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15. STATUS OF THE PEARL OYSTER POPULATION IN THE GULF OF MANNAR

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INTRODUCTION

The five volumes of Herdman (1903-1906) on the "Report to the Government of Ceylon on the pearl oyster fisheries of the Gulf of Mannar" and the treatise of Hornell (1922) on "The Indian pearl fisheries of the Gulf of Mannar and Palk Bay" are the works of scientists who had mastery over the subject of pearl fisheries of the Gulf of Mannar on both the Indian and Sri Lankan sides. Subsequent to 1922 the only major contributions, aside the routine survey, have been the use of dredge for fishing of pearl oysters on the Sri Lankan side (Sivalingam 1958) and the survey and charting of "Pearl and chank beds of Gulf of Mannar" on the Indian side by Baschiere-Salvadori and his Indian associates introducing SCUBA-diving for the first time as reported in First through Third Report to the Government of India (FAO 1960, 1962 a, b, Mahadevan and Nayar 1967).

The fragmentary information on the pearl fisheries of Gulf of Mannar as gleaned through the travelogues of Marco Polo and Ibn Batuta, the glory as sung by the Tamil poets of Sangam Age, the scanty records maintained since 1663 by the European rulers and works of Herdman (1903-1906) and Hornell (1922), and all that scientific investigations that followed indicate without any doubt that the pearl oyster resource of the Gulf of Manner is the most fluctuating one among the molluscan resources of the World. The causes for these fluctuations have been listed severally in the above-cited works, all of plausible explanations. However, how these have accountably worked, singly or in combination, in any one situation of depletion has not been investigated thoroughly. Perhaps the fact that the Gulf of Mannar pearl oyster resources are on beds down to about 20 m depth and as far away as about 10 n. miles from the shore and that no direct observation are practically possible during June through September when major physico-chemical and biological population changes take place on account of monsoon conditions have been the real problems in not understanding the phenomenon of fluctuations.

jhig paper gives an account of the pearl oyster resource position during the period 1975.36. It indicates the need for further specific scientific investigations to understand the dynamics that work in favour of or against ^^e building up of fishable stocks on the pgg^i banks

PEARL FISHERIES

Production of pearl oysters m the natural beds of the Gulf of Mannar had been an irregular feature. Even forty years of barrenness ^^^ observed in some periods. Records show that there were 18 pearl fisheries since the *1*^^' ^^OO- The recent series of pearl fishery ^as conducted from 1955-61. The pearl oyster beds situated in between Vaipar in the north a"d Manapad in the south had been the most productive ones where most of the pearl fisheries had been conducted in the past, During the last series of pearl fishery, pearl banks of this region had been fished (Table 1). It is evident that the Tholayiram paar "where more oysters reach the full maturity of three or four years needed for the reasonable production of pearls" had been the main source of oysters for the entire period of the fishery. Next in importance was the Kudamuthu faar followed by Karuwal paar. The number p oysters per diving unit ranged from 1603 in 1957 to 26^79 in 1958 (Table 1).

TABLE 1. *Pearl fishBrias of Gulf of Mnnar (f955-61 Series) After Sivalmgam {W61) and l\Aaftadevan ar\d Nayar (1973)*

Year	No. of dives	No. of oysters fished	Oysters/ Unit of effort	Size of oysters (mm)	Estimated age	Paars fished
1955	759	35,08,967	4,623	..	3^	Tholayiram, Sa/athonpathu
1956	457	21,29,058	4,659	55	3	Tholayiram
1957	733	11,75,214	1,603	55-65		Tholayiram, Kodamuthu, Karuwal, Pudu, Rajavukku Chippi Sothicha
1958	805	2,14,76,514	26,679	60-75		Thoiayiratn, Kodamuthu, Karuwal, Poonthottam, Rajavukku chippi Sothicha
1959	1896	1,64,28,298	8,665			Tholayiram, Kodamuthu, Karuwal, Poonthottam, Rajavukku chippi Sothicha
1960	1821	1,58,29,263	8,093			Tholayiram, Karai Kodamuthu, Kodamuthu
1961	1350	1,53,96,928	11,405			Tholayiram, Kodamuthu

POST FISHERY CONDITION OF PEARL BANKS

In the northern sector of the pearl banks including Fernando, Nagarai, northern and central part of Tholayiram, Salvadori (1960) has found the settlement of oysters to be 132/sq. m during December 1958 to may 1959- The settlement was 74 in the central sector which includes the paars such as southern part of Tholayiram, Kuthadiar, Melonpathu, Vadaonpathu, Sayathonpathu, Pulipundu, Kudamuthu and north Karuwal and, in the southern sector, which includes Tiruchendur and Manapad group of paars, large quantities of both adult and young oyster settlement were observed.

Mahadevan and Nayar (1973) reported that, subsequent to the pearl fishery of 1955-1961, the pearl banks were having very few oysters, most of them having been fished, remaining perished or eaten away by predators. During the year 1961-62, Tholayiram, Karai Keluthi and south Tholayiram paar had one oyster per square yard (Sambandamurthy 1966) and the pearl oyster population was "rare" in the northern paars including Devi, Cruxian, C thundu, Authurai Arupagam and Vanthivu Arupagam. No oyster was available in the 15 pearl banks inspected during 1962-63 (Chacko and Sambandamurthy 1969). The pearl banks off Rameswaram, Thondi and Kilakarai were not productive during 1'965 (Rajendran and Chandrasekharan 1969.)

STATUS OF PEARL OYSTER POPULATION IN THE RECENT DECADE

Survey of the pearl oyster beds of the Gulf of Mannar during 1975-1985 by the Central Marine Fisheries Research institute further confirmed the fluctuations in the population of pearl oysters from year to year and oaar to paar. The beds surveyed extended from Vaipar periya paar in the north to the Karuwal paar in the south. This Central division has been the most productive in the past and 39 out of 40 fisheries that had taken place between 1663 and 196i, had been in the paars located in this division. For the sake of convenience, the paars of this division are divided into (i) the northern group (near shore, depth less than 7 fathoms) and (ii) southern group (depth 8-10 fathoms).

Thepeari banks included in the northern group are Vaipar periya paar, Devi paar Fernando paar, Nagarai paar, Utti paar Uduruvi paar, Paduthamarikan paar, Cruxian parr, Vanthivu arupagam paar and Karai paar. The year-wise collection of pearl oysters from this group is given in Table 2. The maximum number of oysters coHected from this group was during 1981-82 at the rate of 35.7 oysters per diving minute. The minimum was during 1980-81 with a total of only 45 oysters for 1090 diving minutes.

TABLE 2 *Oyster collection from Nortfiern group of pears (1975-1985)*

Season	Diving effort (mt«)	No of Oyster *P. fucata*	Average Size (mm)	Paars surveyed
1975-76	1526	165	24.5	Devi, Paduthamarikan, Fernando, Vanthivu arupagam, Kurichan, Nagarai, Vaipar Periya, Karai. Otti and Uduruvi.
1976-77	3507	5748	33.9	Devi, Paduthamarikan, Vanthivu arupagam, Kurichan, Naflarai
1977-78	3530	9720	247	Devi, Kurichan
1978-79	5896	33417	34.8	Devi, Vaipar Periya
1979-80	1784	9171	32.0	Devi, Kurichan, Nagarai, Vaipar Periya
1980-81	1090	45	196	Devi, Paduthamarikan, Fernando, Vaipar Periya
1981-82	2785	99568	29.5	Kurichan, Nagarai
1982-83	2676	36461	47.7	Kurichan, Nagarai
1983-84	823	260	22 0	Devi, Fernando, Kurichan, Nagarai, Paduthamarikan
1984-85	2380	10890	30.5	Devi, Fernando, Kurichahv Nagarai, Vanthivu arupagam

TABLE 3. *Collection of Oysters from Southern Group of pBars (1975-1980/*

Season	Diving effort (minutes)	No. of Oysters *P. fucata*	Average size (mm)	f^aars surveyed
1975-76	3650	820	24.0	Tholayiram, Kodamuthu, Koothadiar, Poonthottaiti, Karuwal, Sayathu Kudamuthu, Karai Kudamuthu, Outer Kudamuthu, Sayathonpathu, Vadaonpathit
1976-77	1755	2240	37.0	Tholayiram, Kudamuthu, Koothadiar, Pulipoondu, Poonthottam, Karuwal, Sayathu Kudartluthu
1977-78	277	428	29 8	Tholayiram, Kudamuthu
1978-79	1332	233	37.4	Tholayiram
1979-80	538	2302	40.0	Tholayiram, Kudamuthu, Pulipoondu, Poohthottam, Kafuwal

The southern group surveyed included ThoJayiram, Kuthadiar, Pulipundu, Poonthottam, Karuwal, Kudamuthu, Sayathu Kudamuthu, Karai Kudamuthu, Outer Kudamuthu, Sayathon-pathu, Vadaonpathu and Melonpathu. A maximum number of 4.3 oyster per diving minute was collected during the season of 1979-80 from this group of paars. Except during 1976-77 and 1977-78 when the collect-ion exceeded 1 oyster par diving minute, it was far less in the other years (Table 3).

AGE AND SIZE OF OYSTERS

In the northern group of paar, the mean length of oysteis collected during 1975-1985 ranged from 19.6 mm in 1980-81 to 47.7 mm in 1982-83 (Table 2). Only during 1976-77 to 1979-80 and 1982-83, the maximum size of oysters exceeded 50 mm. But their contribution to the collection was less than 5.5%. In the southern group of paars, tha mean length of oysters ranged from 24.0 to 40.0 mm (Table 3). Even though oysters of 50 mm and above were collected during 1976 to 1980, the percentage of occurrence of the large oysters was less.

CAUSES OF FLUCTUATION OF OYSTERS OF THE NATURAL BEDS

Several factors have been suggested by various workers as the causes for the destruction of pearl oysters in the natural beds. Shifting of sand by the bottom currents caused by south-west monsoon, ravages of natural enemies, the most destructive of which were fishes such as *Batistes* sp, *Lethrinus* sp, *Serranus* sp, *Tetradon, Rhinoptera javanica* and *Ginglymostoma,* smo-thering and boring molluscs, boring sponge, boring worms, star fishes, crabs, octopus and fouling organisms. Overt ishing, over crowding anddiseases were the other causes attributed for the depletion of stock from the beds (Herd-man 1903). Hornell (1916) had witnessed the total destruction of immense beds of young oysters within a period of a few weeks by the predatory fishes. Devanesen and Chidambaram (1956) suggested that overfishing, predominance of females and paucity of males as the probable causes tor depletion. Moray eels and octopi occupied in great number the beds of the young oysters (Salvadori 1950). The growth of A7oo'/o/ys population on the pearl oyster beds was cited as the cause of destruction of spat on the beds (Mahadevan and Nayar 1973). Con-siderable mortality to the young oysters was caused in the beds by the predatory gastropods (Chellam et al 1983).

CONSERVATION MEASURES

Revival of pearl oyster populations in the natural beds may ba possible only with a series of favourable seasons. Hornell (1916) was of the opinion that there were three distinct sources of spat supply for the replenishment of the paars of the Gulf of Mannar, Of these, mutual dependence between the pearl banks of Indian and Sri Lankan coasts was considered to be the most important one. Transplantation of young "strikes" or broods of oysters from useless or unreliable paars to areas that give better living and growing conditions (Herdman 1906), maintenance of "breeding reserve" in the Tholayiram paar (Devanesen and Chidam-baram 1956), development of hollows in the pearl oyster beds by filling with rocks to provide better anchorage (Salvadori 1960) and spat collection by suitable spat collectors during intense spawning months (Mahadevan and Nayar 1976) were some of the measures sug-gested in the past to improve the pearl oyster population on the natural beds.

Sea-ranching of pearl oysters

The successful development of hatchery technology in India for production of pearl oyster spat (Alagarswami et al 1983) is an important development and production of required quantity of pearl oyster spat has become possible in the hatchary. As high as 1.3 million spat could be produced under moderate conditions in one of the rearing experiments in the experimental hatchery at Tuticorin.

The "barrenness" of the pearl oyster beds of the Gulf of Mannar after the last pearl fishery series of 1955-61 has made it necessary to think in terms of sea-ranching the excess spat as an attempt to repopulate the natural beds themselves. For this purpose Vanthivu

arupagam paar in the Gulf of Mannar, one of the nearshore beds, was initially selected. Spat from the hatchery were allowed to settle on materials such as old fish net, velon screen and monofilament. These were placed in a rectangular basket (90x 60 x 15 cm), covered with old fish net, and placed on the paar. The spat would crawl out and disperse themselves after awhile. A total of 7,78, JOO spat of *Pinctada fucata* were sea-ranched between December 1985 and January 1987. Efforts are underway to monitor the sea-ranched spat.

NEED FOR A FRESH LOOK AT THE RESOURCE

As already pointed out, several hypotheses have been put forth in the past to explain the irregular nature of the pearl oyster resources of the Gulf of Mannar. However, detailed scientific investigations on the appearance, survival and dis-appearance of the stocks on the beds are yet to be made. There appears to be a need for afresh look into the whole problem. The aspects of research that should receive attention in future are identified as follows:

Exploitation: It would appear from the records of the pearl fisheries that the pearl oyster has been considered as a revenue earning resource and haste has been the order of the day to fish them out rather than rational exploitation. The norms declared that only oysters of three years or older should be removed from the beds during a fishery and the younger ones should not be removed, or returned when brought ashore, cannot be expected to be practised by the divers who are after the quantity of harvest rather than quality of the oysters fished given the nature of sharing of the collections. Inspection of beds after a fishery series had been ended had always revealed the barrenness of the beds. Would that mean that the beds have been over-exploited or plundered beyond the level of renewability? This question can be answered only after marked beds with plentiful oysters are left unexploited and allowed to go through their natural cycle and subsequently monitored. This does not seem to have been done as the motivation in the past has solely been the revenue.

Environmental: A lot has been said about larval drift and mutual dependence of pearl oyster beds of India and Sri Lanka. So far, no reliable records are seen in the literature on having identified the pearl oyster larvae in the oceanic waters where the beds are located. Only very recently, the pearl oyster has been successfully bred in the laboratory and the larval characters established. With this information, it should be possible to identify the pearl oyster larvae and trace their movements in the open sea. Peaks of larval occurrence in the Gulf of Mannar over the Indian and Sri Lankan beds have to be followed concurrently in order that the mutual dependence theory is accepted or rejected. This also envisages detailed studies on the seasonal current patterns at the larval moving depths in the gulf between India and Sri Lanka Also quantitative observations would be required on the sand drift over the pearl oyster beds, which is stated to be responsible for the mortality.

In addition to testing of the above historical hypotheses, there is need to investigate the more recent phenomena such as the effect of industrial pollution, the changes brought about by the intense bottom-trawling operations on the beds, as also the effect of floods due to occasional heavy monsoon which brings down the salinity by several ppt. The coast of Gulf of Mannar is the seat of several industries which discharge their effluents, toxic or non toxic, in one form or another. Although the pearl oyster beds are located offshore, the effluents would be dispersed by currents and microlevels of pollutants would reach the pearl oyster beds in the column and/or bottom waters. This has to be monitored and bio-assay studies made on the tolerance and lethal limits of pearl oyster for specific industrial pollutants.

The paars are the natural haunts of quality perches and, in the recent years, bottom-trawling operations by the commercial fishing boats have intensified on the pearl banks and adjacent areas. It is known that such activity can change the ecology of sea bottom over a

period of time. How far this would affect pearl oyster settlement and sustenance is to be ascertained through investigations on the beds.

Hornell (1916) had already indicated the possibility of floods affecting the population through dilution of sea water over the beds. There has been at least one such instance of drastic reduction of salinity in coastal waters off Tuticorin due to unusual heavy monsoon (Alagarswami and Victor 1976). Experimental work has shown that dilution up to about 15ppt can be tolerated by oysters for a short spell but not of longer duration Monitoring of such dilutions, when they occur and their effect on the population would be necessary in future.

Unit stocks: Is the pearl oyster population in the Gulf of Mannar a homogenous one? Hornell (1916) has pointed out that oysters of certain beds were always stunted and useless as a resource for pearl production. Alagarswami and Chellam (1977) noticed certain differences in morphometric characters of the oysters in different paars by statistical analysis. The data of the recent decade show that, in the shoreward paars, the oysters collected during several months in the same season (October-May) and during consecutive years do not show a natural progression of growth and the populations of these paars remained at modes ranging between 25-35 mm. Would this indicate that there are different stocks of *P. fucata* with different growth characteristics or that those settling on the shoreward paars would not progress beyond the 'stunted' size? If oysters on all paars are of the same stock, what are the factors responsible for stunting their growth on certain paars? These are some important questions that remain to be answered.

Biological: Mention has already been made of the planktonic larvae of pearl oyster. Investigations are required on the short pelagic life of the larvae in relation to the environment in the open sea and to monitor their distribution and abundance. Particularly important is to locate the pediveliger stages. Settling of pearl oyster preceded by the exploratory "wandering" phase of the larvae to locate suitable substrata and the ideal conditions for spat setting should be studied critically.

The stomach contents of pearl oyster from natural beds invariably include items such as bivalve eggs and larvae, and copepod appendages which cannot apparently be digested (Chellam 1983). Only studies on the mechanism of functioning of labial palps which are supposed to discriminate the particulate matter wafted by the ciliary currents, and physiology of digestion can throw light on this so-called "wasteful" feeding behaviour. The microalgal population in the different paars has to be studied in detail to understand the food availability for the oyster.

The natural enemies of pearl oyster have been listed in the literature from the time of Herdman (1903-1906) to recent times. These are the predators (fish, starfish, gastropods and octopus), the foulers (barnacles, ascidians etc.) the borers (polychaetes and sponges) and the mat-forming weaving mussel. In a syn-ecological situation, there is co-existence of various organisms, the level of each component being kept optimal through natural processes. The pearl oyster, however, appears to be one of the most passive organisms in this complex with no means of defence against those which disturb them in one way or another and, hence, it falls an easy prey. While soma information on individual aspects of animal association on the beds is available through the works of Mahadevan and Nayar (1967, 1974, 1976), it is yet to be studied with the pearl oyster as the central point and how the other biological communities interact with the pearl oyster population in the natural situation and how the adverse processes are overcome when the pearl oyster builds itself up as a dominant community.

Oyster *(CrassostreajOstrea)* beds in several parts of Europe, America and Japan have been, at various times, subject to widespread devastation by diseases. Such beds do not easily

rebuild for several years and, therefore, transplantation is resorted to. Specific to pearl oyster, *P maxima* of Australia has recently been affected by disease and the stocks had reduced. An instance of mass mortality of *P. margaritifera* in Sudan is also on record. Does a similar phenomenon works in the case *oi P. fucata* of Gulf of Mannar? The pathobiology of pearl oyster is yet to be touched upon and this is a subject which needs serious consideration.

Sea-ranching is being attempted in the Gulf of Mannar with a view to finding out the feasibility of repopulating some of the beds. It is a regular commercial practice to sea-ranch abalone in Japan. Monitoring the result depends on locating the exact sites where the pearl oyster has been ranched. But the Conventional method of locating the paars has not so far been helpful in this effort. A vigorous programme on this should include improvement in the technique of locating actual sites and continuous follow up. The spat that are ranched may be marked appropriately to distinguish them from the natural population. If done successfully, this work can also provide very useful data on many aspects of biology of the species.

Vear-rouAJrf oAseAi/af/ons; June-September (south-west monsoon) has remained a blank period in pearl oyster research as no observations could be made on the resource or environment due to the turbulent conditions of the sea and lack of clarity over the paars. Like-wise, observation is hampered during several short spells in November-January due to north east monsoon. Changes in the life of the pearl oyster take place during these periods such as gameto-genesis and spawning, larval production and drifting and physiological adaptations to changes in environmental parameters. A comprehensive investigation on the pearl oyster resource cannot exclude such periods. Sampling and observation techniques have to be developed for year-round study without which a total picture cannot emerge.

In future, with the additional knowledge that might be acquired through the above investigations if put through, the pearl oyster resource, as and when it builds up, should merit management and judicious exploitation and not a hasty step to fish it out for the sake of a paltry revenue.

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