyster seed in 1981, an experimental sea ranching programme was commenced at Tuticorin. For this purpose, 3 nearby paars namely Van Thivu Arupagam paar, Kurichan paar and Fernado paar were selected. The depth of these paars is 12 m. Between December, 1985 and December, 1990, a total of 10,25,00 spat of *Pinctada fucata* were sea ranched on 17 occasions. The size of the spat ranged from 0.9 to 11.3 mm with an average length of 1.53 to 5.7 mm (Table 4).

Mode of ranching

The spat to be sea ranched are kept in the hatchery tank and the spat are allowed to settle on synthetic materials like old fish nets, velon screen fabric and tufts of monofilaments. These materials with the spat were placed in large rectangular cages (90 x 60 x 15 cm) covered with synthetic webbing. The cages were further enclosed with old fishnets. The spat could crawl out though the meshes for dispersal on the paar. The spat-filled cages were lowered and kept inside hollows or secured coralline projections with synthetic ropes to prevent drifting.

Trend of fisheries

The pearl banks located off the coastline of Tuticorin and Thiruchendur accounted for the longest pearl fishing operations from 1955 to 1961. A total of 95,867,460 pearl oysters were fished. The details of pearl oysters fished during the pearl fisheries of 1955 to 1961 are shown in Table 1. Tholayiram paar was fished moderately in 1955 and 1956 and left out during 1957, 1958 and 1959 respectively. The other paars viz. Karual, Rajavukku Sippi, Sothitha paar, Kudamuthu group etc. were fished heavily during 1957, 1958 and 1959 and there were no fishable stock in the succeeding years.

From 1961 to till date, the Tamil Nadu Government has not announced pearl fishing due to the reason that there were no fishable stock of oysters in the paars. The Central Marine Fisheries Research Institute took up the survey of the pearl oyster beds of the Gulf of Mannar from 1975-76 onwards. The facility of SCUBA diving was utilized for the survey. During the period 1975 to 1986, a total of 289 sea trips were made to different pearl oyster beds and collected 2,39,025 oysters. Table 2 gives the diving effort and number of oysters collected season-wise for the period 1975 to 1986. Table 3 gives the

TABLE 1. *The number of pearl oyster fished during the longest fishery series 1955-1961*

Year	Tholayiram (T) and Koothadiar (K)	Name of peral oyster				
		Karuval	Rajavakku Sippisothicha	Kodamuthu	Saithu Kodamuthu	Total
1955	3,200,000	—	—	—	—	3.200,000
1956	2,129,058	—	—	—	—	2,129,058
1957	—	272,263	2,037,012	4,611,597	3,984,800	10,905,672
1958	—	7,638,997	3,430,366	4,604,872	5,547,977	21,222,212
1959	—	4,154,250	430,806	19,040,945	3,387,054	26,986,055
	219,093			219,093		
1960	12,040,009 (T)	—	—	—	—	12,040,009
	3,768,429 (K)	—	—	—	—	3,768,429
1961	15,073,838 (T)	—	—	—	—	15,073,838
	323,094 (K)	—	—	—	—	323,094
Total	36,534,428	12,284,603	5,871,184	28,257,414	12,919,831	95,867,460

picture of the paar-wise collection of oysters during the years 1975-86. It is evident from the table that the least number of oysters were collected during 1980-81 and the more successful season was 1981-82, the one following the unproductive season. The number of oysters collected per diving hour was as high as 2,164 oysters in the year 1981-82, whereas it was just 3 in 1980-81. Fig.1 illustrates the collection of oysters from different pearl oyster bed and the number of the oysters per diving hour. Nagarai paar accounted for the maximum collection 2,282 oysters per diving hour, in 1981-82.

TABLE 2. *Season-wise collection of pearl oysters during the period 1975 to 1986 from the pearl banks of the Gulf of Mannar*

Season	No. of sea trips	Diving effort in hrs.	Total No. of oysters collected	%
1975-76	32	81.00	1,244	0.52
1976-77	50	120.03	27,208	11.38
1977-78	43	67.22	12,322	5.16
1978-79	38	110.23	35,919	15.03
1979-80	31	56.52	12,335	5.16
1980-81	25	35.09	101	0.04
1981-82	21	46.25	99,569	41.66
1982-83	23	44.36	36,457	15.25
1984-85	18	42.45	13,621	5.70
1985-86	8	8.25	249	0.10
Total	289	595.00	2,39,025	100.00

General remarks

The present investigation undertaken with the aim of correlating the sea-ranching of pearl oysters with the revival of pearl oyster population in the pearl banks has provided many interesting results. A comparison of 96 million oysters collected during 1955-1961 with that of the 0.2 million oysters collected during the period 1975-1986 clearly shows that the pearl oyster population in the pearl banks have become dwindled.

TABLE 3. *Paar-wise collection of pearl oysters during the period 1975 to 1986 from the pearl banks of the Gulf of Mannar*

Name of the paar	No. of sea trips	Diving effort in hours	Time spent %	Total No. of oysters collected	Percentage in total
NORTHERN PAARS:					
Devi paar	101	220.00	36.97	66,181	27.690
Nagarai paar	39	80.13	13.47	1,26,038	52.730
Vaipar Periya paar	15	41.78	7.02	14,394	6.020
Kurichan paar	20	40.30	6.77	12,824	5.370
Fernando paar	13	27.00	4.54	8,328	3.480
Van Thivu Arupagam paar	10	13.60	2.29	1,328	0.560
Padutha Marikan paar	4	7.63	1.28	501	0.210
Karai paar	4	7.22	12.10	36	0.020
Uttipaar and Uduruvi paar	2	4.00	0.67	2,676	1.120
SOUTHERN PAARS:					
Tholayiram paar	40	73.35	12.33	4,428	1.850
Saith Kudamuthu paar	12	38.63	6.49	876	0.370
Karuval paar	7	15.72	2.64	1,300	0.540
Poonthottam paar	4	5.42	0.91	25	0.010
Pulipundu paar	7	4.35	0.67	12	0.005
Kudamuthu paar	3	3.97	0.67	12	0.005
Vada Onpathu paar	2	3.42	0.57	8	0.003
Sayath Onpathu paar	1	2.33	0.39	—	—
Koothadiar paar	1	2.00	0.34	33	0.013
Vada Kudamuthu paar	2	1.97	0.33	3	0.001
Karai Kudamuthu paar	1	1.92	0.32	—	—
Rajavukku Sippi Sothitha paar	1	0.25	0.04	1	0.004
Total	289	595.00	99.98	2,39,025	100.000

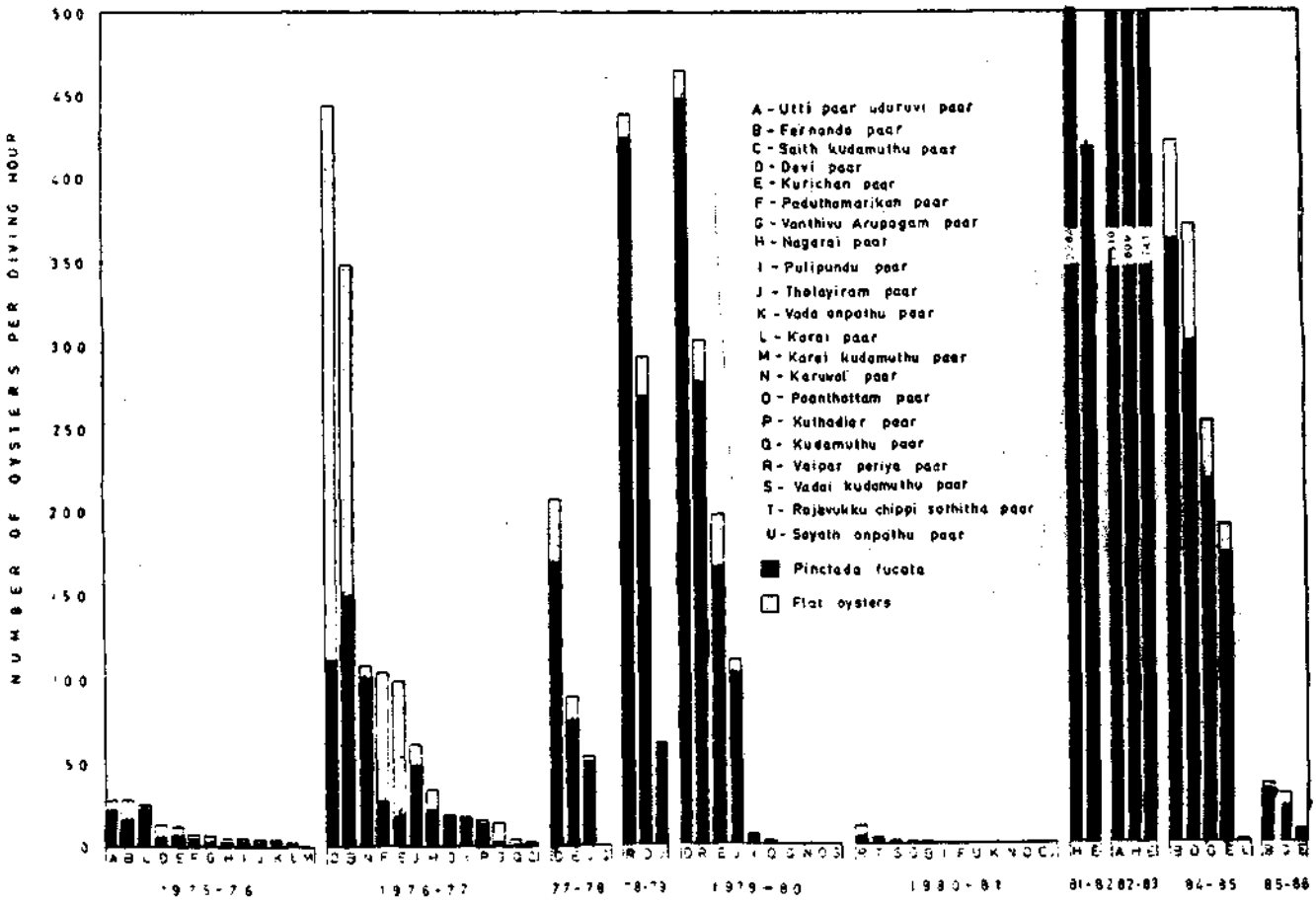

Fig. 1. Collection of pearl oysters from the pearl banks of Gulf of Mannar during 1975 to 1986.

TABLE 4. *Number of pearl oyster ranched during 1985-90*

Date of spawing	Number of spat ranched	Size range of spat in (mm)	Mean size (mm)	Oyster series & date of spawning		Name of paar where ranched
10.12.1985	5,92,000	2.8 — 6.2	4.78	22S	28.08.85	Van Thivu Arupagam
15.02.1986	70,800	1.5 — 3.1	2.29	24S	10.12.85	Van Thivu Arupagam
15.03.1986	5,500	2.1 — 5.2	3.45	24S	10.12.85	Van Thivu Arupagam
	6,68,300					
11.04.1986	32,000	1.0 — 2.5	1.67	25S	15.02.86	Kurichan
30.06.1986	12,000	1.7 — 3.6	2.80	25S	15.02.86	Van Thivu Arupagam
28.07.1986	6,000	2.4 — 4.8	3.54	25S	15.02.86	Van Thivu Arupagam
23.11.1986	10,500	2.1 — 6.6	4.66	27S	26.06.86	Fernando
12.01.1987	53,500	1.0 — 2.5	1.53	28S	13.10.86	Van Thivu Arupagam
20.03.1987	10,000	3.8 — 8.4	5.70	28S	13.10.86	Van Thivu Arupagam
20.03.1987	54,800	1.0 — 2.0	1.70	29S	28.11.86	Van Thivu Arupagam
	1,78,800					
24.04.1987	59,600	1.8 — 11.3	6.50	29S	28.11.86	Van Thivu Arupagam
28.11.1987	34,600	0.9 — 2.1	1.39	31S	18.09.87	Van Thivu Arupagam
	94,200					
18.06.1988	15,000	1.3 — 5.8	3.00	33S	02.04.88	Van Thivu Arupagam
28.12.1988	15,000	1.3 — 5.8	2.80	35S	24.07.88	Van Thivu Arupagam
	30,000					
30.12.1989	34,000	2.0 — 2.5	2.20	39S	24.08.89	Van Thivu Arupagam
16.08.1990	10,000	2.5 — 4.0	3.00	41S	15.06.90	Van Thivu Arupagam
30.12.1990	10,000	2.1 — 5.2	3.60	42S	22.09.90	Van Thivu Arupagam
	20,000					
Total	10,25,300					

During the period 1955 to 1961, the southern group of paars namely Tholayiram paar, Karuval paar, Rajavukku Sippi, Sothitha paar and Kudamuthu group of paars supported the pearl fishery which yielded a total of 96 million oysters whereas the same group of paars yielded a mere 6,700 oysters during the years 1975-1986. The number of sea trips made to these paars during 1975-1986 was 81 and the average number of oysters collected per trip amounted to 82. The number of oysters collected per diving hour was 43. In the 1986-1991 period, a total of 6137 oysters were collected from a mere 15 trips to the same southern group of paars (Table. 5). The collection of oysters per trip was 498 which is almost 5 times more than that of the 1975-1986 season. Similarly the number of oysters collected per diving hour was 365 which is almost 9 times more than that of the 1975-86 season. On 20.7.1990 in about 10 minutes of diving, a total of 215 oysters were collected which amounted to 2,388 oysters per diving hour. This clearly shows that the programme of sea ranching of pearl oysters has begun to show signs of revival.

While ranching the pearl oyster spat in the paar, several billion pearl oyster larvae were also released in the paar. It is a known fact that the water current plays a vital role in the dispersal of pearl oyster larvae. Very little is known about the water movement pattern over the paar area

TABLE 5. *Paar-wise collection of pearl oysters during the period 1986 to 1991 from the pearl banks of the Gulf of Mannar*

Name of the paar	No. of sea trips	Diving effort in hours	Time spent %	Total No. of oysters collected	% in total	No. of oysters per diving hr.
NORTHERN PAARS:						
Devi paar	4	4.20	8.64	11	0.18	3
Vaipur periya paar	1	1.45	3.49	—	—	—
Nagarai paar	2	3.05	6.15	—	—	—
Van Thivu Arupagam paar	7	10.30	20.93	—	—	—
Padutha Marikan paar	1	1.35	3.15	—	—	—
Fernando paar	3	4.30	8.97	6	0.10	1
Kurichan paar	2	2.55	5.81	—	—	—
Klathi paar	1	1.45	3.45	—	—	—
Petha paar	1	1.35	3.15	—	—	—
Utti paar	1	1.30	2.99	—	—	—
Karai paar	1	—	—	—	—	—
SOUTHERN PAARS:						
Koothidiar paar	1	1.30	2.99	—	—	—
Tholayiram paar	2	2.15	4.49	—	—	—
Pulipundu paar	3	2.10	4.32	279	4.54	129
Kanava paar	1	1.15	2.49	1,261	20.50	1,009
Kadayan paar	1	1.30	2.99	155	2.52	103
Vadai Kudamuthu paar	1	1.00	1.99	670	10.90	670
Kuruval paar	1	1.00	1.99	707	11.50	707
Pullavali	1	0.30	1.00	29	0.47	58
Kudamuthu paar	2	3.00	5.98	2,585	42.04	862
Poonthottam paar	1	1.00	1.99	101	1.64	101
Rajavukku Sippi Sothitha paar	1	1.30	2.99	345	5.61	230
Total	39	50.10	99.99	6,419	100.000	3,773

excepting extrapolation from local current and tide conditions. There is a general drift of water over pearl banks from south to north between April to September and north to south during October to April. Hence the pearl oyster larvae that were released over a particular paar need not necessarily settle on the same paar but can be carried away from the paar by the water current. The current velocity in the coastal waters of Tuticorin ranged from 0.047 knot/hour to 1.15 knots/hour. Therefore the larvae released over the paar may be carried to the distant paars and settle down as spat. If the sea bottom is conducive for their survival and growth, they may attach themselves to the substratum and grow. Otherwise they perish after settlement. Another assumption is that the sea ranched spat in the paar grow and attain sexual maturity within an year. These oysters act as 'breeding reserve' to resuscitate the population. The larvae resulted from the spawning of these oysters may also be carried away to distant paars and settle down as spat.

In order to study the effect of ranching on the revival of pearl oyster population, several sea trips were made to different pearl beds and collected data on the population density of oysters by direct underwater observations utilizing the facilities of SCUBA diving. On several occasions the ranched spat could not be traced at the sea bottom. Unless a scientific method is devised to locate the site, it would be impossible to make further observations on the survival and growth of ranched spat.

From 1975 onwards, the pearl oyster beds of Gulf of Mannar were inspected at regular intervals and oysters from the paars were collected for mother oyster culture and seeding operations. When the technology for mass production of pearl oyster spat in the hatchery laboratory was perfected, the collection of oysters from the natural beds for farming purposes came to a stand still in 1986. Thereafter from 1986 onwards the number of trips to the various oyster beds have been reduced. Between the years 1986 and 1993, only 39 sea trips were made and as a result many paars were not surveyed. However, some data on the pearl oyster population could be obtained from M/S TNFDC, Tamil Nadu through personal communication. Dense population of pearl oysters were recorded both in the southern as well as northern group of paars.

Discussion

C. S. G. Pillai : How can we say that the increase in the pearl oyster population is due to searanching ?

A. C. C. Victor : Eventhough locating the ranched oysters is a major problem, the considerable increase in number of oysters per diving over that prior to sea ranching is clear indication that the increased population is due to sea ranching.

S. Sivakami : Can pearl oyster seed be ranched into bays or other enclosed areas for enabling us to re-locate tham at a later stage ?

A. C. C. Victor : No, they can be ranched only on paars as they require hard substratum and other ecological conditions.

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RANCHING OF CLAMS IN THE ASHTAMUDI LAKE*

Introduction

It is well known that ranching of the hatchery-produced seed of commercially important finish and shellfish in the natural habitat or the other suitable areas would enhance their population. Certain aspects in the ecology and biology of the clams such as their restricted movements, feeding by filtering the naturally available plankton in the water and their occurrence in shallow coastal waters which renders monitoring easy, make the clams highly suitable for ranching.

Clam resources, exploitation and utilisation

Among the exploited bivalve resources, clam occupy top position with an annual production of about 50,000 t. Kerala ranks first accounting for 72% of clam landings. Several species of clams contribute to the fisheries, the notable being *Villorita cyprinoides*, *Meretrix meretrix*, *M. casta*, *Katelysia opima*, *Paphia malabarica* and *Anadara granosa*. They are fished all along the Indian coasts in numerous estuaries and bays. Men, women and children collect the clams usually during low tide either by hand-picking or with the help of a hand-operated scoop net or dredge. They are a cheap source of animal protein for coastal people and play an important role in the rural economy. The shell is used in several lime-based industries.

A beginning was made in the export of frozen clam meat to Japan in 1981 and since then the market has expanded and now the clam products are being exported to several countries like U. S. A., Australia, Kuwait, Belgium, France, Italy and U. K. In 1990 the exports amounted to 520.7 t valued at Rs. 1.01 crores. Among the clams, *P. malabarica* followed by *K. opima* are much sought after in the export trade. A recent addition to the exports is the individually quick frozen meat of *M. casta* and *V. cyprinoides*.

Development of hatchery technology

The Central Marine Fisheries Research Institute at its Tuticorin Research Centre has initiated work in 1987 to develop hatchery technology for the production of clam seed. A break through was achieved and hatchery technology has been developed for the production of the seed of *M. casta*, *A. granosa* and *P. malabarica*. The methods are being standardised by scaling-up the operations.

Selection of species for ranching

In view of its ready acceptance and the high value it fetches, *P. malabarica* holds a prime place in the overseas markets. The meat is sold at Rs. 20 to Rs. 30/ kg depending upon the size, at the production centres to the processing plants. This species contributes to the bulk of clam export earnings and a 20 hactare bed in the Ashtamudi area is contributing significantly to the export earnings. In view of its importance in the export market, *P. malabarica* has been chosen as a candidate species for ranching.

Ranching of *P. malabarica* at Ashtamudi and Munambam

P. malabarica was spawned at the Tuticorin hatchery in September 1992, and after nursery rearing in the Tuticorin Bay the seed were transported to Ashtamudi and Munambam near Cochin.

In Ashtamudi near Delavapuram, a total of 64,000 seed of *P. Malabarica* measuring 12.4 mm average length were ranched on 18.2.1993 in 25 m^2 area in 1 m depth and the site was fenced with 3.0 mm netlon screen. On 19.3.93 they measured 20.4 mm and by 3.5.93 they grew to 30.3 mm. In the same area a total of 30,000 seed of *P. malabarica* measuring 4.9 mm length were reared in cages as their size was small for planting in the field. By 3.5.93 they attained 12.2 mm and were ranched in the same area. These seed were covered with 1 cm mesh synthetic net to protect them from predators.

At Munambam, *P. malabarica* occurs rarely and with a view to study whether a population of this species can be established by introduction, a consignment of 8,500 seed were ranched in 10 m^2 area on 19.2.93 in 0.5 m depth. The clam seed measured 12.4 mm and they were covered

* This article is based on the work carried out by K. A. Narasimham, D. Sivalingam, T. S. Velayudhan, V. Kripa, K. Jayapalan and M. Enose. The article was prepared and presented by K. A. Narasimham.