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HISTORY OF THE INDIAN PEARL BANKS OF THE GULF OF MANNAR*

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ABSTRACT

The history of the pearl banks from the year 1904 are traced and presented here with particular emphasis on the role played by the various banks in contributing to pearl fishery and the results of the various fisheries conducted in the area.

INTRODUCTION

THE PEARL FISHERIES of the Gulf of Mannar have been famous from time immemorial and pearls derived from these fisheries were noted for their roundness and lustre. Though the pearls were known to have been used for ornamental purposes more than 2000 years ago, the exact period when the pearl fisheries of the Gulf of Mannar were first exploited is not known (Arunachalam, 1952). The earliest reference to pearl fishery is in the great Tamil epics *Chilapadikaram* and *Manimekalai* which were probably written in the first or early second century A.D. But more detailed and pointed references to the earlier fisheries are also available from some of the travelogues of Greeks, Romans and Arabs who had visited this coast during their travels during the first two centuries of the Christian era. The organisation and conduct of pearl fisheries which attracted the merchants from many countries from afar had been events of great local importance during the past several centuries and in the earlier periods were very prosperous and yielded good revenue to the powers that controlled the fishery. These pearl resources in this region had also been the single major factor responsible for changing the history of the area bordering Tirunelveli and Ramanathapuram Coasts, in view of the perennial lure these pearls invariably had over the local Kings and foreign powers.

Until about the middle of the 16th century the rights of pearl fishery had been the virtual monopoly of the Paravas who paid tributes to the reigning monarch for the enjoyment of the rights from the produce of these fisheries which exempted them from the payment of taxes to the King. The monopoly was threatened by the Mohammedans then spreading along the eastern coast who had taken up the profession of diving and there had been a few instances of skirmishes between the Paravas and the Mohammedans. The Portuguese arrived in Southern India at about that time and their help was sought by the Paravas in their attempt to safeguard themselves from the Mohammedans. This help was promised by the Portuguese on

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condition that the Paravas convert themselves to Christianity which they did subsequently. The Portuguese in addition to baptizing them as Christians brought the Paravas firmly under their control and took over the control of pearl fisheries themselves. The sovereignty over the Paravas and the command of the pearl fishery passed on to the hands of the Dutch from the Portuguese in 1658 and then to the British in 1796. With the gaining of Independence by India these rights automatically became State monopoly from 1947.

Despite the worldwide demand for the pearls from the Gulf of Mannar, the pearl fishery itself could not be conducted either annually or even with any predictable regularity. From Table 1, it may be seen that pearl fisheries never formed any uniform pattern but were sporadic and that only 26 fisheries had been held during the last 156 years. This irregular cyclic character of pearl fisheries of the Gulf of Mannar both off Tuticorin and Sri Lanka Coasts are well known and has been reported by many scientists (Herdman, 1906 ; Hornell, 1922 ; Pearson, 1925).

The rocky ground where the pearl oysters generally occur are locally called ' Paar ' or ' Pearl Bank '. There are about 80 such pearl banks in the Gulf of Mannar along the Indian Coast. These banks are examined periodically with the help of skin divers for getting detailed information regarding the population, age and distribution of the oysters as well as the ecological factors existing in these banks. The results of the analysis of these data make it possible to decide if a fishery could profitably be conducted. Even if the paars are barren of oysters in one year, inspection is conducted periodically so that any eventual settlement of the oyster spat is not allowed to go unnoticed.

Prior to 1832, the pearl fisheries were declared based on the Independent inspections of the Jadi Talaivan or the headman of the Paravas and this function was later taken over by the Britishers. The banks were surveyed in detail by Franklin of the Mannar survey in 1840 and he had then charted and taken bearings for 71 paars. Since then the pearl bank inspections have been periodic and systematic except for brief periods when the inspections were suspended. The pearl bank inspections in the past were conducted by the then Marine Department but with the establishment of a separate Fisheries Department in 1907, the inspections are carried out by the Research wing of the Tamil Nadu Fisheries Department. The earliest history of the pearl banks is given by Thomas (1884) and Hornell (1905, 1922). After this there is no compiled information about the outcome of the various inspections held from 1904 till 1969. Therefore in this paper the history of the pearl banks in the Gulf of Mannar from 1904-1969 is given with the hope that the information provided will be of much use for future pearl fishery scientists.

Our thanks are due to Thiru P. Gopalakrishnan for his assistance in preparing this paper.

Topography

The sea bottom in a stretch of 70 km along the Tirunelveli Coast of the Gulf of Mannar where the more productive paars exist slopes rather gradually at the rate of 2 m per km for a distance of nearly 20 km and then the slope runs rather steeply. The slope off Ramanathapuram Coast, however runs less steeply. Three rivers namely Vembar, Vaipar and Tamiraparani confluence in the Gulf at Vembar, Vaipar and Punnakayal villages respectively. The areas off these river mouths are muddy upto a considerable distance in the sea. Due to the heavy discharge during the south west monsoon period from the river Tamiraparani, there is a deep gully

ranging in depth from 22 to 27 metres known as Punnakayal *Madai*. Off Manapad too there exists a large deep area varying in depth from 20 to 22 metres locally known as Manapad *Madai*. All along the coast from Tuticorin to Pamban running parallel at a distance of about 8.10 km from the coast there are a number of coral islands.

The rocky outcrops which support these pearl oysters or pearl banks are assigned different names by the local fishermen and these nomenclatures have not undergone any appreciable change in the past two centuries. Generally the paars are all roughly parallel to the coast line lying at depths varying from 12 to 25 m. From Manapad to Vaipar they are in two series, an inner one at depth range from 12 to 14 m and an outer series from 18 to 25 m. The inner series do not usually enjoy good clarity because of their nearness to the coast and the vicinity of the embouchure of Vaipar, Vembar and Tamiraparani. The outer series do not suffer from this drawback.

The pearl banks lie between 9° 20′ N, 79° 20′ E and 8° 10′ N, 71° 10′ E. The extent of each paar varies from small paars of the size of 0.5 sq. km area to huge stretches like the one off Tuticorin covering an approximate area of 23 sq. km.

Lomas (1903) has commented after a study of the substrata of paars off Sri Lanka Coast that these paars have been formed by the disintegrated materials discharged by the rivers which were cemented into calcareous and sandstones or calcretes mainly through the agency of Polyzoa and Millipores. The same origin can be very well be attributed to the paars off the Indian Coast since similar samples from bottom have been brought out during diving operations.

The currents are generally found to run with the winds *i.e.* to the North East or South West according to the monsoons. The sea is choppy and the water turbid during the southwest monsoon months. But most of the days of northeast monsoon months the water is clear and sea calm except for occasional stormy days when sea is unapproachable. Naturally diving is resorted to only during north-east monsoon *viz.* October-April and the pearl bank inspection as well as pearl fisheries are possible only during this period of good weather.

Inspection and Methods

During the years 1904 to 1960 the Departmental vessels M.V. *Lady Nicholson*, M.L. *Leverett*, M.L. *Sutherland*, M.L. *Pearl*, M.L. *Sea Scout*, M.F.V. *Tuticorin* and M.F.V. *Gouhar Khaleeli* and three canoes were employed for the inspection of the banks. Since 1960, two pablo boats (30 footers with 20-25 H.P. Diesel Engine) were utilised in the survey of the pearl beds. The survey party consisted of the Marine Biological Research wing staff and the administrative staff of the Assistant Director of Fisheries. In addition a ' Paar mandadi ' (rock-pilot), 3 or 4 skin divers, two manducks helped in the actual prospecting work. The rectangular method of inspection which is generally followed even at present is briefly summarized below.

When the pearl bank to be inspected is located which is ascertained by the transit bearings of land marks and also by sounding the depth and nature of the sea bottom, it is buoyed. Usually an area 0.8 km by 0.4 km is marked off with sparbuoys. The area is so fixed as to enclose the shoreward and seaward boundaries of the bank. The boats are then employed at the seaward or shoreward ends of the area marked at either its northern or southern extreme according to the

direction of the wind and the current. Each boat then works parallel to the opposite extreme and as each boat moves along its course the divers make periodic dives at regular intervals and bring up oysters and fauna and flora found in his area of dive. The nature of bottom, number of dives, oysters and the other fauna and flora brought up by the divers are noted for each boat in a tabulated statement. From the data recorded by the two boats the composite inspection chart for the area is prepared incorporating all details collected for the day. The nature of the bottom is denoted in the chart by the following symbols :

Flat rock	△	Sand	●
Living coral	//	Sand over rock	▲

The area of the paar to be inspected is divided into squares each having an area of 1/12 nautical mile square (28,560 sq. yds.) for convenience. Random diving is conducted at the rate of a dive per square and the number of oysters obtained in each dive are entered in the square. If the oysters are old the numbers are recorded inside circles and in plain numbers if young. From the tabulated chart the area occupied by the oysters noted in each square can be known by multiplying the number of squares with oysters by the area of the square *i.e.* 28,560 sq. yds. The average number of oysters per dive is arrived at by dividing the total number of oysters fished in the entire area *i.e.* adding all the number of oysters entered in the square by the total number of square in which oysters are found. Working on the convention that a diver is capable of covering 3 sq. yds per dive, the total number of oysters are calculated by multiplying the oysters per dive by the area of the paar covered with oysters divided by three. Similarly the population of young and old oysters inhabiting the area of the inspection can also be found separately. Since all the paars have areas less than 2 sq. miles except a few paars, the chart is restricted to the actual area of the paar and the oyster population estimated as per the procedure indicated above.

Since heterogeneous beds of more than one age group in an oyster ground are more often encountered, in the recent years the percentage composition of various age groups are worked out. If the percentage of oysters measuring more than 60 mm in height (length from hinge to ventral edge) exceed 60% of the total population, it is then generally considered as fishable. Before actually declaring a fishery, sample oysters from the prospective beds are taken out, allowed to rot in lots of thousands and pearls extracted. The pearls thus obtained from 1000 oysters are got valued by expert pearl merchants and if the estimated value is encouraging (*i.e.* above Rs. 20/1000) the fishery is then considered worthwhile from the point of view of adequate revenue to Government as well as sufficient incentive for the divers to take part in the fishery.

History of the Pearl Banks

The paars of the Gulf of Mannar are classified into three divisions namely Northern or Kilakarai Division, Central or Tuticorin Division and Southern or Comorin Division (Hornell, 1922). The paars of Northern and Central Divisions are further divided into seven and seventeen groups respectively based on geographic and other characteristics. Hornell (1922) has charted nearly all the banks of the Central Division only. The paars of the northern half of the Central Division has been recharted by the under water survey party (Mahadevan and Nayar, 1967). The paars in the Northern and Southern Divisions are now charted and are shown in Fig. 1. The history of the pearl banks are now traced from 1904 onwards division and group-wise.

NORTHERN DIVISION

The paars that are grouped under this division lie between 78° 28′ E, 8° 55′ N and 78° 20′ E, 9° 15′ N in the sea off Ramanathapuram Coast in the Gulf of Mannar. The substrata of these paars in this division are composed mostly of flat limestone whereas the paars off Kilakarai have a thin covering of sand and gravel in patches over the rocky surfaces.

The faunistic life in these banks are relatively poor, the most common fauna being gorgonids. The other salient fauna are corals, sponges and polyzoans. Among these paars, the Vembar Periya Paar has a better representation of the fauna particularly of sponges, starfishes and molluscs. Pamban Periya paar and Valinukkam group of paars abound in fish population. Seaweeds and algae are in plenty in all the paars and algae specially in paars off Kilakarai.

Group I or Inner Pamban Group : This is the northern most group of paars in the Gulf of Mannar comprising of Pamban Karai paar, and Pamban Velangu paar. The Pamban Karai paar is situated at approximately 9.5 kms SSE of Pamban at 9 to 13 metres depth. Southeast of this paar at a distance of about 4 km lies the Pamban Vilangu paar at the same depth. Very few inspections had been carried out in this group of banks presumably due to their comparative unimportance. The pearl bank inspections during this century were in the years 1930, 1931, 1932 and 1936 with negative results. No oysters settlement had been ever reported from this group.

Group II or Pamban Periya Paar Group : A fairly large bank lying directly about 19 km south of Kundukal Point is known as Pamban Periya paar group. The longer side measuring roughly 3 km lies west to east. The depth varies from 15 to 17 metres. This paar was inspected on the same years as the Inner Pamban Group with the same results.

Group III or Musal Tivu Group : Musal Tivu Paar and Cholava Karai Paar which form this group lie in close proximity to each other and are located south-east of Musal Tivu Island at 8-13 m depth. These paars were inspected in 1917, 1930, 1933, 1936 and 1939. Two oyster spats were obtained from Mussal Tivu paar during the inspection of 1930 but the rest of the inspections proved futile.

Group IV or Kilakarai Group : This Group covers a collection of three paars namely Vallai malai karai paar, Vallai malai velangu paar and Anna paar and is far removed from the groups discussed earlier. Vallai malai karai paar and Vallai malai valangupaar are close together and lie almost directly 12 kms. South of Kilakarai and Anna paar lies SSW of Kilakarai at a distance of 13 km. The depth of the paars varies from 9.5 to 13 m. This group was inspected in 1917, 1930, 1933, 1936, 1958, 1965 and 1968 and the results were not encouraging though three oyster spats were taken from Vallaimalai karai paar in 1930. The inspection in the rest of the paars of this group had been totally disappointing.

Group V or Valinukkam Group : This Group consists of Valinukkam paar, Valinukkam thundu paar, and Nalla Tanni Tivu paar. Valinukkam paar lies very close about 2-3 km from Valinukkam point and the other two paars are disposed approximately 7-9 km south off Valinukkam. The depth ranges from 9 to 13 m. This group was inspected in 1917, 1930, 1933, 1936 and 1939 and found to be barren of oysters.

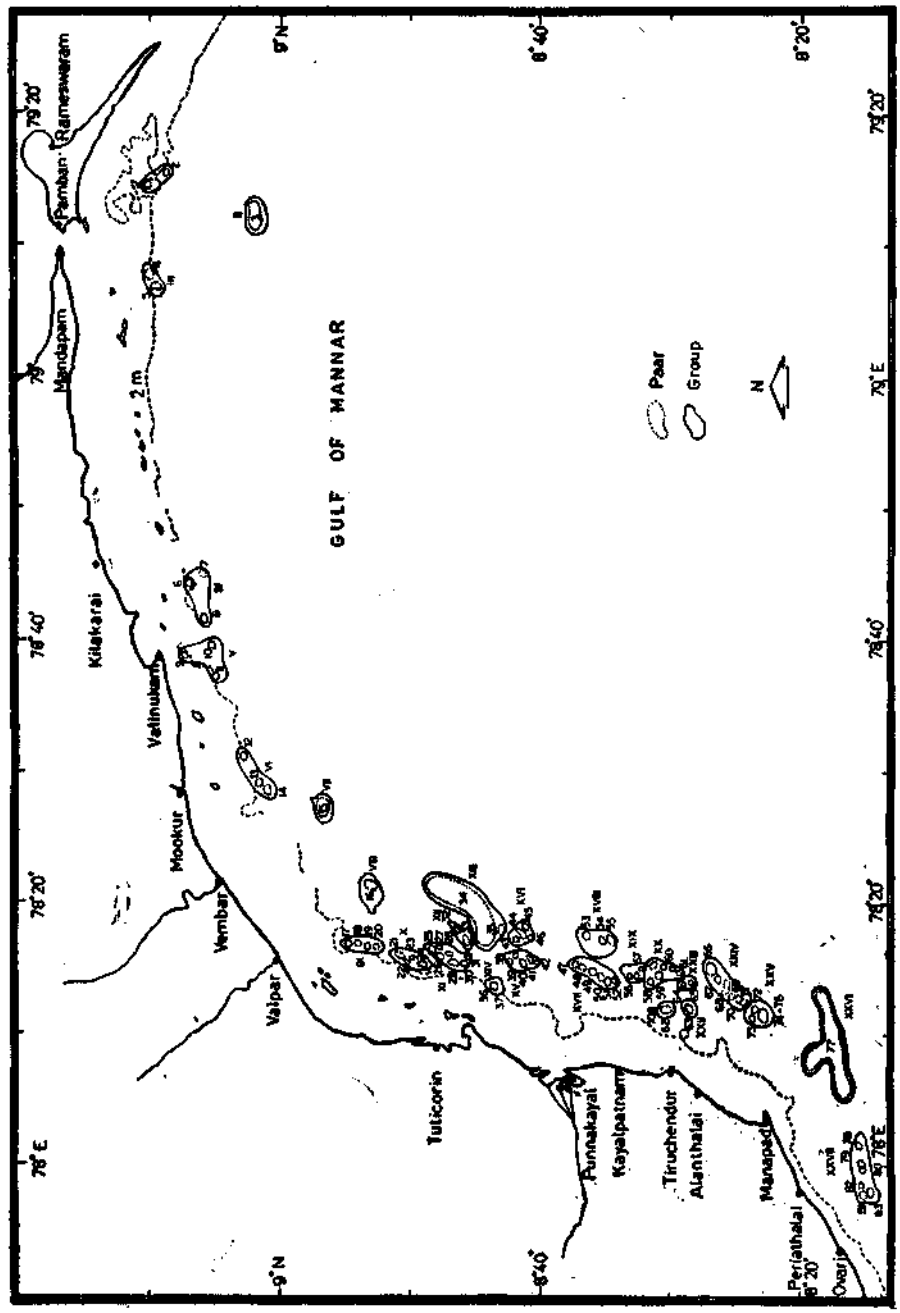

Fig. 1. Paars in the Gulf of Mannar (see index to fig. 1 on facing page)

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Group VI or Inner Vembar Group : It includes Uppu Tanni Tivu paar, Vembar Karai paar and Kumulam paar. Vembar karai and Kumulam paars are located about 13 km southeast of Vembar and 11 km south of Mookur and 3 km south of Uppu Tanni Tivu. The depth of the paars varies from 9.5 to 12.5 m. These paars were surveyed in 1917, 1930, 1933, 1936 and 1939 for oysters with no favourable results.

Group VII or Outer Vembar Group : This is named after the one paar namely Vembar Periya paar which was also known as St. Patricks Bank. This is a comparatively larger paar in this division and lies about 14.5 km south of Mookur. The extent of this paar is about 4 km from east to west and 2.5 km from north to south. The depth varies from 15 to 16.5 m in the southern and western portions and 17.5 to 18.5 metres in the eastern and northeastern regions. Inspections were carried out in 1917, 1930, 1933, 1936, 1939 and 1966; but in spite of favourable environmental and other conditions, this paar has recorded only 12 oysters in 1936 and 5 oysters in 1966.

These paars of this division have not known to support any oyster population in this century and there are no recorded instances of any fishery importance having been conducted in earlier centuries also. Therefore from the point of Commercial fishery these paars have no value. Of all these paars in this division Vembar Periya paar is the only paar that possesses the necessary environmental and ecological features to support any pearl oysters.

Central Division

Of the three divisions, the paars that are classified under this group are of considerable importance in that all the pearl fisheries of the last two centuries in the Gulf of Mannar had been confined only to this division. The paars under this division lie between 78° 20′E 8° 55′N and 78° 10′E 8° 20′N and extend in the sea from Vaipar to Manapad. The surface of the paars in this division varies from flat rock to rock covered with sand, the thickness of sand covering, differs from paar to paar. In Nenchurichan group the rocky surface is strewn with Porolithon gravel.

The predominant fauna in this division are sponges which are rich in all the groups except in inner and outer Vaipar groups, though the species vary from group to group. Molluscs are also fairly abundant in all the groups of the Central Division, the other common fauna being *Rhabdocynthia*, barnacles, Pinna, *Alcyonarians* and *Echinoderms*. Sea weeds are also abundant in Inner and Outer Vaipar groups and in all the groups of southern half of the Central Division.

A—Northern Half of the Central Division

Group VIII or Outer Vaipar Group : This consists only of Vaipar Periya paar lying about 16 km SE of Vaipar at 13 to 14.5 m depth. This paar was inspected in 1912, 1913, 1923, 1924, 1927, 1930, 1936, 1960, 1962, 1966 and 1967 and does not appear to have received any spatfall during the past 60 years. Though this paar was not fished during the present country, it had taken part in the fishery of 1862.

Group IX or Inner Vaipar Group : Four small paars lying in a series from north to south namely Devi paar, Pernandu paar, Paduthamarickan paar, Paduthamarickan Thundu paar are classified under this group and lie 11 to 13 km south of Vaipur. The depth of the paar varies from 11 to 13 m. These paars were inspected during the same years when Vaipar Periya paar was inspected. Spat fall was observed in plenty in 1923 only in Devi paar, Paduthamarickan, and Thundu paar but the spat did not survive to offer a fishery. This was probably due to dense population of *Modiola* spp. found along with the oysters in November 1923. Again in 1933 spats were noticed only in Paduthamarickan Thundu paar but with enormous quantity of *Modiola* spp. In 1934 only a few oysters of 1½ years of age were observed again in this paar with dense population of *Modiola* spp. After 1939 this group of paars were inspected in 1951 and 1952 when a fair number of oysters aged 2 years and less were obtained. However these paars do not seem to have been inspected from 1953 to 1962 due to its relative unimportance. But later inspections showed the paars to be barren till 1968 when oyster spats were seen in small numbers in 1968 and 1969 along with *Modiola* spp. No fishery had taken place during this century although there are several recorded observations of the presence of fairly good number of oysters. Among the paars in this group, the Paduthamarickan Thundu paar is the only one that had part-taken in the pearl fishery in 1830.

Group X or Cruxian Group : Tuticorin Kuda paar, Cruxian paar, Cruxian Thundu paar, Vantheevu Arupagam paar lying SSW of inner Vaipar group come under this group. The depth ranges from 11 to 13 m. Among these paars Tuticorin Kuda paar had not been charted by Hornell and on later surveys it was found to lie between Cruxian and Cruxian Thundu paars. This paar had not been inspected regulary and had been completely left out since the inspection of 1936. The other paars were however inspected in 1912, 1913, 1916, 1922, 1923, 1925, 1930, 1933, 1934, 1936, 1939, 1947, 1955, 1962, 1967 and 1968. In 1923, spat fall, observed in all the four paars was extensive and subsequent inspections in 1924 confirmed the growth of these spat in all these paars. However, 1924 inspection was disappointing in that along with the grown oysters many dead oyster shells were also found but the percentage of dead shells was higher in Cruxian Thundu paar than in Vantivu Arupagam paar. In 1926, Vantivu Arupagam paar alone sustained a fishery yielding 13 lakhs oysters. In 1927 only a few stray oysters were noticed in this paar. There had been no fishery in this group of paars since then though spat fall to a small extent had occurred in Cruxian and Cruxian Thundu paars in 1933 and survived upto 1934 but later found missing. The oysters could not survive further probably due to the overgrowth of *Modiola* spp. The spat fall of 1933 was not seen in Vantivu/Arupagam paar and the bed was barren upto 1938. Subsequent inspections form 1939 to 1968 however brought to light only a few oysters from these banks.

The only pearl fishery in the last century in this group of paars was in 1861 when a fishery was conducted based on oysters fished from Cruxian and Cruxian Thundu paars.

Group XI - or Utti Paar Group or Karai Group : This group covers a number of small paars more or less equal in areas such as Nagarai paar, Utti paar, Petha paar, Uduruvi paar, Kilathi paar, and Athuvai Arupagam paar lying due east of Tuticorin. Petha paar lies SE of Nagari paar and east of Utti paar. The depth of these paars varies from 13 to 15 m. These seven paars are clustered together from north to south and due to its nearness to Tuticorin is known as Karai group.

All these paars have been inspected fairly regularly almost once in 2 years since 1912. Young oysters 2 to 3 months old were noticed in abundance in Nagari, Kilathi and Petha paars in November 1922. In 1923, in addition to these three paars Utti and Uduruvi paars also supported plenty of young oysters. All these oysters were found to grow well upto 1924 and fresh spat fall was also recorded in Kilathi paar in 1924. But in November 1925, 25% of these oysters had perished in Utti and Uduruvi paars and were found covered with faunistic life mostly of barnacles. However inspection of November 1926 revealed the absence of most of the live oysters.

A perusal of the pearl bank inspection reports shows that on 31-3-1932 while removing the anchor, the ships cable was found completely covered with pearl oyster spats. On 30.3.1932 young spats few days old were noticed in Petha paar and on 19.4.1947 the buoy left in Kilathi paar was found covered with oyster spats. The occurrence of spat around March, April perhaps indicates that March would probably be one of the spawning periods of Tuticorin pearl oyster.

In 1934, Utti and Uduruvi paars showed the presence of few young oysters along with *Modiola* spp. From 1934 onwards the beds were barren upto 1951 except for the occurrence of a few stray oysters along with *Modiola* spp. The spat observed in 1951 in Utti, Uduruvi and Kilathi paars were not present subsequently in 1953. Again oysters 2 years old seen in 1958 were found missing in 1959. The banks were again barren till 1968 except for a few oysters found in 1962. *Modiola* spp. was very often encountered during inspection of this group of paars. Ever since the pearl fishery held in Nagarai and Uduruvi paars in 1861, this group of paars have not produced any fishery.

Group XII or Pasi Paar Group : Attonbotu paar and Pasi paar that form this group are wedged between Utti paar group and Tholayiram paar. The depth of these two paars varies from 14.5 to 16.5 m. Large population of young oysters observed in November 1922 were found to grow normally upto March 1924. Fresh spat also had fallen upon these paars in March 1924 but due to unfavourable weather conditions detailed inspection could not be attempted in April 1925 when a few oysters could only be brought out of a few dives that could be made. These paars for some reason had been neglected during 1926 and 1927 but when subsequent inspection was conducted in 1928, these banks were almost destitute of oysters. The paars continued to remain barren during the years 1929-1954 but there were a fair number of oysters during 1954 and in 1955, the existing population appeared to have perished due to sand drift. These paars were left out of the inspection till 1962 but inspections of 1962, 1965 and 1967 showed the complete lack of oysters.

The last recorded fishery in these paars was in the year 1861 ; these paars remained unproductive since then due to its inability to support the oyster growth despite the occurrence of spat frequently. This might have been due to the strong current prevailing over these banks which might tend to uproot the oysters in the earlier stages due to the frequent sand washes these paars are subjected to.

Group XIII or Tholayiram Paar Group : Tholayiram paar and Koothadiyar paar come under this group. Among the paars of the Indian Coast in the Gulf of Mannar, Tholayiram paar is the most extensive pearl bank about 23 sq. kms in area and this has also been the most productive and renumerative of all the banks of the Gulf of Mannar. This paar lies 13-18 kms off Hare Island and is shaped like an elongated kidney and the longer side lying north to south. The depth of the

paar varies from 12 to 14.5 m. Since 1904, thirteen pearl fisheries had been conducted and in eleven of these fisheries the Tholayiram paar had contributed to a very great extent to the total yield of oysters. There was no fishery in this paar only during the pearl fishery of 1958 and 1959.

The first pearl fishery in this century was in 1908 after a lull of about 18 years. There was again a barren period till 1923 when oyster spat 8-9 months old were found to have settled over this paar which continued to grow and thrive well to yield a sizable fishery for a stretch of 3 years in succession from 1926 to 1928. The mature oysters were estimated at a little less than 12 crores in March 1925 inspection. The enormous population was however not fished in the subsequent years either due to mortality of part of the brood due to overpopulation or some other unknown causes or due to over estimation in 1925. This paar yielded only about 105 lakhs in February-March 1926 fishery and the average rate at the time was Rs. 23 per 1000 oysters. A winter fishery in November-December of the same year was responsible for clearing about 16 lakhs oysters from the original population which fetched a rate of Rs. 29-1-7/1000. This was followed by another fishery in March 1927 when 103 lakhs oysters were removed and another winter fishery in November 1927 in which 61.5 lakhs oysters were lifted which realized a rate of Rs. 31-1-8/1000 and Rs. 47-8-2/1000 respectively. There was another fishery in March-April 1928, the yield being in the order of 35 lakhs, the auction of which obtained a price of Rs. 87-6-6/1000 oysters, the highest then.

The average rate per 1000 increased from Rs. 23 in March 1926 when the average age of oysters would have been about 3½ years to Rs. 87 in March 1928 two years later when the same oysters would have grown to 5½ years. This sharp rise in the rate through the two years fishery indicates that the pearl content increases with the age of the oysters from 3 years when they are considered to be fishable to about 5½ to 6 years beyond which they become senile and ultimately perish.

After the pearl fishery of April 1928 this paar still contained oysters which was estimated to be 20 lakhs based on the inspection conducted in November 1928 and these oysters were found to be much scattered and therefore did not warrant the declaration of a fishery. These oysters thinned out gradually during subsequent years and by April 1929 the bank was almost devoid of oysters. During the next eight years till 1938, the bank was nearly barren except for a few stray oysters that were encountered during inspections. These broods however developed only to small patches in the later years *i.e.*, till 1941 but did not develop into sufficiently thick population to yield a fishery. The paar then again fell into a period of barrenness till 1948. The next occurrence of spat fall was in 1949 when the inspection of November 1949 showed the presence of a thin population of oyster spat (Chidambaram *et al.*, 1951). This paar continued to receive spat falls during 1950 also and by April 1951, another fresh spat fall had occurred particularly in the SE region and this spat fall was extended to the central region by November 1951. In November 1952, the oyster population had increased enormously the major age group being less than one year. This brood was supplemented by yet another spat fall in 1952 which was dense and more evenly distributed throughout the bank. Larger oysters were also recorded during the inspection of 1952 presumably from the brood of 1949 spat fall. These oysters had a satisfactory development during 1953 and 1954 and by 1955 the earliest brood was ripe for a harvest and the population was then estimated at 3 crores. A pearl fishery was declared and conducted in 1955. After this fishery the survey of 1955 recorded the presence of fishable oysters estimated at 6.75 lakhs in this bank which could sustain a small fishery. Consequently

a fishery of a moderate extent took place in 1956 when 21 lakhs oysters were then fished. The presence of another generation of thickly populated young oysters together with mature oysters was revealed by the inspection of 1956. The quantum of mature oysters was estimated to be 2 lakhs which when fished during 1957 yielded 2,69,542 oysters. The pearl content was found to be high for the oysters taken out during 1957 and an average rate of Rs. 75.68/1000 was realised. The oysters continued to develop in this paar during this period and the yield of oysters was 20 oysters/dive and 32 oysters/dive at the time of inspection in 1957 and 1958 respectively almost throughout this bank and the age of these oysters was just 2 years in January 1958. Inspection carried out in October, November 1959 confirmed the existence of well developed oysters and the population was estimated at 200 lakhs. This resulted in a fishery in 1960 when 141 lakhs oysters were removed from this paar and the rate realised was Rs. 20.30/1000. Subsequent to this fishery, November 1960 inspection brought out the existence of oysters of fishable age in sufficient quantities which on estimation was 338 lakhs. The fishery of 1961 resulted in the removal of 151 lakhs oysters and the average price of these oysters was Rs. 30.46. This was the last fishery conducted in this paar as well as in the Gulf of Mannar off the Indian Coast. During 1961 inspection, there were still mature oysters present in this bank and in a total of 1053 dives, 1632 oysters were obtained (Sambandamoorthy, 1966). These oysters had however perished within a year and there were no oysters in this paar when inspected in December 1962 except for 7 spat and one oyster. This paar was completely barren during the subsequent years as revealed by the inspections between 1965-69.

Going back to the earlier history of this bank during 18th and 19th centuries this paar had been outstanding for its productivity. Since 1904, there had been spat falls in the years 1920, 1922, 1940, 1951, 1952, and 1956 and pearl fishery took place in this bed in the years 1926, 1927, 1928, 1955, 1956, 1957, 1960 and 1961. If a spat fall occurs in this bank the chances of its survival and attaining maturity appears to be greater in this paar than in any other paars.

Koothadiyar Paar : This paar is one of the smallest banks having an area of about 0.5 sq. km lying at the south-west extremity of Tholayiram paar at 14.5-16.5 m depth. This bank was inspected regularly at least once in 3 years. Oysters spat first noticed in November 1922 grew well /upto April 1925 and the estimated population of oysters was 6 lakhs in April, 1925. However this bed does not seem to have been included in the fishery during 1926-1928. The bed was barren upto 1954 when mature oysters were obtained during inspection and the estimated population was 2 lakhs and it was fished during 1955 fishery. Again mature oysters were found when inspected in April 1958 which were fished in 1960 and 1961. The bed was barren subsequently.

Group XIV or Kanna Tivu Group : Consisting of two beds Kanna Tivu Arupagam paar and Tundu paar lies very close to the shore about 8 km due ESE of Harbour Point. The depth of the paar is about 11 m of the two banks, Kanna Tivu Arupagam paar was inspected regularly upto 1944 and although plenty of dead pearl oysters were seen in 1912 and 1913, oysters in fair quantities were never recorded in these paars. In view of the unimportance of these paars, detailed inspections were not carried out from 1944. No pearl fishery had ever taken place in these beds.

Group XV or Pulipoondu Group : Five small banks, Vada Onbotu paar, Saithonbotu paar, Pulipoondu paar, Kanna Pulipoondu paar and Alluva paar which constitute this group lie SW of southern end of Tholayiram paar and about

9-13 km from land. These paars have an average depth of 14.5 to 16.5 metres. Though the record of these paars had been most discouraging during the last century the results of inspections and a profitable fishery in 1926 in Pulipoondu paar and in 1955 in Vadanbotu and Saithonbotu paars establish these paars as potential banks. 1923 inspection brought out the existence of young oysters in all the paars but produced a fishery in 1926 only in Pulipoondu paar. 23 lakhs oysters were removed during this fishery and the average rate of Rs. 29-3-0 per 1000 oysters was higher than Rs. 23-0-0, the rate obtained in Tholayiram paar. In 1941 plenty of dead oyster shells were found in Pulipoondu paar together with *Modiola* spp. An old bamboo buoy which was left in Aluva paar for about 2½ months when removed on 10-5-1944 was found covered with young oysters but this did not prove to be extensive at the bottom. The next deposit of young oysters made its appearance in this group in April-May 1951 when the oysters found were 1½ years old and in 1952 the population swelled to a good number only in Saithonbotu and Vadaonbotu paars. This population produced a fishery in 1955 in Saithonbotu and Vadaonbotu paars but the fishery itself was hampered by a sand drift from south to north to a depth of 6 to 12 inches, thus appreciably reducing the number of oysters fished in 1955. This group of paars contained plenty of oysters in January 1958 but fishable oysters were in the order of only 4%. The population however decreased in 1959 and the bed was destitute of oysters by November 1962 which condition continued till 1969.

Group XVI or Nenchurichan Group : A group of paars named Parkudanjan, Nenchurichan, Melaonbotu and Vadaolipathu belong to this Nenchurichan group and is about 16 km SE of Tuticorin. These banks are situated 1.5 km south of Tholayiram paar group and 3 km due east of Pulipoondu group. Vadaolipathu paar lies SE of Nenchurichan and Melaonbotu paar. The depth range is from 15.5 to 18 m. This group continued to have the same disappointing history as during the last century since it had not yielded any pearl fishery at all to our knowledge. Although spat fall have not been wanting over these banks these spat never reached fishable size. Dead shells which were noticed in plenty during 1913 probably represents the brood of spat fall on this bank earlier. Oysters found in 1923 grew well upto 1924 but disappeared in 1926. Spat fall again occurred in 1924 and also in 1926 but the oysters of these two generations were however not found in 1928 when the bed was found to be covered with sand. No settlement of young oysters in considerable numbers were recorded in subsequent years.

The continued inability of this group of paars to sustain the oysters in spite of frequent spat falls is probably due to bottom drifts close to the beds and consequent frequent sand washes over the rocky surface. This group of paars lie at a lower depth as compared to the neighbouring Tholayiram and Pulipoondu paars and this variation of depth probably causes frequent sand washes over the areas and also local eddies which prevent the settlement of the oysters.

B—Southern Half of the Central Division

Group XVII or Inner Kudamutti Group : This group consists of six banks lying off Punnakayal, namely Punnakayal Sultan paar, Sandamaram Piditha paar, Rajavukku sippi soditha paar, Kudamutti paar, Saith Kudamutti paar and Pudu paar and is fairly long about 8 km in extent from north to south. The northern most paar in this group namely Punnakayal Sultan paar is situated directly east about 13 km off Punnakayal and the rest of the paars lie south of this paar in series.

The depth ranges from 13 to 18 m. Of the series of paars, Punnakayal Sultan paar and Sandamaram Piditha paar have not known to receive any spat falls while Rajavukku sippi soditha paar and Kudamutti paars have yielded valuable fishery during 1957-1959 and there are records to show that these paars gave rich fishery during earlier centuries specially when Kayal was the centre of pearl fishing operations. Such diversity in their usefulness is perhaps due to its nearness to the deep gully off the embochure which is discussed later.

These beds were barren since 1904 upto 1929 when young oysters were observed in abundance when the banks were inspected on 12-3-1929. By 30-4-1929 a little over a month the entire brood noticed earlier had disappeared. An influx of sand over this bank in the beginning of April appears to be the cause for this total disappearance. The bed was barren till 1951 when 261 dives yielded 61 oysters concentrated more on the eastern region. This generation was further supplemented by fresh spat fall in 1952 thus increasing the density of population and the population was estimated at 38,86,000. During November 1955 inspection the population was calculated as 30,97,000 when all the oysters fished were found to be less than 3 years old. This would naturally indicate that 1952 spat had perished but however a subsequent spat fall had settled down in 1953-54 and this brood of oysters survived to yield a fishery is 1957, 1958 and 1959. There was no further spat fall in these banks since then.

Pudu paar, the southern most in this group have been omitted during many pearl bank inspections in this region. However during 1957 oysters were recorded and they were fished in 1958.

The 1922 spat fall which was very extensive from Cruxian to Manapad groups in the central division had not however settled over this group of paars. Hornell (1924) has stated that it may possibly be due to rush fresh water from river Tamiraparani which coincided with the time when the adjacent sea was full of oyster larvae. This influence must have been fatal to spat survival and settlement in these banks. After the pearl fishery in 1818 and 1828, this group of paars was fished after more than a century in 1957, 1958 and 1959. In 1958 fishery alone 138 lakhs oysters were fished from these four paars and 57 lakhs oysters in 1959. The pearl contents from the oysters in these beds were found to be far more valuable than those from other paars, including Tholayiram paar.

Group XVIII or Outer Kudamutty Group : A conglomeration of paars lying further east of Inner Kudamutti group namely Kovil Piditha Pathu paar, Sankuraiya Pathu paar, Nillam Kallu paar, and Sethuraiya Pathu paar lying at depth range 17 to 19 m are classified under this group. This group of paars were inspected in 1912, 1913, 1923, 1924, 1929, 1932, 1935 and 1951 but there are no reports of any oysters during these inspections. Abundance of *Modiola* spp. was noticed in 1912 and 1935. There was a long gap form 1935-1951 when these paars were neglected in the inspections. In 1922 when the entire stretch of banks from Devi paar to Manapad had received spat fall no oysterlings were noticed in this collection of paars. During 1951 only a few oysters between 1-1½ years age were noticed. These banks have not yielded any fishery so far.

Group XIX or Kadiyan Group : This group consists of two banks, Kadiyan paar and Kanawa paar lying at about 9-11 km due east of Kayalpatnam. The depth of these rocky patches is between 13 to 14.5 m. A thin population of oysters was noticed for the first time in 1950 after a barren period of nearly 50 years. In

March 1951 the population of Kanawa paar was found to be the most prolific and this dense population of oysters was of 6 months and 1½ years age classes. But by November 1951 the population had dwindled to some extent and decreased further by November 1952 and by the end of 1952 a thin population consisting of only 1952 brood was all that remained. This generation of 1952 spats too did not survive at the time of inspection in 1955 when a fresh brood of oysters less than 3 years old was seen and these too were found extinct by 1957. There is no record of any further spat falls since 1957.

After a fishery in 1828, these banks were never fished again. This group of paars presents indeed a very disappointing history and for some reason not very clear, this group is completely unable to support the oysters beyond earlier stages of development when the nearby paars Kudamutti and Karuval paars have yielded a fishery in 1957, 1958 and 1959.

Group XX or Karuval Group : Nadumalai Piditha paar, Periyamalai piditha paar, Karai Karuval paar and Velangu Karuval lying south of Kadiyan group at depth varying from 14.5 to 16.5 m are treated as one namely, Karuval group. This region recorded plentiful of oysters 9 months old in 1923 and these were in healthy condition upto March 1925 when the age of oysters must have been 2¾ years and surprisingly enough these oysters found on 23-3-1925 were found extinct on 11-4-1925. The beds were barren till 1950 when few oysters aged 1½ years and 6 months were obtained. The density of population increased gradually in 1951 and 1952 though during 1952, only 1952 generation of oysters were predominating. These oysters too had disappeared by the time these paars were inspected next in 1955 when a subsequent generation but thickly populated oysters less than 3 years old were encountered. During January 1957 the population of fishable oysters were estimated as 45 lakhs but 27 lakhs oysters only were fished in 1957 fishery. In 1958 the population of nature oysters were estimated in this group as 117 lakhs and 76 lakhs oysters were lifted in 1958 and 47 lakhs oysters in 1959 fishery. Karuval paar oysters were in high demand due to high pearl yield and the average rate per 1000 oysters was Rs. 91.70 in 1959. This group of paars was barren since then.

After a pearl fishery in 1862, pearl fishery was conducted in this group of paars in 1957, 1958 and 1959 only. The oysters from this paar always had a rich encrustation of barnacles and sea weeds. The Karuval paar has been very famous for bringing oysters to maturity more frequently than any other bank barring Tholayiram paar during 19th century. During the present century this group of paars rated along with the Inner Kudamutti paars in its importance and yielded three valuable fisheries.

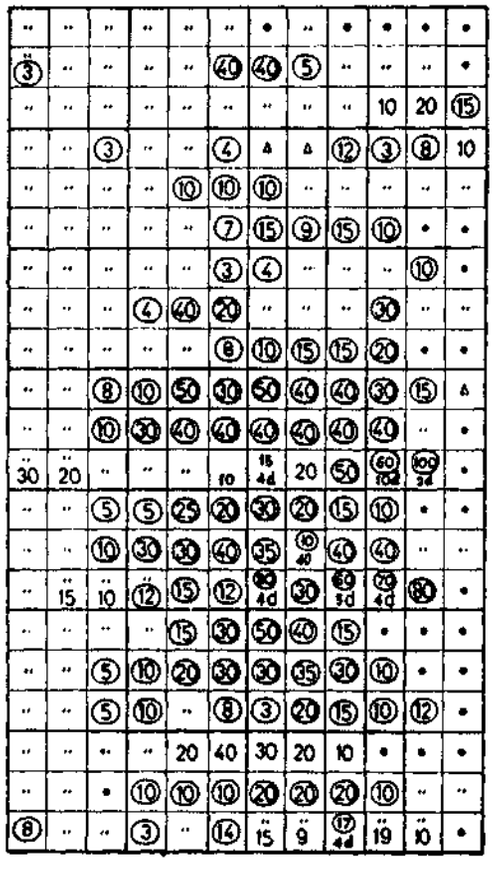
Group XXI or Chodi Group : This refers only to Chodi paar which was first discovered by Capt. G. D. Phipps in 1869. This is fairly large bank lying about 6 km east to Thiruchendur and the depth ranges from 14.5 to 16.5 m. The bed was surveyed in 1923, 1924, 1929, 1932, 1935, 1944, 1965 and 1966 but no oysters were recorded except in 1944 when a few numbers of oysters of 3 and 9 months old were obtained. There is no record of any fishery having been conducted in this paar from the time of its discovery in 1869.

Group XXII or Odaikarai Group : Odaikarai bank lying SW of Karuval paar at 14.5 m depth is known as Odaikarai group. The paar was inspected in 1912, 1923, 1924, 1929, 1932, 1935 and 1944 with negative results. The bank was subjected to strong currents in 1929 and the divers reported heaps of graval during

inspection. Till 1944 this paar was inspected fairly regularly but there had been a period of neglect since then perhaps due its unimportance.

Group XXIII or Tundu Group : Comprises of one bank, Tundu paar lying about 3 km south of Chodi paar. This bank was surveyed in 1923, 1929 and 1932 with no encouraging results. The last known fishery was in 1900 when this paar was reported to have yielded large sized oysters fetching a good price and since then there has been no fishery.

Group XXIV or Manapad Group : A series of six paars, Thiruchendur Poonthottam paar, Katil Parakku paar, Sandamam Piditha paar, Teradi Pulipiditha paar, Semman Pathu paar and Surukku onbotu paar extending from NE to SW



Area with oysters
= 125 x 28,560
= 35,70,000 sq. yrds.

Oysters per dive
$= \frac{2724}{125} = 21{\cdot}8$

Total number of oysters
$= \frac{2724}{125} \times \frac{3570000}{3}$
= 2,50,32,480 oysters

Young oysters
$= \frac{346}{18} \times \frac{18 \times 28,560}{3}$
= 32,93,920

Dead shells
$= \frac{40}{8} \times \frac{8 \times 28560}{3}$
= 3,80,000

Fig. 2 Chart references of Tiruchendur Poonthottam paar recorded on 27-3-1925

almost parallel to the outline of the coast at a distance of 13 kms from the shore and at a depth of 13 to 17 km are grouped under this heading. Recent surveys made in these paars show that there is no gap between the banks from Semman pathu paar to Poonthottam paar.

Thiruchendur Poonthottam Paar lies 14 km SE of Thiruchendur and is the northern most bank in this group. This bank was found to contain oysters in abundance during March 1925 inspection and the density of population was 35 oysters per dive and estimated number of oysters were 4.5 crores. This bank could not be inspected properly in April 1925 due to unfavourable weather since the water was found very turbid and no oysters were obtained from the few dives made. However the bed was found to be completely devoid of oysters in 1927. Spat to a moderate extent seemed to have fallen upon this paar in 1928 but subsequent inspections revealed the barren nature of the bank upto 1949. In May 1951 young oysters less than a year in considerable numbers were noticed and again 1954 inspection showed the presence of moderate numbers of young oysters about a year old, the earlier brood having perished. During 1955-58 there had not been any inspections presumably due to preoccupation in the fishery during the same years in other paars. The existence of large population in this paar was accidentally found out during the fishery of Karuval and Kuddamutti paars in 1959 and was therefore fished during 1959. 59 lakhs of oysters were fished from this paar and this is the first successful fishery conducted in this paar since 1805. The available records indicate that a pearl weighing 11.6 cts—the biggest in recent times, was obtained from this paar during the 1959 fishery. Early in 1960 this paar was found with plenty of spats but by 1962 these oysterlings had disappeared. No subsequent spat fall was recorded during the inspections of 1964 to 1966.

The other paars of this group also present a similar trend of conditions as that of Thiruchendur Poonthottam Paar. In 1923, these paars were seen with plenty of oysters that had healthy growth till March 1925 but found non-existent when the paars were inspected in April 1926. The same history repeated during 1926-1928. A good population together with *Modiola* spp. was available at the time of inspection in February 1928 in all these paars but in Semman Pathu paar and Surukku onbotu paar however many of the young oysters found were dead and Surukku onbotu paar surface was flushed with sand. By 1929, no oysters could be seen in any of the paars. These banks were barren till 1951 when they received spat fall to small extent but the fate of these oysters are not known since there had been no further inspections subsequently. The later inspections in 1965-1966 showed the complete absence of oysters.

The earliest fishery in this century in this group of paars was in 1900 in which Teradi Piditha paar alone took part and this too did not prove successful in view of commencing the fishery too early to be of any value. The next fishery in this group was in 1959 when Thiruchendur Poonthottam paar yielded a lucrative fishery. The 1959 fishery establishes the Thiruchendur Poonthottam paar is an important bed and the rest of the paars in spite of the failure in this century, as a group, ranks in importance equally with Karuval and Kudamutti groups of paars.

Southern or Comorin Division

The paars which are grouped under this division extend from 8°25′ N, 78°15′ E to 8°15′ N, 77°55′ E corresponding to Manapad in the north to Ovari in the south. The southern most bank namely Pulli Kallu paar lies ESE of Ovari and the northern most bank Kanawa parakku Sodhi Thundu paar lies ENE of Manapad. These paars are confined to a fairly small area and the chartered banks, contrary to what is implied by the name given to this division, do not extend beyond south of

Pulli Kallu paar. According to Hornell (1922) there is historic evidence that some of the paars have been occasionally productive but there is no reliable record of any fishery having been conducted in recent centuries. This division should have been appropriately named as Southern or Manapad division which would indicate the location more correctly. Among the three divisions of the Gulf of Mannar, this division has received the least attention from the earliest times though there are records of several inspections of paars of this division particularly Manapad Periya paar during this century.

Sea bottom of the banks in this division is rocky scattered with sand. In Manapad Periya paar, the rocky areas are at the two ends and the central portion is practically sandy. In the banks off Ovari, the samples of rock brought out had a peculiar formation and had holes in it. The chief fauna and flora are cup sponges, corals, echinoderms, gorgonids and seaweeds.

Group XXV-Inner Manapad Group : Four small banks, namely Kanawa Parakku Sodhi Thundu paar, Paracherry Pathoor, Alanthalai Pathoor, and Manapad Pathoor are clustered so close together as to make it difficult to differentiate them, which lie immediately south of Surukku onbotu paar of the Manapad group and the tiny Paracherry paar that lies near west of this cluster are classified as Inner Manapad. The depth varies from 16.5 to 18.0 m. These beds were inspected in 1912, 1923, 1925, 1926, 1929, 1932 and 1935. These banks did not receive any spat fall during 1922 when the nearby Thiruchendur Poonthottam paar had a heavy spat fall. All these paars were found with oysters fairly distributed during April 1925. No proper inspection could be carried out due to bad weather and turbidity of water subsequently and when next surveyed in 1929 there were no oysters present. These banks were not inspected since 1935 because of their unproductive nature and distance from Tuticorin base.

Group XXVI or Manapad Periya Paar Group : Manapad Periya paar, a large paar next in size only to Tholayiram paar is named as Manapad Periya paar group. This bank is fairly long and narrow about 16 km in length from NE to SW and about 1.5 km in width with slight projection in the centre. It is located SE of Manapad point and very near the Manapad Madai. The depth of the paar varies from 10.5 to 13 m. The bed was surveyed in 1912, 1923, 1924, 1929, 1932, 1935, 1938, 1941, 1964 and 1966. Of these inspections only 1941 survey yielded 3 oysters and the bed was devoid of any oysters in all other years. It is doubtful if the paar has had any pearl fishery value at any time due to its openness to current and wind.

Group XXVII or Ovari Group : Five paars, Kallan Pulli paar or Semman pallai kalli Paar, Ovari Anthoniyar Kovil Piditha paar, and Pulli Kallu paar or Periya thalai Semman Tharai paar, Killi paar and Kooduthalai paar lying almost from east to west are grouped together and termed as Ovari Group. Periya Thalai Semman Tharai paar is the southern most bank in the Southern division and lie almost due south of Periyathalai and hence the name Periyathalai Semman Tharai paar. Ovari Anthoniyar Kovil Piditha paar lies 1.5 km NE of Periyathalai Semman Tharai paar and about 10 km ESE of Ovari. Semman Pallai Kallai paar lies about 1.5 km east of Kovil Piditha paar. All these banks lie about 7 to 11 km off Ovari and at depth of 12.5 to 16 m. These banks were inspected in 1929, 1932, 1935 and 1941 and no oysters were obtained during the survey in any of the years. Pulli Kallu paar was found to be a very good chank ground.

Discussion

From the above detailed account of the history of the pearl banks in the Gulf of Mannar the picture that emerges is one of uncertainty and unpredictability of the pearl fisheries and continued unproductivity of certain paars which is not dissimilar to the history of these banks during the earlier century. From the record of performance since 1904, of the eighty and odd banks that skirt the Indian Coast, these can be differentiated into the following three categories.

Table 1. *Pearl fisheries off Tuticorin in the Gulf of Mannar from* 1805 *to* 1961

Year	Grand total of oysters fished	Gross Govt. Revenue (in Rupees)	Paars fished
1805 ..	7,16,47,305	39,109	Velangu Karuval
1807 ..	—	2,91,539	Tholayiram
1810 ..	2,20,36,658	2,38,897	Tholayiram
1815 ..	Unsuccessful fishery		Karuval, Poonthottam
1818 ..	1,55,00,000	1,67,708	Kudamutti, Saith Kodamuttu, Pudu
1822 ..	—	1,55,698	Tholayiram
1828 ..	75,41,940	70,127	Kudamutti, Saith Kodamutti, Pudu, Rajvukku sippi soditha, Kadiyan, Kanawa
1830 ..	1,28,58,993	1,01,639	Tholayiram, Utti, Uduruvi, Kilathi, Paduthamarikan thundu
1861 ..	—	2,50,276	Cruxian, Cruxian thundu, Nagarai, Uduruvi, Attonbottu, Kilathi, Devi, Pernandu, Vaipur, Karuval
1862 ..	45,48,126	1,29,003	Attonbottu, Vaipur, Pudu,
1889 ..	1,26,00,531	1,89,984	Tholayiram
1890 ..	18,06,762	25,061	Tholayiram
1900 ..	28,01,036	19,461	Teradi Piditha, Thundu
1908 ..	11,01,642	10,218	Tholayiram
1926 ..	1,40,96,839	2,25,498	Tholayiram, Pulipoondu, Vantivu Arupagam
1926 ..	1,16,48,312	31,387	Tholayiram
1927 ..	1,03,37,061	2,54,497	Tholayiram
1927 ..	61,50,320	1,95,039	Tholayiram
1928 ..	34,54,729	2,02,575	Tholayiram
1955 ..	35,08,967	1,36,527	Tholayiram, Koothadiyar, Saithonbotu
1956 ..	21,29,058	44,795	Tholayiram
1957 ..	1,11,75,214	1,68,807	Tholayiram, Kudamutti, Saitha Kodamutti, Rajavukku sippi soditha, Karuval
1958 ..	2,14,76,514	4,65,098	Kudamutti, Saith Kodamutti, Pudu, Rajavukku sippi soditha, Karuval
1959 ..	1,63,90,710	8,00,568	Kudamutti, Karuval, Poonthottam
1960 ..	1,57,91,916	2,15,267	Tholayiram, Koothadiyar
1961 ..	1,53,96,928	2,88,860	Tholayiram, Koothadiyar

Banks which have not recorded any appreciable spat fall and therefore are relatively unimportant. All the groups of paars in the northern and southern divisions except Manapad group and certain groups such as Odakarai, Thundu and outer Vaipar groups and certain paars in the inner Kudamutti group of the central division fall under this category. Inspections of the paars in the northern and southern divisions too have not been regular.

Banks on which spat falls occur frequently but the oysters rarely survive to reach the pearl bearing stage to afford a fishery. This category will include paars grouped under inner Vaipar, Utti, Pasi, Kanna tivu, Kadiyan, Nenchurichan and outer Kudamutti.

Banks that are productively important and have yielded a fishery at least once in this century. These are shown in Table 2.

The characteristic features and other natural causes that have made certain paars unsuitable for oyster settlements and their survival in the early stages have been dealt under each group while tracing the history of the banks. In general, the major factors that can be said to exert an adverse influence on oyster settlement on these paars are turbidity, currents and excessive weed growth. Among the unproductive paars the northern banks are known to suffer from excessive turbidity of the sea which prevail during stormy weather. Added to this, the paars in this region support dense growth of sea weeds which invariably was—has a deleterious effect on the oyster settlement. The weeds in addition to preventing the spat from settling down and attaching themselves to the rocky bottom get washed away along with oysters that adhere to them. Pearson (1926) has specifically found *Sargassum* spp. to be a menace to oysters. Another cause that has been reported as responsible for the barrenness of these paars in the northern division is the eddies that are formed by the deflection of the current by the presence of a chain of islands lying parallel to this part of the coast which conduce to the formation of mud deposit brought in by rivers entering the sea between Vaipar and Pamban (Hornell, 1922).

The chief disadvantage of the paars in the southern division appears to be their direct exposure to the stormy south-west monsoon which sweeps with great force from south to north. Owing to the changing coastline from south to southwest, south of Manapad and due to the presence of proximate deep gullies these paars feel the impact of strong currents and whirlpools created by the cross currents. Such hostile surface of these paars are therefore not likely to be favoured with spat fall.

The Vaipar, Odikarai and Thundu groups of paars although have not proved to be renumerative in this century have yielded fishery during the nineteenth century and there is no reason why they cannot become productive again. Punakayal Sultan and Sandamaram Piditha Paars of the Inner Kudamutti group in the Central division remained barren during this century in spite of their nearness to productive ones. The exact causes of barrenness when other favourable environments exist cannot be explained with any degree of certainty but the more possible explanation appears to be their placement direct east of the embouchure of Tamiraparni River which during freshes must bring in considerable quantities of silt and mud which find their way to these banks. Mud and sand are considered highly detrimental to the pearl oyster, especially the former and the pearl oyster thrives best in clear water, the depth being immaterial (Jeffreys, 1867).

TABLE 2. *Pearl Fisheries in the various paars since* 1904

Year		Thola-yiram paar	Kootha-diyar paar	Kuda-mutti & Saith kudamutti paars	Rajā-vukku sippi soditha paar	Pudu paar	Karuval & Saith Karuval paars	Puli-poondu paar	Saithon-botu & Vadaom botu paars	Thiru-chendur poon-thottam paar	Vantivuaru-pagam paar
1908	..	1908									
1926	..	1926						1926			1926
1926	..	1926									
1927	..	1927									
1927	..	1927									
1928	..	1928									
1955	..	1955	1955					1955	1955		
1956	..	1956									
1957	..	1957		1957	1957		1957				
1958	..			1958	1958	1958	1958				
1959	..			1959	1959		1959			1959	
1960	..	1960	1960								
1961	..	1961	1961								
Total	13	11	3	3	3	1	3	2	1	1	1

Some of the paars that have received spat fall too are rendered unproductive by certain natural calamities that destroy oysters on a large scale. The principal causes that have been ascribed to such disasters are sand silting, crusting growths of other organisms and predacious fishes. Sand silting or sand wash is known as one of the major causes in cases of disappearance of oysters in Past paar group in 1924 and 1955 (Anon, 1955). Young oysters noticed in paars were found later covered with sand in Surukku Onbotu paar in February 1928, Nenchurichan and Parkudanjan paars in November 1928, Attonbotu, Kudamutti, South Kudamutti and Rajavukku Sippi Soditha paars in April 1929. Herdman (1906) considered the silting of sand being the most adverse influence at work on the pearl banks in causing widespread death of pearl oyster young and old and Pearson (1926) too had referred to the harmful effects of silting sand. Sand silting is generally caused by sand in suspense on settling down gradually or sand being bodily moved as a result of very strong currents. Sand movements due to strong currents can be extensive depending on the intensity of the current and can at times completely cover the oysters, thus strangling the entire population in a bed. Such movements of large body of sand over the bank at times make a bed totally unsuitable for further oyster settlement till the ingress of sand is removed by natural causes. To counteract the menace of silting sand, cultching the bottom to provide means of attachment for young oysters was attempted in 1955 (G.O. No. 2923 dated 19.12.1955) and 1962 (Mahadevan and Nair, 1967). Cultching to improve the surface had been experimented in Sri Lanka Coast but had to be abandoned in view of the colossal expense involved (Herdman, 1905 ; Pearson, 1926).

Great stress had been made by the earlier pearl fishery organisers on the pernicious influence of *Modiola* spp. (Suran) which settle in larger numbers in clusters over the oysters. *Modiola* spp. had been noticed in Vaipar group of paars in 1923 and again in 1933 and was often found in Utti group and in all these instances the oyster stock never built to sufficient numbers to yield a fishery. The malefivient influence of *Modiola* spp. on young oysters had been referred to by many earlier workers (French, 1860 ; Phipps, 1963 ; Richardson, 1870 ; Wicks, 1885 ; Thurston, 1890 ; Hornell, 1924).

The destruction of oysters by predacious fishes particularly rays had also been observed in certain paars. Evidence of many broken and bitten shells left in Saithonboty and Vadaonbotu paars during April 1955 pearl fishery certainly indicate invasion by shools of rays (*Rhinoptera*). Hornell (1916) had emphasised the destructive roll of the predacious fish such as rays, balistes, serranids and Pearson (1926) too considered these to be a serious threat to large beds of pearl oysters of all ages. Chacko (1959) had recorded fragments of pearl oysters shells in the stomach contents of three specimens of *Abalistes stellaris* caught in the Tholayiram paar. Herdman (1906) had however pointed out a redeeming role of these rays and had stated that the rays are a necessary link in the life history of cestode which is supposed to form the nucleus of pearl.

The productive group of paars and the years in which fisheries have been held in this century are shown in Table 2. From the record of these fisheries, the principal groups of banks which have proved to be commercially valuable can be arranged in the order of importance as Tholayiram, Kudamutti, Karuval, Pulipoondu, Manapad and Cruxian group of paars. The pearl fishery since 1904 apart from a solitary fishery in 1908 had been held in two stretches, the first from 1926-28, the second from 1955-61. Though the spat fall had been quite extensive prior to 1926 the fishery however had more or less been confined to Tholayiram paar whereas

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TABLE 3. *Details of pearl fisheries held since* 1904

Year	No. of days fished	Total oysters fished	Govt. share of oysters	Average value/1000 oysters (in Rupees)	Approximate age of oysters fished	Gross Revenue (in Rupees)
1908	20	11,01,642	7,34,428	13-13-1	4	10,218-0-0
1926	33	1,40,96,839	93,09,493	23-4-0	3½	2,25,498-6-0
1926	23	16,48,312	10,72,627	29-1-7	3¾	31,386-11-7
1927	45	1,03,37,061	68,91,374	31-1-8	4-5	2,54,497-1-0
1927	56	61,50,320	41,00,213	47-8-2	4-5	1,95,038-14-0
1928	31	34,54,729	23,03,156	87-6-7	5¾	2,02,575-6-0
1955	44	35,08,967	23,39,312	58-5-11	3½-4½	1,36,526-15-9
1956	18	21,29,058	14,19,371	31-9-1	3½-4	44,795-5-3
1957	51	1,11,75,214	74,08,031	22.22	3½-4½	1,68,807.31
1958	54	2,14,76,514	1,44,44,866	32.19	3½-4½	4,65,097.77
1959	62	1,63,90,710	1,09,52,199	87.24	4-5	8,00,568.00
1960	52	1,57,91,916	1,05,52,841	21.94	3½-4½	2,15,266.88
1961	44	1,53,96,928	1,02,75,776	30.65	3½-4½	2,88,860.00

TABLE 4. *Oysters fished in various paars and their value obtained per* 1000 *oysters in the fisheries held since* 1904

Year	Tholayiram paar	Koothadi-yar paar	Kudamutti and Saith kudamutti paar	Rajavukku Sippi Soditha paar	Pudu paar	Karuval & Saith karuval paars	Puli poondu paar	Saithon botu and Vadambotu paars	Tiruchen-dur poon-thottam paar	Vantivua-rupagam paar	Total oysters
1908 ..	1101642										1101642
	Rs. 13-13-1										13-13-1
1926 ..	10476901						2318988			1300950	14096839
	Rs. 23-0-0						29-3-0			14-4-0	23-4-0
1926 ..	1648312										1648312
	29-1-7										29-1-7
1927 ..	10337061										10337061
	Rs. 31-1-8										31-1-8
1927 ..	6150320										6150320
	Rs. 47-8-2										47-8-2
1928 ..	3454729										3454729
	Rs. 87-6-7										87-6-7
1955 ..	3200000						300000*				3508967
	(Approx.)						(Approx.)				58-5-11
1956 ..	2124058										2129058
	Rs. 31-9-7										31-9-7
1957 ..	269542		8596397	2037012		272263					11175214
	Rs. 75.68		13.38	Rs. 12.45		13.51					Rs. 22.22
1958 ..			10152849	2430366	1254302	7638997					21476514
			Rs. 17.17	Rs. 26.15	Rs. 23.59	Rs. 36.19					Rs. 32.19
1959 ..			5298244	403119		4693111			5696236		16390710
			Rs. 56.07	Rs. 88.42		Rs. 91.70			Rs. 88.41		Rs. 87.24
1960 ..	14071888	1719478									15791916
	Rs. 20.30	Rs. 21.00					550				Rs. 21.94
1961 ..	15073834	323094									
	Rs. 30.46	Rs. 33.13									15396928
											Rs. 30.05

* The paar-wise details of oysters are not available for the year 1955.

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the second spell of successive fisheries had covered practically all the five groups of paars. The total number of oysters fished together with the gross revenue and average value per 1000 oysters in each of the fishery conducted since 1904 are furnished in Table 3. Out of the thirteen fisheries conducted, the maximum harvest of 2,14,76,514 oysters had been fished in the year 1958 though the maximum revenue of Rs. 8,00,568.00 was realised in the year 1959 when the oysters fished had been considerably less. Table 3 and 4 reveal the progressive value per 1000 oysters in the 1926-1988 series. The fisheries of 1957-1959 were held in a different set of paars and the rate can be seen to increase as the fishery progressed till it reached a maximum in 1959. Again in 1960-61 when the fishing was in Tholayiram paar only, the rate was higher in 1961 than in 1960. The fall in the rate from 1955 to 1956 may probably be due to the restricted fishery conducted in 1956 and consequent limited numbers of merchants the fishery attracted. The general increase in the rate per 1000 oysters lends further evidence to the generally known phenomenon that the pearl yield increases with the age of the oysters. In spite of this increase the optimum age at which the oysters could profitably be fished has to be determined with due regard to the age limit of these oysters and considering the fact that the mortality rate of the older oysters is exceptionally high. Though there are several conflicting opinions in this regard, it is generally accepted that the best age for fishing is probably between $3\frac{1}{2}$ and $4\frac{1}{2}$ years (Pearson, 1933). To judge the age of oysters with any degree of accuracy is indeed difficult and hence the more practical approach has been to consider the oysters mature if the height *i.e.*, the length along the dorso-ventral axis exceeds 60 mm which will approximate to the age of about $3\frac{1}{2}$ years.

Tracing the broods of oysters from the time they were first noticed till they were removed especially in Tholayiram, Kudamutti and Karuval group of paars, it can be said that the average life span of oysters probably extends upto 6 years under normal conditions, though a few individuals could be expected to survive till the seventh year. Devanesan and Chidambaram (1956) have reported after study of the farm grown pearl oysters at Krusadi that the maximum span of life of the Indian pearl oyster is about six years.

Going through the history of some of the banks, it is interesting to observe that repopulation of the banks after long barren periods takes place over a period of years. For instances after a barren period of 50 years the Kudamutti paar recorded a few oysters in 1950 which increased in 1951 and 1952 and this brood had given place to another in large numbers which finally resulted in a fishery in 1957-58 and 1959. The same pattern can be traced in the case of similar paars which yielded a fishery in 1956-1961. After the fishing in 1961, a few young oysters noticed in 1968 in some of the paars are repopulating only gradually as had been observed in recent inspections.

The pearl oysters are extraordinarily prolific breeders and they are sexually mature at the age of twelve months (Pearson, 1926). There are two spawning maxima in a year though the oysters are known to breed throughout the year (Herdman, 1905 ; Pearson, 1926). The find of spats a few days old in some paars, namely, Nagarai paar on 31-3-1932, in Petha paar on 19-4-1947, oysters 2 months old in Aluva paar on 10-5-1944 and again oysterlings of size 5.2×6.0 to 8.0×11.4 mm in Inner Vaipar or Cruxian group in September 1968 confirms the view of Hornell (1922) that the Indian pearl oysters spawning maxima are March-April and September-October. The two spawning periods noticed in the case of Indian oysters will therefore indicate that oysters prefer to breed during comparatively calm weather just before the onset of the S.W. and N.E. monsoon. This coincides with the period when the temperature of the water and salinity are high (Freda Chandrasekharan *et al.*, 1967).

The cause of long periods of barrenness between successful fisheries had always been a matter of great concern and one of the reasons advanced for this condition in the past is overfishing of oysters from the beds. Overfishing means denuding the beds without leaving any oysters for subsequent reproduction as well as indiscriminate removal of all oysters both young and old from the beds. Pearson (1926) has strongly refuted this and stated that it is impossible to strip a bank completely with the existing arrangement of employing skin divers for the removal of oysters. However fishing of young oysters along with older ones is inevitable since it is difficult to distinguish the age of the oysters when a large scale fishing is in progress. An attempt to remedy this indiscriminate fishing of young oysters was attempted in 1955 when 16,000 young oysters fished were released for repopulation in the Central section of Tholayiram paar. Though it is not possible to state with accuracy how far this helped it is likely that this stocking was responsible for subsequent heavy spat fall in central and northern regions of Tholayiram paar in 1956. Such transplantation has been carried out frequently in the Sri Lanka Coast to relieve the over populated paars from congestion as well as to transfer oysters, from paars which are unreliable, to rear the oysters to maturity, to more favourable ones. Transplantation on a limited scale particularly in Tholayiram paar will certainly be useful and can be attempted in future fisheries with profit.

From the discussion of the causes that are responsible for large scale mortality and the uncertainty of spat settlement it will be clear that the success of pearl fisheries primarily depends upon several natural events most of which are beyond human control. The best use has therefore to be made of the available oysters by organising timely fishery and this is possible only if accurate, periodic and extensive inspections are carried out. Hornell (1922) has cited a few instances in this century when it is possible to have missed fishing from certain banks due to neglect of inspection and has laid great stress on proper inspection on scientific lines. This recommendation holds good even in the present time.

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