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PEARL CULTURE

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P.B. No. 2704, Cochin 682 031, India

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PEARL OYSTER RESOURCES OF INDIA

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DISTRIBUTION

The pearl oysters belong to the genus *Pinctada* Roding under the family Pteriidae. They enjoy a world wide distribution occurring in almost all the seas of the tropical belt and also in the subtropical region. Six species of pearl oysters occur in the Indian waters viz., *Pinctada fucata* (Gould), *P. margaritifera* (Linnaeus), *P. chemnitzii* (Philippi), *P. sugillata* (Reeve), *P. anomioides* (Reeve) and *P. atropurpurea* (Dunker), of which *P. fucata* alone has contributed to the pearl fisheries in the Gulf of Mannar and Gulf of Kutch. *P. fucata* is distributed in the Red Sea, Persian Gulf and the Indian and Pacific Oceans. In the Indian waters, these oysters are found in large numbers on ' paars ' in the Gulf of Mannar which extend from Kilakarai to Kanyakumari. In Palk Bay the pearl oysters are found on coarse sandy bottom and in the Gulf of Kutch on intertidal reef known as ' khaddas '. In the south-west coast of India (Vizhinjam, Kerala), *P. fucata* spat are collected in large numbers on mussel culture ropes. The black-lip pearl oyster *P. margaritifera* is confined mostly to Andaman waters. From Lakshadweep, settlement of spat of *P. fucata* and *P. margaritifera* are found on the ridges of rocks and corals.

TOPOGRAPHY

The pearl oysters are always found attached by byssus to some hard substratum such as rocks, dead coral outcrops or sand grit covered with marine organisms. In the Gulf of Mannar, the areas of occurrence of pearl oysters are known as pearl banks or ' paars '. The Gulf has about 65 such pearl banks located between Kanyakumari and Rameswaram (Hornell, 1922). These banks lie at a distance of about 12 to 20 km away from the coast at depths of 15 to 25 m. Hornell (1922) divided these paars into three divisions viz., Northern or Kilakarai Division extending from Adam's bridge to Vaipar, the Central or Tuticorin Division extending from Vaipar to Manapad and the Southern or Kanyakumari Division extending from Manapad to Kanyakumari. Of these, the central division is the most productive one in view of the fact that out of the 40 fisheries that had taken place between 1663 and 1961, 39 fisheries had been in the paars located in this division. A notable feature of these fisheries is their irregular character, fishing sometimes being conducted after long intervals. This is due to the periodical decline of fishable quantities of pearl oyster population in the pearl banks for a number of years. The probable factors responsible for the decline of oyster population are failure of spatfall, pests like weaving mussels and boring worms, predation by gastropods, octopi, sharks, rays and sea breams, overgrowth of algae, changes in the oceanographic conditions, occasional silting and non-availability of sufficient number of breeding population (Hornell 1916, Mahadevan and Nayar, 1973). In the Gulf of Kutch, the pearl oyster reefs are scattered along the southern part of the Gulf of Kutch. There are about 42 known pearl oyster reefs covering an area of 24,000 ha located between Sachana on the east and Ajad on the west. These beds are located in the intertidal region and are exposed at receding tides (Pandya, 1974).

HISTORY

From time immemorial, the pearl oyster resources along the Indian coast have been exploited and the fishing rights passed on in succession from one ruling power to another. Hornell (1922) gives the history of the pearl fisheries of the Gulf of Mannar. During

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the 16th centuary, the history of pearl fisheries is intricately connected, on the one hand, with the 'ruling power' (the Nayaks of Madura, Nawab of Carnatic and the Portuguese with their battles for controlling the land and sea of that region) and on the other with the 'Paravas' who traditionally exploited the fisheries and the 'moors' who had an interest in pearl fishing largely for trade (Hornell, 1922). With the independence of the country in 1947, the rights over the pearl fishery are being fully exercised by the Government of Tamil Nadu. Similarly the pearl fishery of the Gulf of Kutch was under the control of the Jam Saheb of Nawanagar and the fishery was conducted under unique rules (Hornell, 1909). In 1926, a separate department called 'Moti Khata' was organised to manage the fisheries and finally, with the merger of the Nawanagar State with the Indian Union in 1948, the pearl fishing came under the control of the Government of Gujarat.

Pearl Fishery Series 1955-61

Chacko (1970) and Mahadevan and Nayar (1973) have given vivid accounts of the pearl fisheries of the series 1955-61. Oysters of the central sector including Tholayiram paar and the zone south to that which includes Kudamuthu paar, Karuwal paar, Poonthottam paar, Kuthadiar paar, Sayathonpathu paar and Rajavukku Chippi Sothitha paar were fully exploited during the fishery. From the account of the paars fished, number of oysters fished and the effort spent, it is evident that oysters ranging in length from 55-75 mm, in the age group 3-3½ years, formed the fishery. During the entire period of fishery, Tholayiram paar was fished in all the years of the series. A maximum number of 26,679 oysters per diving unit were collected in the year 1958.

Post-fishery Condition of the Pearl Banks

Baschieri-Salvadori (1960) during December 1958 to May 1959 had seen in the pearl banks of the northern sector (Pernandu, Nagara and northern and central parts of Tholayiram), 132 oysters per square meter. In the central sector (southern part of Tholayiram paar, Kuthadiar, Melonpathu, Vadaonpathu, Sayathonpathu, Pulipundu, Kudamuthu and north Karwal) the number per square meter was 74 while in the southern sector (Tiruchendur and Manapad) large quantities of both adult and young oysters were found. About the post-fishery condition of the pearl banks, Mahadevan and Nayar (1968) report that 'the pearl oysters were very few, almost absent, most of them having been fished and the remaining either perished or eaten away by predators.'

The oyster population in three paars (N. Tholayiram, Karai Keluthi and S. Tholayiram) was less than 1 oyster per square yard and the population in the northern paars (Devi, Cruxian, C. Thundu, Authurai arupagam and Vanthivu arupagam) was 'rare' while in the other 15 paars, no oyster was available during 1961-62 and 1962-63 (Sambandamurthy, 1966; Chacko and Sambandamurthy, 1969). The pearl banks off Rameswaram, Thondi and Kilakarai were not productive during 1965 (Rajendran and Chandrasekaran, 1969).

Survey of Pearl Oyster Beds during 1975-1986 in the Gulf of Mannar

Intensive survey of the pearl oyster beds of the Gulf of Mannar was taken up by the Central Marine Fisheries Research Institute from the season 1975-76 onwards. The facility of SCUBA diving was utilised for the survey. The central region, as referred by Hornell (1922) is divided into north and southern group of paars (Fig. 1). The northern group of paars are nearshore paars, lying within a depth of 7 fathoms. This group extends from Vaipar periya paar in the north to Pasi paar in the south. The southern group includes the Tholayiram paar in the north to the Karuwal paar in the south. The depth at which these pearl banks situated ranges from 8 to 10 fathoms.

The results of the survey of the northern group of paars is given in Table 1. From the table, it is seen that there are a lot of fluctuations in the pearl oyster settlement from year to year during the period 1975-1986. Only in one season (1981-82), the number of spat/oyster exceeded 35 per diving minute.

The pearl banks of the southern group of paars was not at all productive during the years 1975 to 1986 (Table 2). Only during the season 1979-80, more number of oysters (4.5 oyster) per diving minute were collected from this group of paars. During 1980-81, only one spat of the size 22.2 mm was collected out of 10 hours and 38 minutes of diving. During the season 1983-84, no oyster could be collected during 2 hours and 8 minutes of diving effort.

Rameswaram group of paars (Palk Bay) were surveyed during August 1974 and September 1978. The paars in this group included Narikuzhi, Kannika, Kondal, Nadu and Kothandaraman Koil piditha paar. The depth of the paars ranged from 2.5 to 6 fathoms. During August 1974, 245 oysters were collected. But

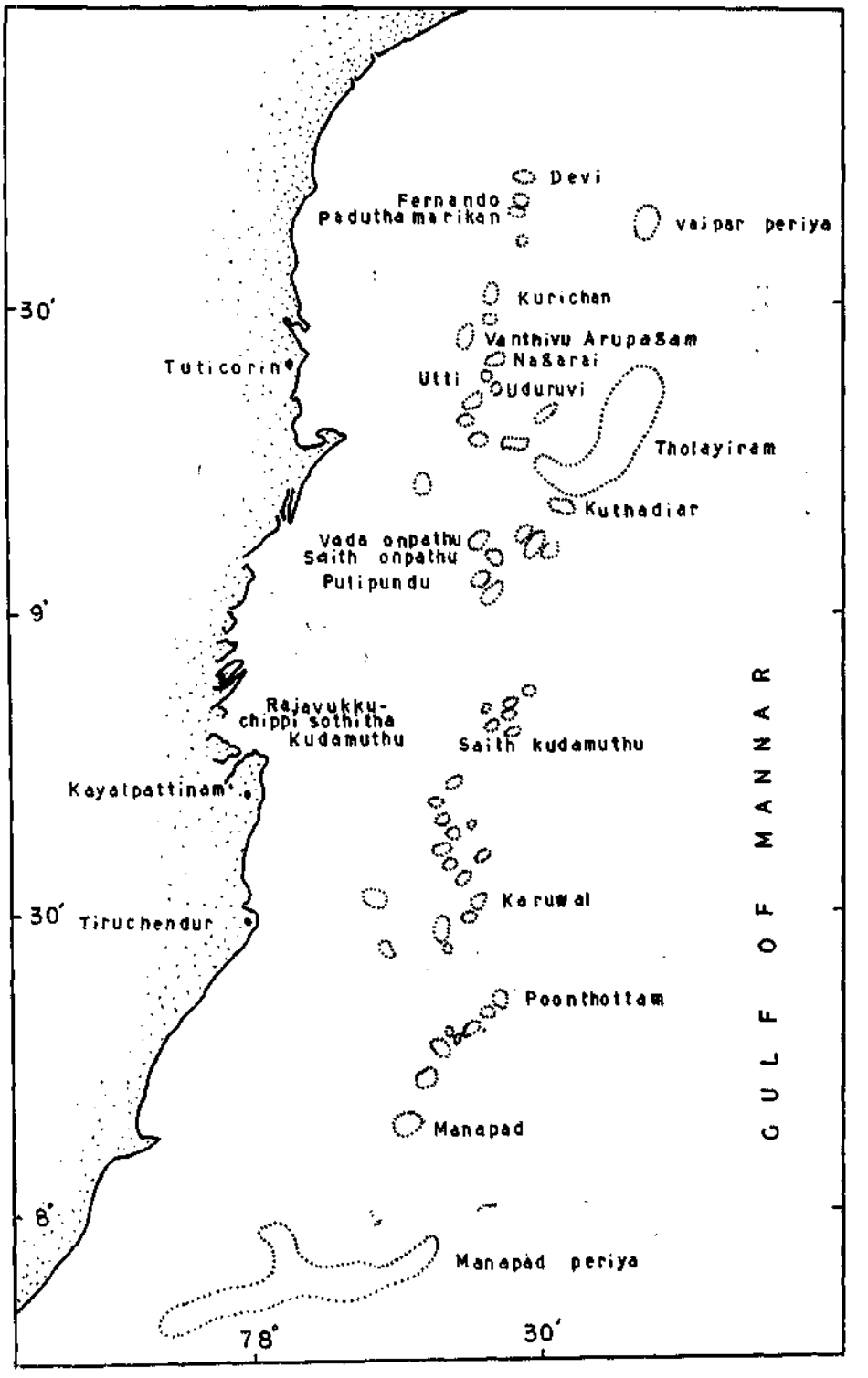

FIG. 1. Distribution of pearl oyster beds in the Gulf of Mannar.

TABLE 1. *Collection of pearl oysters from the northern group of paars from* 1975 *to* 1986

Year	Diving Hours hrs. min.	No. of oysters fished	Size range and (mean) (mm)	Paars surveyed
1975-76 ..	25.26	165	9.0 —43.8 (24.5)	Devi, Paduthamarikan, Fernando, Vanthivu Arupagam, Kurichan, Nagarai, Vaipar, periya, Karai, Utti and Uduruvi.
1976-77 ..	58.27	5748	11.0 —57.0 (33.9)	Devi, Paduthamarikan, Vanthivu Arupagam, Kurichan, Nagarai.
1977-78 ..	58.50	9720	6.2 —69.3 (24.7)	Devi, Kurichan.
1978-79 ..	98.16	33417	15.4 —69.6 (34.8)	Devi, Vaipar periya
1979-80 ..	29.44	9171	9.5 —58.0 (32.0)	Devi, Kurichan, Nagarai, Vaipar Periya
1980-81 ..	18.10	45	7.8 —31.1 (19.6)	Devi, Paduthamaraikan, Fernando, Vaipar Periya
1981-82 ..	46.25	99568	8.2 —50.5 (29.5)	Kurichan, Nagarai
1982-83 ..	44.36	36461	36.0 —62.0 (47.7)	Kurichan, Nagarai
1983-84 ..	13.43	260	7.5 —37.3 (22.1)	Devi, Fernando, Kurichan, Nagarai, Paduthamaraikan
1984-85 ..	39.40	10890	9.0 —47.5 (30.5)	Devi, Fernando, Kurichan, Nagarai, Vanthivu Arupagam
1985-86 ..	8.25	190	18.5 —42.6 (29.0)	Vanthivu Arupagam, Fernando, Kurichan

TABLE 2. *Collection of pearl osyters from the southern group of paars from* 1975 *to* 1980

Year	Diving Hrs.	Hours Min.	No. of oysters fished	Size range and and (mean) (mm)	Paars surveyed
1975-76 ..	60	50	820	5.5 —46.4 (24.1)	Tholayiram, Kudamuthu, Kuthadiar, Pulipundu, Poonthottam, Karuwal, Sayathu Kudamuthu, Karai Kudamuthu, Outer Kudamuthu, Sayathu onpathu, Vada onpathu.
1976-77 ..	29	15	2240	13.1 —58.0 (37.1)	Tholayiram, Kudamuthu, Kuthadiar, Pulipundu, Poonthottam, Karuwal, Sayathu Kudamuthu.
1977-78 ..	4	37	428	12.4 —67.0 (29.8)	Tholayiram, Kudamuthu.
1978-79 ..	22	12	233	15.2 —61.3 (37.4)	Tholayiram
1979-80 ..	8	58	2302	16.2 —57.5 (39.9)	Tholayiram, Kudamuthu, Pulipundu, Poonthottam, Karuwal.

in September 1978, only 12 pearl oysters with length ranging from 43-56.5 mm were collected in 4 diving hours.

Density of Population

To have a picture of the density of pearl oysters available at the different paars, the oysters collected were combined paar-wise for the entire period of observation. The diving hours here indicated the total time spent underwater in collecting the oysters. Table 3 and Fig. 2 give the picture of the paar-wise collection of pearl oysters during the years 1975-1986. In all, a total of 289 sea trips were made to the pearl oyster beds and 2,39,025 oysters collected. Nagarai paar was the most productive one yielding 52.73% of the total collection. Vaipar Periya paar and Kurichan paar accounted for 6.02% and 5.37% respectively. It can be seen from Table 3 that, of the 595 diving hours spent on surveying the pearl oyster beds of the northern and southern groups, 36.98% of the effort was spent on Devi paar. The number of oyster per diving hour on different paars is given in Table 3.

Table 4 gives the diving effort and the number of oysters collected season-wise for the period 1975 to 1986. 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.

Species Composition

Another important observation on the resource is the incursion of multispecies *Pinctada* populations especially in the inshore waters, which was not known before. They comprised of *P. atropurpurea*, *P. anomioides*, *P. sugillata* and other *Pinctada* species. Species other than *P. fucata* and *P. margaritifera* are referred to here as 'flat' oysters as in all these species the bulge of the valves is not as prominent as in *P. fucata*. They were most abundant in the shoreward paars, such as Paduthamarikan, Karai, Devi and Fernando than in the offshore paars such as Tholayiram, Karuwal, Utti and Uduruvi paar in certain years (Fig. 2). The flat oysters on the pearl banks constituted 20.8% of the total collection in 1975, 68.25% in 1976, 17.63% in 1977, 6.32% in 1978 and 6.99% in 1979. In the year 1980, a sudden increase to 50% was noticed and thereafter the flat oysters were not present in 1981 and 1982. They reappeared with 14.4% in 1984 and 23.69% in 1985 (Table 4). These species of flat pearl oysters at present do not carry any significance in pearl culture. Their declining trend which was noticed in 1977 and 1981 to 1985 and that of the 100% *P. fucata* component obtained in the years 1981 and 1982 would indicate that the incursion of multispecies *Pinctada* population was a temporary phenomenon. The economics of a pearl fishery, in future, would be badly affected if the flat pearl oysters were to occur in any significant proposition.

Size Distribution

For the study of size frequency distribution, only *P. fucata* was taken into account. In Table 1, the size range of oysters collected from the northern group of paars for the entire period is given. It is seen from the table that the average size ranged from 19.6 to 47.7 mm. The minimum size of the spat available in the collection indicated the fresh settlement during the season itself. The maximum size observed was 69.6 mm. The percentage of the size group 50.0-69.9 mm, among the oysters collected, never exceeded 6 per cent (Table 5) during the period. The same trend was observed in the southern group of paars for the period 1975-1980 (Table 2). The average size of oyster ranged from 24.1 to 39.9 mm. The minimum and maximum size of the spat/oyster collected during 1975 to 1980 was 5.5 and 67.0 mm. In Fig. 3, *P. fucata* collected from different paars during the period 1975 to 1986 is combined to give size-wise distribution and percentage frequency.

To find out the recruitment and growth of oysters on the pearl oyster beds, the pearl oysters collected from Devi paar for the two successive seasons (1976-77 and 1977-78) were studied (Table 5). In the beginning of the season, 1977-78 (November), the size group 10-20 mm and 20-30 mm were the dominant ones. This had moved to size group 30-40 mm in the month of March (1978) few individual moving to the groups 40-50 mm. In the next season (1978-79), the size groups 20-30 mm and 30-40 mm were the dominant ones. But at the end of 4 months, viz., April, 1979, this had moved to next group (40-50 mm) with a few numbers moving further to the 50-60 mm group. In order to find out whether different pearl banks of the southern and northern group of paars get the spatfall simultaneously or at different times, Devi and Kurichan from the northern group and the Tholayiram from the southern group were selected and the oysters were studied for the period 1975 to 1981, season-wise (Table 6). The mean length and mean weight were taken as the parameters. It may be seen from the table that the spatfall was simultaneous on all the pearl banks for the period of observation.

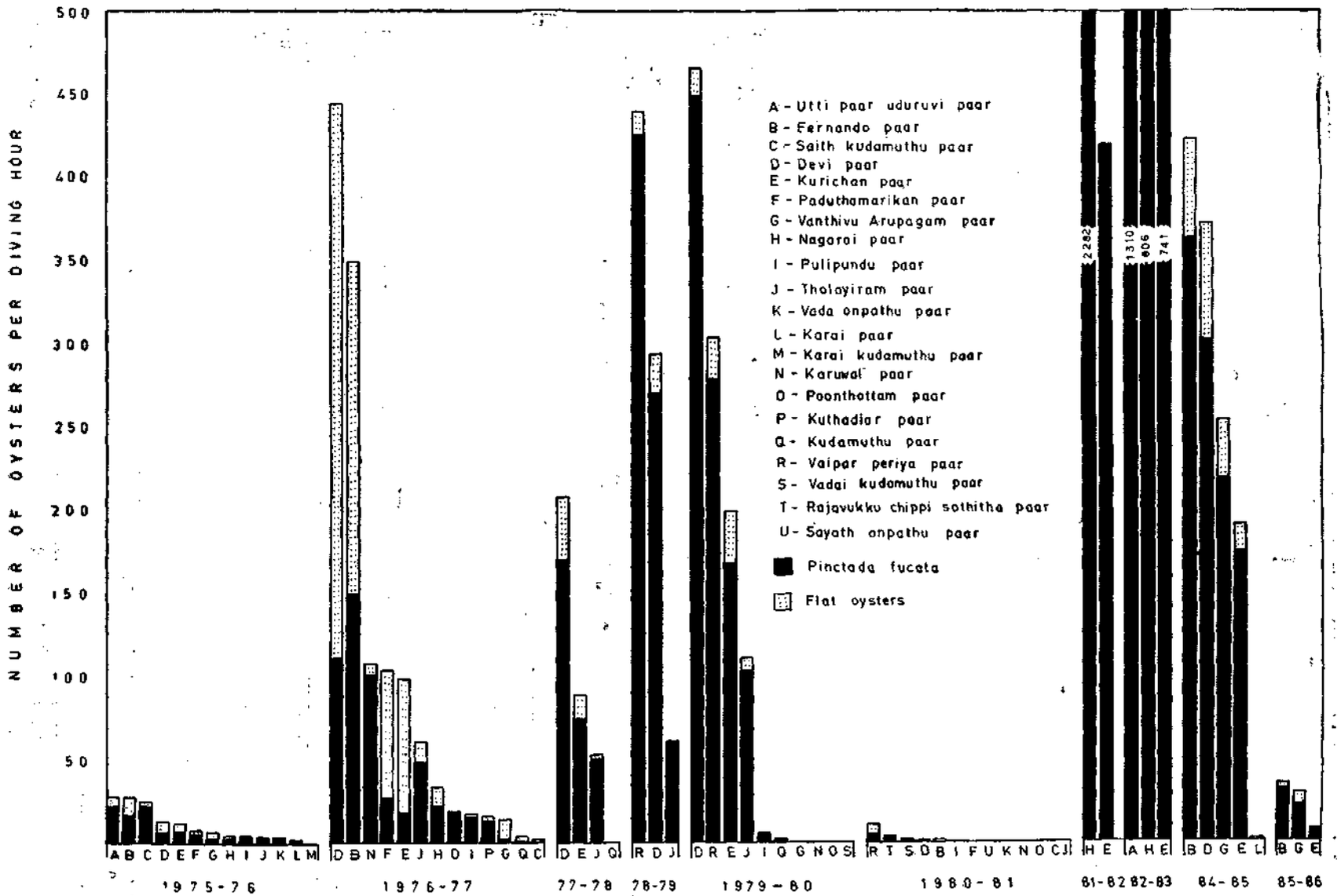

FIG. 2. Collection of pearl oysters from the pearl bnaks of Gulf of Mannar during 1975 to 1986.

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	*P. fucata* %	Flat oysters %
Northern paars :							
Devi paar ..	101	220.00	36.97	66181	27.69	67.18	32.82
Nagarai paar ..	39	80.13	13.47	126038	52.73	99.99	0.01
Vaipar periya paar ..	15	41.78	7.02	14394	6.02	96.00	3.90
Kurichan paar ..	20	40.30	6.77	12824	5.37	93.36	6.64
Fernando paar ..	13	27.00	4.54	8328	3.48	78.13	21.87
Van Thivu Arupagam paar ..	10	13.60	2.29	1328	0.56	88.63	11.37
Paduthamarikan paar ..	4	7.63	1.28	501	0.21	26.55	73.45
Karai paar ..	4	7.22	12.1	36	0.02	47.22	52.78
Utti paar and Uduruvi paar ..	2	4.00	0.67	2676	1.12	99.51	0.49
Southern paars :							
Tholayiram paar ..	40	73.35	12.33	4428	1.85	90.49	9.51
Saith Kudumuthu paar ..	12	38.63	6.49	876	0.37	86.99	13.01
Karuwal paar ..	7	15.72	2.64	1300	0.54	93.38	6.62
Poonthottam paar ..	4	5.42	0.91	25	0.01	96.00	4.00
Pulipundu paar ..	7	4.35	0.73	33	0.01	90.90	9.10
Kudamuthu paar ..	3	3.97	0.67	12	0.005	33.33	66.67
Vada onpathu paar ..	2	3.42	0.57	8	0.003	87.50	12.50
Sayath onpathu paar ..	1	2.33	0.39	—	—	—	—
Koothadiar paar ..	1	2.00	0.34	33	0.013	78.79	21.21
Vada Kudamuthu paar ..	2	1.97	0.33	3	0.001	100.00	—
Karai Kudamuthu paar ..	1	1.92	0.32	—	—	—	—
Rajavukku Chippi Sothitha paar ..	1	0.25	0.04	1	0.0004	100.00	—
	289	595.00	99.98	239025	100.00		

TABLE 4. *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 oysters collected	%	*P. fucata*		*Flat oysters*		No. of oysters per diving hour
					Nos.	%	Nos.	%	
1975-76 ..	32	81.00	1244	0.52	985	79.18	259	20.82	15
1976-77 ..	50	120.03	27208	11.38	8638	31.75	18570	68.25	267
1977-78 ..	43	67.22	12322	5.16	10150	82.37	2169	17.63	183
1978-79 ..	38	110.23	35919	15.03	33650	93.68	2269	6.32	326
1979-80 ..	31	56.52	12335	5.16	11473	93.01	862	6.99	217
1980-81 ..	25	35.09	101	0.04	50	49.50	51	50.50	3
1981-82 ..	21	46.25	99569	41.66	99568	100.00	1	—	2164
1982-83 ..	23	44.36	36457	15.25	36457	100.00	—	—	829
1984-85 ..	18	42.45	13621	5.70	11657	85.58	1964	14.42	319
1985-86 ..	8	8.25	249	0.10	190	76.31	59	23.69	30
Total ..	289	595.00	239025	100.00	212828	89.04	26204	10.36	402

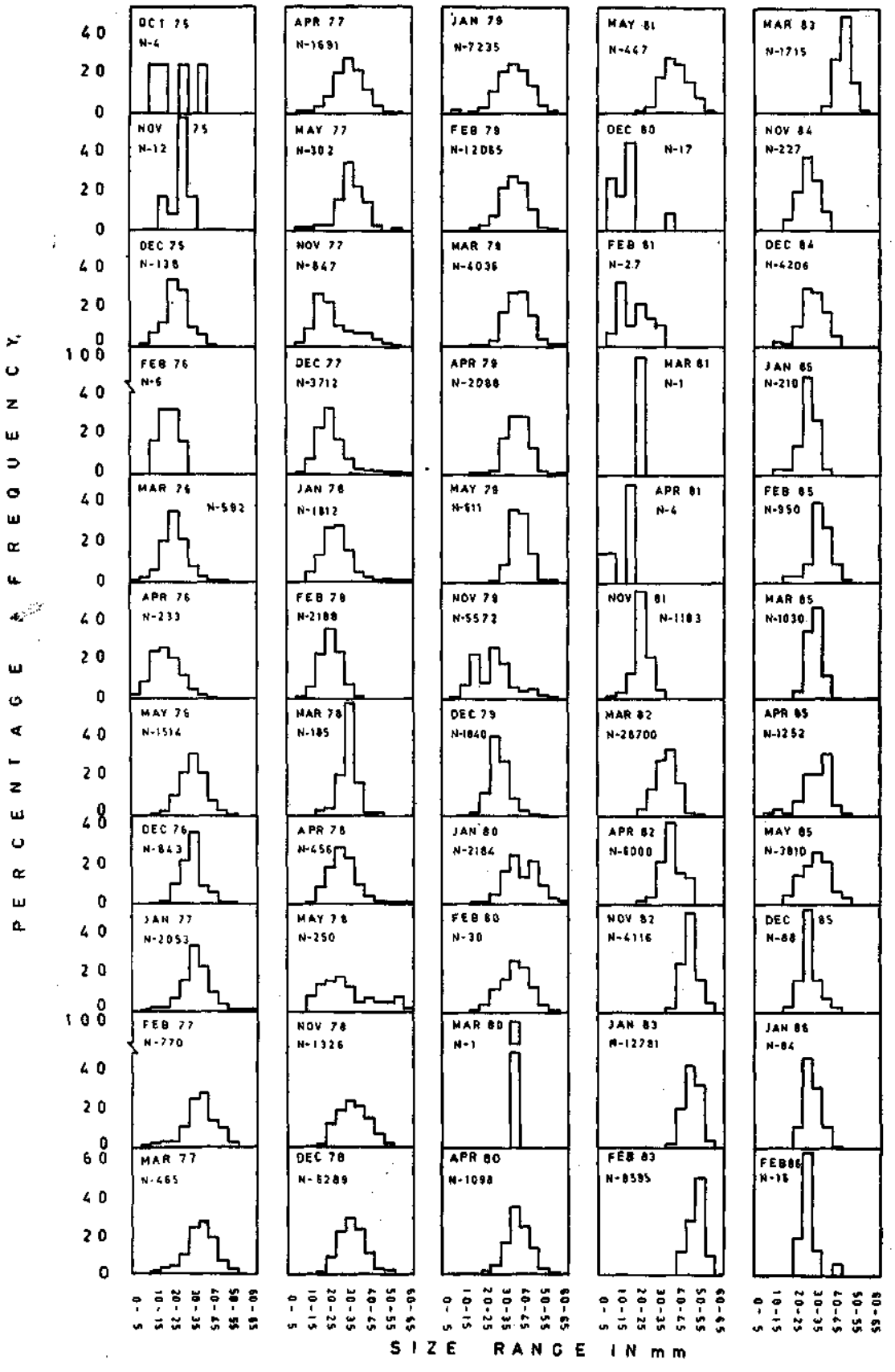

FIG. 3. Number and percentage frequencies of different size groups of *Pinctada fucata*, from the pearl oyster beds of the Gulf of Mannar.

TABLE 5. *Length/weight distribution of pearl oysters of Devi paar during two seasons, November 1977 to April 1978 and November 1979 to April 1979*

Period	% of oysters in size groups								% of oysters in weight groups							
	0-9.9 (mm)	10-19.9 (mm)	20-29.9 (mm)	30-39.9 (mm)	40-49.9 (mm)	50-59.9 (mm)	60-69.9 (mm)	Mean (mm)	0-5.9 (g)	6-11.9 (g)	12-17.9 (g)	18-23.9 (g)	24-29.9 (g)	30-35.9 (g)	36-41.9 (g)	Mean (g)
Nov '77 ..	1.6	36.0	33.3	15.6	10.8	2.6	—	25.48	67.47	19.48	7.14	2.85	1.43	1.18	0.25	5.66
Dec ..	1.4	32.9	52.0	10.2	2.6	0.7	0.2	23.14	91.58	4.80	2.15	0.90	0.38	0.07	0.12	3.10
Jan '78 ..	—	18.2	56.6	20.8	3.3	1.0	0.1	25.29	86.77	9.27	2.09	1.32	0.11	0.33	0.11	3.96
Feb ..	0.8	29.6	60.5	8.4	0.6	0.1	—	27.80	84.24	14.50	0.72	0.36	0.18	—	—	4.56
Mar ..	—	2.9	25.5	68.6	3.0	—	—	31.37	47.06	50.98	1.96	—	—	—	—	6.48
Apr ..	—	7.1	50.5	37.4	4.3	0.7	—	28.67	78.46	17.97	2.06	0.94	0.19	0.19	0.19	4.87
Nov '78 ..	—	1.2	30.6	44.4	22.2	1.6	—	33.95	50.07	32.38	13.80	3.00	0.45	0.30	—	7.50
Dec ..	—	1.4	31.3	52.9	13.6	0.8	—	33.30	53.75	36.02	8.35	1.44	0.29	0.13	0.06	6.92
Jan '79 ..	—	3.4	31.2	41.7	23.7	—	—	36.70	25.31	38.69	23.11	11.19	1.46	0.24	—	10.92
Feb ..	—	1.2	7.9	46.9	40.4	3.6	—	38.98	16.44	45.20	25.32	8.22	0.82	—	—	11.11
Mar ..	—	—	4.8	53.5	36.0	5.3	0.4	39.42	6.46	53.24	25.52	9.50	1.14	0.76	0.38	12.35
Apr ..	—	—	1.4	50.0	45.7	2.5	0.4	36.32	6.47	44.25	37.38	8.99	2.16	0.75	—	13.00

TABLE 6. *Length/weight distribution of pearl oyster at three different paars during the seasons 1975 to 1981*

Year	Devi paar			Tholayiram paar			Kurichan paar		
	No. of oysters	Mean length (mm)	Mean weight (g)	No. of oysters	Mean length (mm)	Mean weight (g)	No. of oysters	Mean length (mm)	Mean weight (g)
Oct 1975—Apr 1976 ..	53	23.58	2.57	51	23.38	3.15	14	24.64	3.14
Oct 1976—Apr 1977 ..	3174	32.89	10.50	482	37.14	8.80	6	37.65	11.75
Oct 1977—Apr 1978 ..	4871	25.59	4.07	214	29.86	8.10	—	—	—
Oct 1978—Apr 1979 ..	5108	35.36	8.23	97	37.42	9.01	—		—
Oct 1979—Apr 1980 ..	756	32.65	5.96	754	39.02	12.69	151	37.25	10.65
Oct 1980—Apr 1981 ..	3	21.00	2.00	1	22.20	5.30	—	—	—

EXPERIMENTAL DREDGING

Collection of oysters by diving in the natural pearl oyster beds depends on clarity of water. On certain months, when collection of oysters from the natural beds became impossible, it was resorted to use a light dredge. Accordingly, an experimental light dredge was fabricated in the year 1978 and operated on a few paars in the Gulf of Mannar and Palk Bay. In all, a total of 14 oysters were collected with the dredge on 2 trials. In 1956, the first dredge was employed in Sri Lanka for harvesting oysters. The dredge had the capacity to scrap up as many as 45,00,000 oysters a day. The dredge inflicted massive disaster on the pearl oyster beds, brought up seed oysters as well as mature oysters and had a detrimental effect on future prospects of pearl fisheries (Sivalingam, 1958).

COASTAL AREAS

At Vizhinjam Bay, an experimental pearl oyster farm was established in 1976 through the several thousand pearl oyster spat collected from the Bay. The spat were collected by suspending various types of spat collectors at the column water, 2 m below the surface. At the Tuticorin Harbour basin, the inner sides of the breakwater wall offer suitable site for the settlement and growth of pearl oysters. The breakwater has a greater slope and is filled with quarry rubbish leaving numerous crevices in which oysters are found settled. On the outer sides of the breakwaters there was very poor spat settlement as they are directly exposed to the breakers. A survey of breakwater was organised in November-December 1974 and a total of 2393 oysters were collected. In the first year of observation *P. fucata* formed about 15% of the samples. In the subsequent years 1975 and 1976 *P. fucata* component showed a decline to 8.7% and 3.3% respectively. In 1977 there was considerable reduction in the density of population as well as *P. fucata* component (0.5%). The reason attributed to the decline in oyster settlement may be due to the spreading of corals on the breakwaters (Alagarswami, 1977).

ANDAMAN AND NICOBAR ISLANDS

The survey of the Andaman and Nicobar Islands conducted by C.M.F.R.I. in 1978 provided some important information on the pearl oyster resource and pearl culture potential of the region (Alagarswami, 1983). The marine ecosystem of the Islands with numerous creeks and protected bays offer some of the best sites for pearl culture operations. The main species of pearl oyster which occurs at several regions is the black lip pearl oyster *Pinctada margaritifera.* The other there species available in the region are *P. fucata P. sugillata* and *P. anomioides. P. margaritifera* generally occurs in the intertidal reef flat to depths of 10 m. The reef flat is coralline interspersed with hard sandy bottom. The oysters are found attached to live on dead corals. Their population density is low on the intertidal reef flats. Moreover the survey report indicates the presence of suitable ecosystem for the culture of black lip oysters.

LAKSHADWEEP

In Lakshadweep a sizable population of pearl oysters belonging to the species *P. fucata* and *P. margaritifera* were raised by suspending plain nylon rope and other

spat collectors in the column waters of the lagoon (personal communication from C. G. Koya, Department of Fisheries, Lakshadweep). The lagoon is calm and water is clear during most part of the year. The bottom of the lagoon is mostly hard, rocky or coral stone or sand grit covered with marine plants. The lagoons of the Lakshadweep Island appear to be good for attempting pearl culture.

General Remarks

The information so far available indicate the fluctuating nature of the pearl oyster populations in the pearl banks of the Gulf of Mannar. Many reasons have been put forward as the causes of fluctuation. Herdman (1903) attributed the bottom currents caused by southwest monsoon to be responsible for the 'successive broods of young oysters to appear and as regularly to disappear'. Shifting of sand causes widespread mortality to oysters both young and old besides the natural enemies (Herdman, 1906). Predation by some fishes (Hornell, 1916), moray eels (Baschieri—Salvadori, 1960), settlement of *Modiolus* sp. covering the spat (Mahadevan and Nayar, 1973) and predation by gastropods (Chellam *et al.*, 1983) are some of the factors found responsible for the mortality of pearl oysters in the natural beds.

Replenishment of the beds of the Gulf of Mannar on the Indian and Sri Lankan coasts was considered possible by reciprocal supply of spat (Hornell, 1916). Hornell also discussed the possibility of rehabilitation of the deep water pearl banks from the scattered oysters of the shallow water around the reefs and islands at the head of the Gulf . But Devanesan and Chidambaram (1956) are of the opinion that the pearl banks get repopulated through self effort only. Alagarswami (1977) opined that the replenishment may be due to larval drift.

As a measure of conservation, transplantation of 'young strikes' or brood of oysters to paars which afford better condition (Hornell, 1916), maintaining a 'breeding reserve' in the Tholayiram paar (Devanesen and Chidambaram, 1956) and development of hollows in the pearl beds by filling with rocks to provide better anchorage (Baschieri-Salvadori, 1960) have been suggested.

The intensive survey made by the Central Marine Fisheries Research Institute on the pearl banks of the Gulf of Mannar from 1975 to 1986 indicates the continuation of the same trend as has been existing in the pearl banks since the post-fishery season (1961) to 1974. However, good settlement of spat was seen on some of the pearl banks of the northern group of paars during some seasons. But the same population did not continuously exist in the next year as evidenced from Table 5. Mahadevan and Nayar (1973) are of the opinion that the shoreward group of paars (Karuwal and Kudamuthu group) have been useful in sustaining oysters of fishable size. The observations made for a period of 11 years rule out the possibility of oysters of fishable size (50 mm and above) in the northern group of paars. This was indicated by Hornell (1916) and Mahadevan and Nayar (1973). No pearl fishery has been conducted in the northern group of paars so far. As far as the deep water southern group of paars were concerned, the settlement of spat was very poor during the period. The comparison of pearl oyster settlement on the northern and southern group of paars indicated that the spatfall was simultaneous. Alagarswami and Chellam (1977) based on the study of shell characters, felt that the population of the three paars, Tholayiram, Pulipundu and outer Kudamuthu had a tendency of heterogeneity among the populations.

The pearl oysters grown at Krusadai farm (Gulf of Mannar) attained the length of 45 mm, 55 mm, 60 mm and 70 mm at the end of first through fifth year (Devanesan and Chidambaram, 1956). Chacko (1970) also saw a similar age and growth situation on the oyster population in the pearl banks of Tuticorin based on his observations made during 1954-57. It was also seen that the spat of upto six months old attained a length upto 36 mm. The oysters produced in the hatchery and grown in the protected farm at the Tuticorin Harbour (Gulf of Mannar) had grown to 47 mm at the end of first year, 64.5 mm at the end of second year and 75.0 mm at the end of third year (Chellam, MS). The oysters of the Gulf of Kutch also had shown similar growth rate (Narayanan and Michael, 1968). Based on the above works, it can be confirmed that the pearl oysters upto two years old were available on the pearl banks of the Gulf of Mannar during the period 1975 to 1986. But the percentage of two year old oysters was very less. The bulk of the oysters belonged to '0' age group (Table 1 and 2). Baschieri-Salvadori (1960) has seen in the central sector (including Tholayiram paar) more oysters to reach the full maturity of third or fourth years and in the northern paars (Vaipar paar in the north and Tholayiram in the south) the pearl oysters rarely reach full maturity. Alagarswami and Qasim (1973), based on the collection of pearl oysters from November 1972 to June 1973 on Pulipundu; Outer Kudamuthu and Tholayiram paars felt that the populations on the Pulipundu and Outer

Kudamuthu were denser than the Tholayiram paar. Oysters of the size group 45-65 mm were dominant during this period.

On considering the resources of pearl oysters of the Gulf of Mannar for the period 1975 to 1986, it can be seen that there were spatfall but of fluctuating nature. Unless there is a series of good spatfall, the possibility of revival of pearl fisheries is remote at least for some years to come. The good spatfall in the northern group of paars during some seasons might be due to the farming of oysters in the inshore waters.

Added to the physical and biological factors affecting the survival of pearl oysters in the pearl banks, the recent industrialization along the coasts of Tuticorin, the operation of more number of trawlers and the increased movement of ships in the vicinity of the pearl banks may also affect the ecological conditions of the pearl banks.

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