The object of the present annotated bibliography on Pearl Oysters from Indian Coast is to make available a synopsis of information gathered by pearl fishery experts and Indian scientists on various aspects connected with pearl fishery management, pearl oyster distribution, ecology of the pearl beds, biology and reproduction and culture of pearls. Such information will be of considerable value at a time when our scientists, having achieved a breakthrough in pearl culture technology, are helping the process of establishing a viable pearl culture industry in our country. The present research thrust is on hatchery production of seed, manufacture of indigenous materials for serving as nuclei for implantation, improvements in farming techniques and system and training of skilled technicians. The references and information collected up-to-date from all sources and media of publications in India will, it is hoped, stimulate further work in strengthening our efforts. The idea of annotating the publications was given by Dr. E. G. Silas and fulfilling this assignment was in no small measure due to his encouragement as it was due to the active help rendered by all my colleagues of the Molluscan Fisheries Division. I am really indebted to them.

Scanning through some of the very old records of the Madras Government Revenue Board proceedings I found very interesting observations by those reporting on pearl bank inspections done in yesteryears, before a separate directorate for fisheries came into existence. To allow this material to languish unread by posterity will be doing great injustice to those pioneers who had evinced abiding interest in the subject. Hence I have given a resume of such observations as are of relevance to present day interest.

A total number of 165 references has been scanned in this work. The publications are listed in the alphabetical order. Each reference is divided into four parts, namely (1) author and year of publication; (2) title; (3) periodical, volume and pages; and (4) subject dealt with in the reference.

Great care has been taken to update the bibliography. If by any chance a few scientific publications do not find a place in this it is only due to oversight.


The oyster farm at Vizhinjam provides a good area for the healthy growth of oysters with a variety of fouling organisms settling and growing on the cages. By introducing biological associates, it has been stated that it is possible to attract desirable cultivable animals to settle down and grow.


The designs and details of nylon frills, breeding hapes of 1.5 x 1.5 x 1 m size and cages of 50 x 45 x 45 cm with nylon netting to accommodate 800 oysters used in the experiments at Vizhinjam has been given. A new method of nucleus implantation to produce quality pearl has been attempted.


The data on linear relationship between the length and weight of oysters of Gulf of Mannar arrived at earlier by...

The paper mentions the names of various molluscs employed in pearl culture work in Japan and also the 25 prefectures engaged in pearl culture farming in an area of 30,000 acres. Spot collection techniques, farm establishment, specification of floating raft, pearl oyster net and the tools used for nucleus implantation have all been described. The technology of pearl culture and the post operational care have been highlighted. The status of oyster fisheries in India and the efforts on culturing pearls have been discussed to show the need for developing an indigenous technology for culturing pearls and for the establishment of a cultured pearl industry.


Six batches of operated oysters, of which 77 were examined, produced 43 pearls. Deposition of nacreous layer was observed 30 days after operation and pearly lustre appeared in 43 days. Those produced between 69-191 days had bright lustre. Cent percent success was achieved in pearl production, in one batch of experiments.


The paper describes the technology of pearl culture developed in India.


The genesis of pearl culture work in India culminating in the successful production of spherical pearls by CMFRI has been given in the paper. One problem that has to be solved is the large-scale availability of pearl oyster to meet the needs of pearl farmer. Research efforts are needed for evolving satisfactory techniques for oyster seed production. Establishment of culture pearl industry will help to uplift the economy of the people of the coastal rural sector.


2-5 pearls were produced in individual oysters by this method, with comparable retention rate of nuclei as in single implantation. The average production achieved worked out to 180.5%.


Quick growth of cultured pearls has been reported. In the case of 3.0-3.05 mm nuclei the growth seen in 24 months in Japan was achieved in a little over 6 months in Tuticorin. In the case of 3.95-4.00 mm the ratio of nacreous layer to radius of nucleus was 0.155 in 161 days in India while it was 0.183 in 11, 12 days (2 years) in Japan.


Prospects and progress of pearl culture described.


The pearl oyster farming can afford employment opportunities for several skilled labourers and workmen and will improve the economic prosperity of coastal villages.


Larval raft theory across the Gulf of Mannar propounded by earlier pearl fishery scientists appears to be a plausible one as judged by the settlement and growth of P. fucata, P. sugilta and P. anomoides in the newly constructed harbour basin, at Tuticorin. P. chemnitzii was also seen in the fishing harbour basin, another sheltered coastal area.


Describes the feasibility of commercial pearl culture in India.

ALAGARSWAMI, K. 1977. Pathology of pearls and pearl production. 31st Tamil Nadu State Medical Conference Souvenir, Tuticorin, I.M.A.

The process of pearl sac formation and subsequent coating of nacreous layer on the irritant as implanted nuclei has been explained.


The trend in the Indian pearl fisheries for the past several years and an account of the rate of growth of oysters in natural beds, reproductive cycle, and pearl formation processes had been enumerated.


An exhaustive account of the various aspects of culture has been given.


The important role played by hatchery development of edible and culturable molluscan seed to meet large-scale demand of the industry has been stressed by drawing to the attention to the development in this area of work in advanced countries in Mariculture.


PEARL CULTURE
A major breakthrough was achieved when techniques for the production of cultured pearls were successfully developed in 1973 by CMFRI in India. Training programmes have been conducted to extend the know-how to maritime states. The paper identifies areas needing major thrust to strengthen the technological base.


The survey of Andaman and Nicobar Islands has brought out Pinctada margaritifera as a resource of some importance. Pteria penguin, the black-winged pearl oyster was also collected from Mayabunder, Comora and Havelock Is. The distribution of the former suggests possibilities of raising population of these in column waters. The ecosystem appears suitable for developing pearl culture in Andamans. It is also suggested to try the transplantation experiments on Pinctada maxima.


Heavy fouling noticed in the Veppalodai farm necessitated periodical cleaning operations to remove heavy barnacle settlement, bryozoans and bivalve spat, Arctica sp. and Cretostrea sp. which showed a seasonal pattern in the occurrence. Polydora and Cleona were the chief borers. The rate of mortality of oysters due to the foulers and borers ranged from 0.9% to 27.3%. Exposure of oysters to sun, immersion in freshwater for limited duration, treatment with Pentachlorophenol at 1 ppm, formalin treatment and Dichlorophene at 10 ppm as practised elsewhere have been suggested for experimentation in tackling fouling nuisance.


A change of form occurs from subquadrate in the young to oblong in the adult oysters. The hinge length of both valves becomes equal at a size of 32 mm. Consequent on the change of shell shape the young and adult oysters have significantly different regression coefficients, except in some instances.


Thermal stimulation, salinity variation, chemical control using NaOH, NH₄OH, Tris buffer and hydrogen peroxide were tried during the experiments to induce the ripe oyster to spawn with reasonable amount of success.

In a series of experiments on rearing of Pinctada fucata, success was achieved in rearing the hatched out larvae only up to 'D' shaped veliger stage (straight-hinge stage) which was reached in 24 hours from fertilization. Metamorphosis did not take place even after 16 days when the larvae died. Feeding the larvae with Porcellana and Symbiocomnis did not help. Right type of food is necessary to tide over this problem.


The larvae of P. fucata were reared successfully in the laboratory. The pediveliger metamorphosed to planktigrade and settled as spat. Isochrysis galbana was used as a standard food at a cell concentration of 6-8x10⁵/L. Spatfall occurred on days 24-32. Fibreglass tank bottom showed the highest density (4.71/cm²) of spat settlement.


The article gives details of pearl producing areas in India, level of exploitation, process of natural pearl formation, experiments on culturing pearls in India and future prospects.


By adopting the raft culture technique pearl oyster culture experiments proved successful giving 78% survival. The growth of oysters was faster. At Veppalodai, a coastal village near Tuticorin the technique of producing cultured pearls was developed and for the first time spherical cultured pearls were produced. The results indicate good scope for reviving pearl oyster resources by aquaculture and the establishment of an industry of cultured pearls entirely by indigenous efforts.


The surgical instruments needed for preparation of tissue grafts from mantle lobes and in the insertion of nuclei in culture pearl operations in India had been manufactured indigenously and described.


During 1975-77 oysters were experimented in salinities from 14-58%, range which showed that they can tolerate 24-50%, range for 72 hrs. Rate of mortality in salinity dilutions of 16, 15 and 14% were 16, 50, and 100%. In higher concentrations of 52, 55 and 58% it was 67, 100 and 100% respectively. Rate of filtration was low in dilutions and total below 25% in salinities 14 and 20%. In higher concentration the filtration rate was 49, 53.7 and 41.8% in 44, 50 and 57% salinities.

Marine settlers and wanderers in the farm at Kruasadi cause nuisance value if not periodically removed from the cages. A list of such organism has been presented.


A report on the results of pearl bank inspection conducted in February-March, 1834 by Jadh Thalalvan shows the discovery of 34 beds between Kootapuli and Kooduthkai villages (Cape Comorin Zono). A pearl fishery was predicted in 1835; but subsequent poaching by fishermen led to the total disappearance of fishtable oysters.


The Collector of Tirunelveli reported 192 oysters having been fished from Thollayiram paar during the inspection of that bed. On the recommendation of Sir Frederick Adam in 1834, the Governor of Madras appointed Lt. Col. Monteith, Superintending Engineer for future pearl bank inspection. This was done in November, 1835 wherein the occurrence of 24-34 year old oysters was reported; but clandestine fishing by fishermen again spoiled the possibility of fishery being declared.


The dismal record of pearl bank inspections made the Government to requisition the services of Captain Quinton, Supervisor of Ceylon pearl banks to inspect the Tirunelveli Coast and authorised a boat to guard against the depredation of clandestine fishers as well. Quinton stressed the need for charting the pearl banks. He also advocated the policy of avoiding the use of dredges adopted by Monteith and precaution to be taken to prevent 'Dhoney' or boat anchoring on or near oyster beds.


Mr. Franklin appointed for pearl bank inspection till 1939 divided the banks into: (1) 12 banks from Vaipar to Mookur, (2) 21 banks off Tuticorin, (3) 24 banks off Pinnakayal and (4) 14 banks off Tiruchendur making in all 71 banks. The locations and names of these were listed. The report mentioned about the existence of 25 year old oysters in 13 beds but population estimation was apparently not done due to overgrowth of 'Suram' on oyster beds. 21 banks off Tuticorin which contained oysters were considered good for fishing. Dredging in deeper areas where divers cannot reach was also recommended.


Mr. Franklin's report to Government was discouraging, stating that the oysters had disappeared from the beds, probably due to natural causes.


Mr. Thomas, Collector of Tirunelveli suggested the leasing out of pearl banks and the right of fishery to wealthy merchant on 50-50 basis to effectively check the poaching on beds by divers. Government rejected the suggestion. The banks continued to be plundered as revealed by the results of inspection.


The results of inspection confirmed the fears of Mr. Thomas. The entire oysters had disappeared. But the Master Attendant who conducted the inspection attributed this to the action of increased current occasioned by the enlargement of the Pamban Pass and also due to the frequent passage of vessels in consequence of increased trade.


During the pearl bank survey only 17 young oysters were reported from the beds. (Till 1855 no record is available to show that inspection was conducted—S.M.)


Only 6 banks were inspected by a cargo schooner boat. 'Suram' was abundant on the beds. No oysters were found.


Results of inspection indicated the possibility of a fishery in 1860 provided the oysters did not migrate from 23 beds off Tuticorin and 6 eastward of it. This theory of Master Attendant did not find favour with the Government who doubted the power of locomotion of a mollusc which habitually lies attached to rocks. They attributed the reasons for a possible failure to imperfect inspection and plundering of oysters by fisherfolk.


A pearl fishery was held in 1860 in the eastern beds off Tuticorin for 23 days yielding a gross revenue of Rs. 250,476-0-0.


Captain Phipps examined 2 banks with poor results. In his report to Mr. J. Silver, Collector of Tirunelveli, he described the reasons for fierce current washing away oysters. He was optimistic about a fishery in 1867 based on his finding of oysters in the northern beds.

PEARL CULTURE

Captain Phipps inspected Tiruchendur beds where he found 5 year old oysters a plenty and recommended a fishery in 1860-1864 season. A submarine diver Mr. Farmer was employed to dive with local divers in all the beds.

(A letter written by Mr. Silver dated 2-4-1862, however, shows that there was a fishery in 1862 for 21 days fishing 2,980,900 oysters fetching a revenue of Rs. 128,769-4-0-S.M.)

Later in 1862 Phipps examined southern beds at the end of which he was disappointed at the intelligence of the failure of Tiruchendur banks.


73 banks were inspected and the results were disappointing. Only 4 banks had a few oysters free of Modiolus (Sauruam). The inspection lasted from 20-10-1862 to 3-3-1863. In November, 17 banks south of Tuticorin Thalayarum Parr were inspected again but no oyster settlement was seen.


Captain Phipps reinspected seaward banks north of Tuticorin and found them barren.


Vembar, Kilakarai and Pamban group of parais were inspected by Captain Phipps in addition to the banks off Tuticorin, Manapad and Tiruchendur. There were no oysters.


66 parais were inspected during January-March. Young oyster settlement was seen in 15 of them. Pearlking prospects were bleak.


67 parais were reinspected by Captain Phipps in March 1869 and found to be mostly barren except those of Pinnakayal which had 1 year old stock. Captain Phipps was of the view that it was a waste of time examining Manapad banks in future.


In December 1869 Captain Richardson conducted examination of Vaipar banks only to find Modiolus settled over the banks extensively to 2 feet thickness. But the shoreward parais of Tuticorin had dense population of 24 year old oysters capable of yielding fishery in 1893. The extent was calculated to cover 4 miles length and half mile width. Similarly those banks off Pinnakayal also had dense stock. Manapad banks condemned by Captain Phipps, had a good population of 24 year old oysters.


In February 1870 inspection, it was found that Pamban parais were dense with oysters. On March 5th, Captain Richardson found evidences of large scale poaching judged by the remains of what must have been an extensive clandestine pearl oyster fishing in Nallathanni Theevu. Many millions of pearl oyster shells were hove up. The people of Kilakarai and Valinokam must have plundered the oyster banks. His findings sparked off a big controversy.


Captain Richardson inspected Vaipar banks from 27-12-1870. Results were not encouraging in Vaipar, Pinnakayal and Manapad banks.


Captain Phipps conducted further detailed survey of all banks from Pamban to Tiruchendur and stated oysters did not exist except in small quantities. No possibility of a fishery.


Mr. Eastland, an European diver was engaged to dive in 73 pearl banks from which he could collect 30 oysters only, 43 banks were barren of oysters.

Mr. Puckle stated that 'there is but little difference of opinion among authorities on the subject; all seem to agree that under-current and formation of sand on some banks, the deposit of mud and the ravages of the skate and parrot-fish and the moonings of fishing canoes destroy the oysters here and there while no one can give an opinion as to how the oysters may best be matured'.


Parais were inspected by Captain Phipps who found that prospects were still not encouraging. He found Tuticorin banks with very large quantities of young oysters attached to the rocks and weeds. He suggested prohibition of fishing activities in this area.

(NO records are available upto 1876—S.M.)


Out of 18 banks inspected 5 parais gave hopes of a fishery in 1876 or 1880.

Capt. Phipps examined 35 pairs from Vaipar to Manapad and came across only crushed oysters brought out by divers by which he concluded that extensive depredation by sharks and skates had precluded the possibility of a fishery.

Mr. Pennington, Collector, commenting on those observed in his report dated 25-5-1878 that there had been no fishery since 1861-1862 but the proceeds of that and the previous years' fishery alone were enough to cover all the cost establishment since the beginning of the century.


Examination of 25 banks by Captain G. A. Phipps showed spat settlement along with Modiolus. Pinnaakayal banks were singled out for a fishery in 1885.


Captain G. A. Phipps conducted inspection in 31 pearl banks in four months of 1882. No oyster population of value was found. Pinnaakayal beds disappointed this time.


G. W. Wicks completed inspection of 46 banks and found only Tuticorin banks with oysters, perhaps fit for conducting pearl fisheries.

(Inspection of banks from 1885-1905 are furnished by Hornell (1905) in his report to the Government of Madras. See pages 93 to 107. Repeated inspections yielded a fishery in 1889, 1890 and 1900 when 12,600,531 oysters and 1,806,762 oysters were fished respectively from Tholayiram paar and in 1900, when 2,801,036 were fished off Tiruchendur. Again in 1908, 1.1 million oysters were fished in 20 days from Tholayiram paar. Inspection report from 1906-1916 are not readily traceable—S.M.).


Inspection of banks off Tuticorin revealed paucity of oysters. Pamban to Vaipar beds were also inspected but with negative results. A few scattered oyster spat settlement was reported on the seaward eastern edge of Rameswaram, settled on pier. The scheme to start pearl culture experiments at Kruasadi island was kept in abeyance.


No inspection was possible due to the non-availability of launch facilities.


Hornell's inspection of oyster bed revealed total absence of oyster settlement.


Based on the results of pearl bank survey made with M.T. 'Lady Nicholson' a, fishery was forecast for 1927-1928.


28 banks inspected showed the spat settlement (1 year old) and a fishery was forecast for 1926-1927. Hornell observed that 1926 fishery would be a farewell gift legacy as he was relieving office.


Possibility of a fishery in 26 banks has been indicated.


24 crores of oysters were estimated to be ready for fishing in 1926 from all pearl banks covering an area of 770 sq. miles. Declaration of rules under 6 of Indian Fisheries Act of 1897 was made this year for preventing theft of oysters.


There had been a pearl fishery in February-March 1926 in Tholayiram paar. 33 days of fishing yielded 14,696,839 oysters and another fishing in November-December for 23 days yielding 16,68,931 oysters fished from Tholayiram paar. The gross revenue for Rs. 2,56,884-0-0. Cholera outbreak forced the fishing to be closed after 40 days of commencement in March.


The conduct and progress of 1926 autumn fishery and 1927 spring fishery have been given. In the former, 29 days of fishing was possible and the latter was in progress from 11-2-27 to 30-4-27, during which time 10,337,059 oysters were fished out. A special feature of this fishery was the participation of 38 Arab divers. (There is no incongruity in the record about the number of days of actual fishing in 1926—S.M.).


Prosperous spring pearl fishery was held for a period of 97 days from 9-1-1927 to 14-1-1928 and the second from 1-3-1928 to 31-3-1928. The fishery was closed due to outbreak of cholera. A total of 6,251,940 and 3,477,593 oysters were fished bringing a revenue of Rs. 3,38,930-10-11 and Rs. 1,93,483-0-0 respectively to Government. It was...
considered that there might be beds of pearl oysters in deeper waters beyond 11 fathoms. It was recommended that a trawler for conducting dredging in these areas be purchased. A set of dredges was also prepared according to the design of Capt. Cribb. Operations commenced on 27-3-1928 at 9 F and oysters were dredged upto 11 F limit. The area dredged extended from Pamban to Colacal. Results not shown.


Inspection of pearl banks yielded very poor results. Three banks off Manapad were also inspected for the first time in 25 years, apart from 39 pairs from Tuticorin to Manapad.


Pamban group was inspected according to a system of triennial inspection principle of Dr. B. Sundararaj who considered that it was enough to inspect one group once in 3 years since oyster settlement, if noticed will not be ready for fishing before the third year was over. 15 banks from Vembar to Pamban, 13 from Vaipar to Tuticorin 11 banks off Tuticorin were inspected but no oysters were found. A Japanese diving equipment was tested at Sethubavachitram sea coast when it was possible for one person, to remain under water at 4 feet depth for 12 minutes.


In Palk Bay area 14 shoreward pairs off Rameswaram and 2 beds off Tuticorin were also searched. All were barren of oysters.


Efforts to get diving apparatus continued. 45 banks from Tuticorin to Cape Comorin were studied from 11th March to 9th April. Only stray specimens of oysters were obtained.


Diving experiments at 5 feet to 23 fathoms were carried at Sethubavachitnam when a person remained under water for 18 minutes. 28 pearl banks from Tuticorin to Pamban were surveyed and found to be barren. It was suggested that poor rainfall had affected spat settlement.


10 pearl banks were inspected and found to be bare of oysters.


Apart from the continued maintenance of oysters in farm at Krusadai nothing of interest about the natural oyster population has been mentioned. 47 banks of South division upto Manapad were inspected from 26-3-35 to 14-4-35. No encouraging result was got.


An account of how Kundugal Point area near Krusadai was selected for pearl oyster farm establishment had been given. 28 banks of Central division were inspected during March 1936. All beds were barren of oysters.


During March-April 1937, 3 Palk Bay beds and Tholayiram pair were inspected which were found to be barren of oysters.


Spatfall was reported in the Vedalai area. At Mallipatnam (near Tanjore) 74,519 oysters were collected from the nets of gill net fishermen. These were taken to Krusadai farm in addition to 364 oysters collected at the time of pearl bank inspection during April 1939.


An account of attempts to grow oysters at Krusadai farm has been given. 6,782 oysters were farmed and attempt at pearl culture initiated. Inspection of Palk Bay area and Tholayiram pairs did not reveal any oyster population.


During 7 days of inspection of 9 Tuticorin pairs 1,250 pearl oysters were collected. A possibility of fishery was hinted.


Inspection of banks started in November 1952 and concluded on 17th covering central and southern sector pairs. In 13 pairs a total of 6,590,000 oysters were estimated due to the good spatfall of 1952. Pearl fishery in 1955 appeared to be a distinct possibility.

27 banks were inspected in April 1954 with 16 banks having fishable oysters. A preliminary account of the organisation of 1955 pearl fishery at Tuticorin has been given. The fishery continued up to 14th May helping to fish 3,508,967 oysters from Tholayiram paar fetching a revenue of Rs. 1,46,000. Labour trouble thwarted a more successful fishery.


The details of a survey of Tholayiram paar is given. An estimated 830,000 of oysters was reported fishable, being the leftover population, unfished during 1955 fishery. A pearl fishery was commenced on 29-2-1956 which continued for 18 days after which it was closed on 18th March 1956. 2,129,038 oysters were fished. Detailed inspection late in 1956 revealed prospects of a fishery in 1957 from Pinnakayal beds. 12.7 million oysters were estimated for next year's fishery.


Inspections in December 1955 and January 1957 revealed bright prospects of a pearl fishery. Labour trouble postponed the start of the fishery to 14th March 1957. The fishery was closed on 20th May 1957 during which period a total of 1,175,314 oysters were fished bringing a revenue of Rs. 168,807.37. Aqualung diving was done on paars by two departmental divers remaining under water for 10 minutes at a stretch. Routine inspection of Tiruchendur beds from 16th December 1957 to 11th January 1958 revealed that the Karuval group of paars had good stock of fishable oysters. A population of 3½ year old oysters totalling 21.7 million was estimated available for fishery in 1958.


A popular article.


Pearl bank survey work done at Tuticorin by the Scientists of C.M.F.R.I. has been briefly mentioned.

ANONYMOUS. 1959. Administration report of Madras Fisheries Department for the year 1957-58. (MS obtained from Directorate of Fisheries, Madras).

Pearl fishery of 1957 continued up to 20th May for a period of 51 days. Kudamuthu paar group was exploited, 11,175 million oysters were fished during the period, realising a gross amount of Rs. 168,807.31. Elaborate details of the various formalities undergone pearl fishery declaration find a place for future guidance. Based on encouraging result of the inspection in December 1957 to January 1958 another pearl fishery was organised from 3rd March 1958 exploiting 6 southern sector paars off Pinnakayal and Tiruchendur. Till March 1958 and it was in progress for 21 days, fishing 8,315,870 oysters. After some labour trouble during which there was a strike, fishing commenced from 14th May 1958 lasting for another 11 days closing on 26th May 1958. On the whole 55 fishing days brought 21,476,817 oysters, bulk of which came from Karuval paar (7,638,997). A total income of Rs. 265,097.77 was realised. During October 1958 to January 1959, 28 banks off Tuticorin were examined. Tiruchendur-Punthottam paar was found ripe for a fishery as also for Karuval and Kudamuthu. During the fishery Dr. Dumas, a French man conducted aqualung diving in many paars to demonstrate the utility of diving with self contained breathing apparatus.


5th year in the series of pearl fisheries. 5 paars in Karuval and Kudamuthu groups of paars were fished. A rapid inspection of paars in the same group of paars done in November-December 1958 enabled declaration of another fishery in February 1959 which started on 12th February 1959. Pearlings operations continued for 36 days (upto March end) and the total catches upto this date were 10,738,520. (The fishery continued upto 16th May for a total of 62 days). Altogether 16,496,246 (16,428,297) oysters were fished mainly due to Punthottam paar stock. Total income was Rs. 800,568.32 (Rs. 874,001.26). Inspection of pearl banks Tholayiram paar, Kudamuthu group and Tiruchendur group made again during Spring of 1959 gave hopes of a fishery in 1960. 22 million oysters were estimated fishable.


Another fishery was conducted from 17th March 1960 to 7th May 1960 for 52 days. A total of 16,175,839 oysters were fished bringing a revenue of Rs. 215,266.88. This time the bulk of oysters fished were from Tholayiram paar (14,459,698) and the rest from the nearby Kathadar paar.


13 banks were inspected of which Tholayiram paar alone was estimated to contain 20 million oysters and Kathadar another 1.3 million. P.B. Salvadori, FAO expert in SCUBA diving and his counterparts helped in the inspection. A total of 16,176 million of oysters were fished out on 30 days. During November-December 1960 again Tholayiram paar area was inspected and a fishery was declared from 22-3-1961 to 15-5-1961. This fishery for 37 days yielded 15,360,928 oysters (vide histogram in Annexure I, III of report in page 131).


Five distinct species of Pinctada have been listed as occurring in Indian waters namely Pinctada vulgaris, P. margaritifera, P. chemnitzii, P. amboinoides, and P. ariinfurcata. P. vulgaris occurs in the Gulf of Mannar and in the Gulf of Khutz. P. margaritifera occurs sparingly. P. chemnitzii
is found in the Gulf of Mannar, Andaman and near Bombay. Ten grades of pearls are recognised viz., Anti, Vadivo, Anathadi, Maasagai, Kaliupi, Kortower, Penal, Mandangai, Kurai and Thul. The market price of pearl increases as the square of its weight or size. An account of the physical structure of cultured pearls and imitation pearls has been given.


The book is divided into 14 chapters giving information about pearl fishing which existed in ancient times as evident from the writings and available records during the days of imperial Cholas, later Pandyas, Portuguese, Dutch and 19th century Governments. Apart from its historic treatment of the subject, little of scientific interest is aimed.


The paper presents an account of the salient features of the oyster biology, the habitat of oyster off Tuticorin, theory of pearl formation and the general organisation of pearl fishery, diving methods and the day to day fishing details.


Although mostly devoted to edible oysters this contains a few references on pearl oysters as well.


The possibility of a pearl fishery in 1955 based on the inspection results indicating fishable oyster population in Thollayiram peer during 1953-54 has been forecast.


An account of a 1955 pearl fishery held at Tuticorin is given.


It has been mentioned that oysters can be transhipped from natural beds to areas of farming keeping down mortality rate while in transit by adequate precautionary steps.


An account of a minor fishery held in 1956 has been given with details of area fished.

CHACKO, P. I. 1959. Food and feeding habits of the fishes of the pearl banks, Thollayiram peer, in the Gulf of Mannar. Fisheries Station Reports and Year Book 1955-56 (Madras Fisheries Dept.): 80-83.

The bottom feeding fishes, Abalista stellaris and Scopogistis bimaculatus, the carnivorous Cephalofoils mitratus and Epinephelus undulosus constituted the main threat to pearl oyster spat.


A brief review of the past and recent pearl fisheries held in the Gulf of Mannar and Palk Bay upto 1961.


The settlement and growth of oyster spat (4-40 mm size) noticed on the carapace of Chelone mydas has made the authors suggest that the turtles may act as dispersing agents, during their sojourns to different areas of ocean.


An account of the oyster stock.


Chemical analysis shows that chank and pearl meat are fit for human consumption due to the high protein value. The flesh contains 14.42% protein in the case of oyster and high in minerals and glycogen. The oyster flesh is palatable.


Dorso-ventral dimension and hinge line showed positive growth upto a certain period followed by growth recession. Thickness increased uniformly throughout the period in size range 30-45 mm stagnating in older size groups 45-60 mm during certain periods of the year. Weight increase was steady in the early size groups. Growth appeared to be faster during September-January and less in other months.


Bivalve eggs and larvae along with appendages of copepods, gastropod and crustacean larvae and spicules of sponges have been observed regularly while analysing the stomach contents of Pinctada fucata. Very often, oyster eggs and larvae fed to the starving pearl oysters were expelled along with faecal discharge as such.


Blooms of Trichodesmium were observed at the pearl oyster farm site during March, April and September 1973 but the high concentration did not cause any unusual mortality of oysters. But in the laboratory, oysters died when they were kept in bloom laden water perhaps due to the decaying algal filaments.

CHILLAM, A., T. S. VELATUDHAN, S. DHARMARAJ AND A. C. C. VICTOR. 1983. A note on the predation of pearl oyster...
**Pearl Culture**

James Hornell initiated culture pearl experiments in India and claimed to have obtained "six tiny, smooth surfaced perfectly spherical free pearls", but the technique followed by him was not made known. The publication mentions techniques followed in Japan for culturing pearls and also a technique evolved as how to implant the mother of pearl nucleus in the virtual chamber formed by the adductor muscle, pallial muscle insertions and the hinge line. This method would, it was hoped, yield quality pearl.


The achievements in research and development of the Institute’s scheme on pearl culture since 1973 have been highlighted as one of special breakthroughs in marine research in India.


The techniques of pearl oyster farming and cultured pearl production are described. Artificial breeding, larval rearing, spat collection, nursery rearing, microalgal food production and water management have been successfully done at Tuticorin to produce pearl oyster seed. It is estimated that 500,000 spat per spawning can be produced using 50 larval tanks.


Oysters from natural beds showed low rate of oxygen consumption compared to those collected from near inshore waters, 0.5-1.5 m depth. Younger oysters (20 mm and below) were found to consume more oxygen/hour. The measure of gap between margin of shell valves was found to vary inversely with the amount of oxygen present in sea water.


**Balanus amphitrite,** *Membranipora* and *Dicarpa* sp. formed the major fouling organisms while *Polydora ciliata* and *Clione vassiljevi* were the main boroza. Barnacle settle-
ment was heavy and seasonal particularly on shells than on live oysters. The seasonal fluctuations in the occurrence of fouling organisms in Vepadalai farm area, Tuticorin harbour basin and in the natural beds showed many contrasting features.


42 khadas occupying 60,000 acres lying from Jodlya to Ajud are exploited for pearl oysters by fishermen. From statistics of pearl fisheries ever since 1913 to 1967 it can be seen that oysters numbering from 522 (1938-39) to 76,658 (1916-17) were fished during the years of fishery. Un-productiveness and thinness of population of oysters have been the main problems of Gujarat Coast.


For the first time a scientific method of charting and studying the pearl banks and their fauna and flora in India, using Aqua-king for direct observation had been followed and reported. 3 selected areas were surveyed in detail by a F.A.O. diving scientist and 4 of his Indian counterpart scientists, trained by him. The studies helped in population estimation of oysters.


The report indicates the progress of work done by Indian scientists using SCUBA in the study of pearl banks. Exploration at intervals of 600 m covering an area of 100 sq. miles of sea bed had been taken up in addition to studies on environmental parameters.


The last report gives further details of the progress made in the underwater studies of pearl banks off Tuticorin by SCUBA diving and outlines the future lines of technical programme to be implemented.


Atmospheric temperature recorded was lowest in January rising upto May, falling again in June and July. A secondary maximum was seen in September-October. The range of variation in surface temperature of water 4.1°C - 6.4°C in different years. Salinity increase was noticed upto June from February. The lowest was in November and December.


Zooplanktonic abundance followed a peak phytoplankton production. During April-May the plankton biomass was low, although phytoplankton abundance appeared to coincide. Low salinity period in January was marked by zooplanktonic abundance.


Chromatograms showed bands corresponding to 8 Alanine. Glutamic acid, Glycine, Taurine and Aspartic acid were also seen in the extracts.


Records of Jamdarkhana show that during the days of Jam Vibul pearls were not fished but the珠者 could collect and give them to Jam Sahibs of Jamnagar. It is surmised that Persian Gulf oysters would have helped originally to populate the Gulf Coast also. A pearl park was created in 1952 for carrying out investigations. The average output of Gulf of Kutch has been given as 30,000-40,000 oysters per year due to the sparse populations.


The oyster shows two distinct periods-one of active growth and the other of rest in a year. They grow fast till they attain their fourth year after which a fall was discernible. Sexual maturity was seen at the age of three or four and the life span calculated to reach up to seven years normally. No overfishing of beds has been reported. On an average 15-20% pearl yield has been obtained from oysters of 4, 5 and 6 year old. Pearl formation might start at the age of 2-3 years.


Depredation by pearl bank fishes wipes out large quantity of oysters in the early stage itself. Of these, filefishes and breams devour enormous number of oyster spat. Oyster-eating rays (Himantura sp.) rank next in importance as oyster enemy causing widespread devastation of beds. The extent of damage done has to be seen at the sea bottom to be believed as did the author during his descent to the oyster bed so ravaged.


Rich pearl oyster reefs are reported lying scattered along the coast line of Nawasgarh. The salient features of the pearl fishery of that state are given. The Fisherfolk received 1/8th of the value of pearls in cash, 1/4 th in cloth and 1/20th in food, in addition to prices for the best pearls.


A detailed account of the results are given.


The history of Gulf of Mannar pearl banks witnessed periodic occurrence of alternating conditions. A cycle of years when oysters were abundant yielding valuable fisheries resulted in increasing predator competition for praying on oyster flesh in the next years thus turning the balance in favour of fishes, sharks, rays and skates which devour oyster spat, crunching the shells and destroying the population.


Transplantation of pearl oysters from deeper area to oyster 'parks' had been advocated to ensure a good and dependable source of revenue from pearls produced by oysters grown in such areas.


The fishery was the first ever held in Palk Bay. The fishing commenced on 27th August 1914 and closed on 19th September 1914. The beds off Karangadu and Pasipatnam, at 5 fathoms depth were exploited, fishing in all 315,998 oysters off Pasipatnam and 39,613 oysters from Karangadu beds. Never before were pearl oysters noticed to thrive on muddy ground as in the present case. The revenue realised was poor and the scale of cholera epidemic kept away many from participating. Added to this, unfavourable weather from 14th September brought about premature closure of the fishery. Hornell suggested that dredging for oysters in such areas might be more economical. He mooted out the idea that Palk Bay area should be observed as a 'breeding reserve' for populating the Gulf of Mannar parks, the dispersal of larvae taking place with help of south flowing current and drift.


Description of *Margaritifera vulgaris* has been furnished. Oyster spat, it is stated, are capable of locomotion in the initial stages for finding out a suitable substratum for attachment before they finally settle down. The spat settling stage is achieved in a weeks time from the time the eggs are fertilized. Gulf of Mannar, Gulf of Kutch and Palk Bay are three areas where oysters settle down and grow in Indian waters.


Inspection of beds from Vaipar to Manapad indicated very dense pearl oyster spat settlement in majority of the banks (28 out of 54). The prospects for a bumper fishery in next few years appeared bright. Legal restrictions to protect the banks appeared to be unnecessary. Beds of Tondi were barren of live oysters, as also the Rameswaram area.


Mention of oyster resources in India has been made.


A list of marine foulers and epifauna of oysters grown in Krusadai farm has been given based on observations made at the time of routine cleaning operations of the cages. The importance of the barnacle as the most prolific fouler has been shown. The foulers during southwest and northeast monsoon periods were most abundant, and the various species collected have been listed under two groups.


This article describes the preparations made by skin divers before diving for oysters in India, the role of tenders and the routines of divers when a pearl fishery is in progress.


Popular article which emphasises the need for culture pearl operations to be started in India.


For the first time results of scientific survey of oyster beds carried out using 'SCUBA' in the Central and Northern sectors off Tuticorin have been presented. The area covered, at intervals of 600 m, was 769 sq. km. and the pearl beds charted out have been mapped showing the extent and position of each. The characteristic fauna and flora have been identified and the interaction among the animal communities explained. The effects of starfish population, *Modiolus* spp. settlement, *Octopus* population and the bottom dwelling fishes on oyster life have been described. Chank beds have also been surveyed and marked showing the density of population. Under-water photographs of important denizens of pearl banks have been given.


An account of 'SCUBA' diving and its progress in scientific investigations of pearl and chank beds in the Gulf of Mannar is given.


An overall review of the pearl oyster resources of world has been given. The areas where oyster occur, an account of pearl fisheries in India and the methods of fishing by skin diving and picking oysters as in Gulf of Kutch have been described. A review of traditional inspection methods used in oyster population estimation and the progress achieved by modern method of Aqualung diving are given.
showing their comparative efficiency in exploitation. The paper outlines the role played by Modiolus spp. and Octopus in destroying pearl oyster population over natural beds.


The flat rock nature of Gulf of Mannar beds covered by coarse sand affords ideal substratum for oyster settlement and the sandy bottom of Palk Bay is less ideal so. Predominant pearl bank fishes in the Gulf of Mannar are the characteristic bottom dwelling Balistes spp. Gasteria spp. and Sarraus spp. The Palk Bay area fauna is mono-tonous and shows contrasting composition.


Periodic ‘SCUBA’ diving observations on the pearl bank during 1970 to 1972 showed that it was not advisable to depend entirely on wild oyster stock for getting requirements of seed for pearl oyster farming work. The spatfall has been irregular and vitiated by the settlement of competitor Modiolus in all beds. The intensity of such settlement is so enormous in almost all years that healthy oyster survival becomes a matter of chance.


Pearl oyster species in India and their diagnostic characters have been mentioned.


The fluctuations in the surface temperature of sea water observed from 31 rocky beds (paars) follow closely those of the overlying temperature. Salinity touches a low in December-February due to probably current direction and discharge of freshets from major rivers during North east monsoon rains. Dissolved oxygen was high and silicate content fairly rich (14.5 gm a/L). Data on other chemical and physical characteristics have been furnished.


Both S.W. and N. E. monsoons affect the hydrographical conditions of the pearl banks. Good mixing of water has been characteristic feature of these areas as revealed by the absence of marked vertical gradients of temperature, salinity and oxygen.


Based on the annual growth ring studies of 2 oysters the authors infer that the oysters life span can extend beyond 8 years, although normally not so. The increase in length, breadth and hinge length in relation to age does not appear to be uniform. Growth arrest in summer and quick growth during November to February have been noticed. The thickness of hinge and hinge-width appear to be proportionate to the age of oysters and hence these two factors are more dependable in age determination.


Monition has been made of the great success achieved in pearl culture at Tuticorin in 1973 and also a pilot scale project on pearl culture started by Kerala Government at Vizhinjam since good settlement of oysters was brought to light in 1974.


Thoroughness and greater efficiency of the exploitation by following aqualung diving calls for introduction of this method in the exploitation of chanks and pearl oysters. CMFRI can impart training to fishermen so that aqualung diving can become popular and profitable.


Totally 7 paars were inspected prior to the fishery, getting 2,000 samples of oysters. The analysis showed that the oysters can be fished at once and population of fishable was estimated to be 12.7 million aged 3-4 years. The pearl fishery which followed yielded 11,175,214 oysters in 51 days of fishing. The Government realised a revenue of Rs. 166,366.87.


Systematic account of the five species of pearl oysters of India P. vulgaris, P. margaritifera, P. chemusiti, P. anomiatus and P. attaparueus has been given indicating diagnostic features for their identification.


The ritual of the divers' fishing day has been described to show their enthusiasm and efficiency. The oyster purchasing public respond with equal expectancy to become owners of valuable pearls, purchasing the oysters either in auction or from divers' lot.


Pearl oyster reefs, 42 in no. occupying 24,000 hectares occur between Sanchana to Ajad. Handpicking of oysters is done during southwest monsoon. The last pearl fish-
ing of 1968 yielded 30,000 oysters. Culture experiments were started in 1956 at Sikka but did not produce desired results.


Mortality of the pearl oyster in the farm at Tuticorin due to sudden fall in salinity has been mentioned.


The identity, synonyms and distribution of six pearl oyster species under the genus Pinctada have been dealt with. Pinctada sugillata has been recorded for the first time from Indian coasts.


The field identification of shell characters of Indian species of pearl oyster have been given. The criteria for recognising the different species are : (1) Presence or absence of hinge teeth, (2) nacreous border (3) width of nacreous layer, (4) shape and positions of anterior and posterior ear and (5) shell colour and markings.


20 important plankters have been reported as occurring in the waters although fluctuating in abundance. This indicative of the seasonal conditions influencing the primary productivity in this area. The presence in good number of larval forms of fishes shows that the zone may be a nursery for pelagic species.


Results of survey of 10 paars showed the waning oyster population after the last fishery. Only 964 oysters were collected in 65-66 mm size, which according to the author should belong to 5 year age group.


A short review of pearl fishery in India is given. The paper gives a resume of the progress made in India of oyster farming, mussel farming, cockle farming and about the potentialities of clams in India. The paper points out the need for organised development, proper extension, availability of seed for large-scale culture, finding out low cost technology and developing post-harvest technology and quality control. Future plans like developing economic data base, cost benefits study of culture of oysters and promoting R and D efforts are envisaged.


678 references pertaining to work on pearl oyster from all parts of the world are listed.


200 veligers from plankton collected over the paar ranged in size 24.3 to 36.5 and have been considered to be pearl oyster larvae based on their resemblance to those described by Herdman (1906) and Hornell (1922).


The bearings and names of important paars of Mannar coast of India have been given in addition to chronology of inspection of paars and fisheries conducted.


The conduct of the pearl fishery and the results were given.


The algal flora of pearl beds is rich. In the four zones where collections were made by diving as many as 69 species had been reported in Zone IV, 15 in Zone III, 61 in Zone II and 25 in Zone I. The algae are mostly of the types found in coral beds, irrespective of depth. Majority of green algae inhabiting deep waters are siphonales. Blue green algae was totally absent in the collections. The presence in good quantity of brown algae in the paar area is interesting. Red algae Gracillaria and Hypnea valentiae are also commonly seen in Zone IV which is off Tiruchendur.


The iron content of the meat without pearl formation is 7 times that of the meat with big pearls. The aminoacid make up of the protein from different portions of meat does not show variations.