



Status of Marine Pearl Culture in India

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Pearls, the gems from the sea, have been admired and adored as symbols of beauty, power and love. In the *Shastras* pearls are recommended as a charm. Ancient *Ayurvedic* and *Unani* physicians have used powdered pearls in their medicines. Natural pearls are formed when an irritant like a grain of sand is swept into an oyster and is lodged within its flesh where it gets coated by a micro-thin layer of nacre, a silvery substance that is about 90 percent calcium carbonate. The oyster continues to coat the irritant, layer by layer, transforming the irritant into the shining pearl, the nature's miracle. The majority of natural pearls are irregularly shaped or blemished.

Pearl-producing molluscs have the shiny mother-of-pearl layer on the inner side of its shell capable of producing a pearl. Pearl as a jewel is produced by only a few species of bivalves. Among the bivalves the prime species of pearl oysters producing the finest pearls are *Pinctada fucata*, *Pinctada margaritifera* and *Pinctada maxima*. The winged oyster, *Pteria penguin* produces pearls rarely. The window pane oyster *Placuna placenta* produces seed pearls which are porcelainous and translucent. These are used for their medicinal properties and are not considered as gems. Other bivalves like the marine mussels, *Perna* sp and several species of the giant clam *Tridacna* sp and several others occasionally produce porcelainous pearls without mother-of-pearl.

Apart from the bivalves, some gastropods available in Indian seas such as the abalone, *Haliotis* spp and the queen conch *Strombus gigas* are also known to produce pearls. Tooth or tusk shapes are distinctive characteristics of many natural abalone pearls. One of the first recorded abalone pearls are in the crown of the Buddhist Goddess of Mercy (installed in 748 A.D) located in the

Sangatsu-do of the temple Todai-ji in Japan. The queen conch is an icon of the Caribbean culture which produces a porcelainous pearl that is variable in shape from extremely baroque to very symmetrical and ranges in colour from beige to pink which are sometimes enhanced by a "flame structure" making these unusual gems intensely attractive. Rare non-nacreous whitish cream pearls are reported to have been recovered from one species of cephalopod, *Nautilus pompilius* or the chambered Nautilus. *Haliotis varia*, a small sized abalone, is an intertidal mollusc along the southeast coast but reports of natural abalone pearling in the Indian waters are not available.

The technique for culturing pearls or pearly objects was first developed in the freshwater mussel in China in the 12th century and small outlines of Buddha made of tin were inserted within the fresh water mussel for pearly coating. Marine cultured pearls have their origin in Japan during the second decade of last century. The credit for formulating the pearl sac theory and for developing a cultured pearl industry goes to the Japanese. Till recently the international market for cultured pearl was controlled by them. However, in recent years several other nations have started utilizing their pearl oyster resources and Japan had to lose its monopoly in the production and trade of this precious jewel. In 1998, the world pearl export valued at 396 million US dollars was controlled by French Polynesia (28%), Australia (20%), Japan (14%) and Indonesia (14%).

Natural Pearl Fishery

Along the Indian coast, natural beds of pearl oysters known as *paars* in Gulf of Mannar and Palk Bay and *Khaddas* in Gulf of Kutch were frequently exploited by fishers to harvest the natural pearls. The Indian pearl fisheries were equated

at one time with the Persian Gulf fisheries for the production of the finest oriental pearls. From 1663 to this date, in 338 years, there have been only 38 pearl fisheries rounds. During 1955 - 61, the annual (restricted season) number of pearl oysters fished in the Gulf of Mannar ranged from 1.18 million (1957) to 21.48 (1958), the average being 10.85 million oysters per fishery per season. In the Gulf of Kutch, the fisheries used to be conducted every 3 or 4 years, seven in all, with an average annual production of about 19,000 oysters between 1950 and 1967. Unfortunately this activity dwindled gradually and virtually came to a halt in southeast coast around 1960s. The collections from Gulf of Kutch also ebbed out in 1966. Descriptions about the pearls harvested are few. Reports about the 1958 pearling indicate that fine pearls of 7 carat and baroque / blisters up to 23 carats were also collected. The main reason for the decline of natural pearling has been identified as paucity of oysters. One peculiarity of Indian pearl industry was that only the pearls were utilised, while the shell and the meat were discarded. In some of the major pearl producing nations, the early pearl industry relied on mother-of-pearl shell mainly used for buttons and inlay work. In India though the pearl beds have recovered slightly from their earlier barrenness, they have not yet recouped to a stage to support pearl fishery.

Pearl fisheries were practised for several centuries in many parts of the world. The most important pearl fisheries contributing to 85% of the world production of natural pearls had existed in the Persian Gulf. The pearling areas were Kuwait, Bahrain, Dubai, Bushire, Charak and Lengeh in the Persian Gulf and Muscat in the Gulf of Oman. After 1952, Bahrain did not conduct any pearl fishery as the divers were gainfully employed in oil companies. Among the Arab nations, Kuwait



still relies on natural pearls even though the probability of landing a commercial sized pearl is one out of 4,200. The Sri Lankan pearl fisheries were also once famous as those of the Persian Gulf, producing the true oriental pearls. However these pearls were generally small. Pearls from the Philippines, ranging in colour from white to bronzy-greenish black, were also famous especially in Singapore, Paris and London. Pearl fishery was practised in the Gulfs of Panama and California, the major species being *Pinctada margaritifera*. The famous Tararequi pearls were from the Gulf of Panama. Other famous areas of Pearl fisheries were in the islands of Cubagua and Margarita in the Caribbean from where the light yellow coloured pear shaped Peregrina pearl weighing 134 grains was fished.

Pearl fisheries used to be conducted for the shells of gold-lip or silver lip (*Pinctada maxima*) and black-lip (*Pinctada margaritifera*) which were commercially valuable as raw material for the manufacture of buttons and for the mother-of-pearl inlay work. In French Polynesia approximately one in 15,000 black-lipped oysters gave a natural south sea black pearl. However, this industry declined dramatically with the introduction of plastic buttons. In Japan, Australia, French Polynesia and China, the pearl industry recovered with the introduction of pearl culture in 1950s. Even after the development of pearl production technique, natural pearl fishery is conducted in many nations. In 1996-97 about 96,510 natural pearls were exported from Australia.

Pearl Oyster Resources and Pearl Culture in India

Among the six species of Pearl oysters recorded in the Indian waters, *Pinctada fucata* (Fig.1.) is the main species, which is used for pearl culture in the mainland. In the Andaman and Nicobar waters the black lip pearl oyster *Pinctada margaritifera* (Fig.2.) is available but is not utilised currently for pearl production. James Hornell, the dedicated British biologist in India, had observed that there were 72 pearl banks, known as *paars*, mainly located between 8°20'N and

9°00'N lat within 78°15'E and 78°25'E long. However, these *paars* became unproductive and barren towards the late sixties causing great concern to the pearl industry of the nation. Right at this period, the Indian Council of Agricultural Research supported the planning and implementation of a Scheme on Pearl Culture by the Central Marine Fisheries Research Institute. In 1972, the technology for pearl production, based principally on the Japanese methodology of pearl production, was tried and adopted successfully in respect of the Indian pearl oysters. The technology essentially involves the introduction of an artificial bead along with a secretory mantle tissue into a recipient oyster. The tropical marine environment of India is found conducive to foster the formation of perfectly spherical pearls within a period of 6-8 months. A Well-directed research on pearl culture was organised by the CMFRI in collaboration with the Government of Tamil Nadu. Subsequently, the Department of Fisheries of Tamil Nadu collaborated with the Institute in an *ad-hoc* scheme on pearl culture. During this period multiple production of cultured pearls was achieved and surgical equipment for nucleus implantation was also developed indigenously. This led to the establishment of a pearl farm at Krusadai Island by the Government of Tamil Nadu.

Technology for Production of High Quality Marine Pearls and Protocol.

While the technology of pearl oyster farming and pearl production were avail-

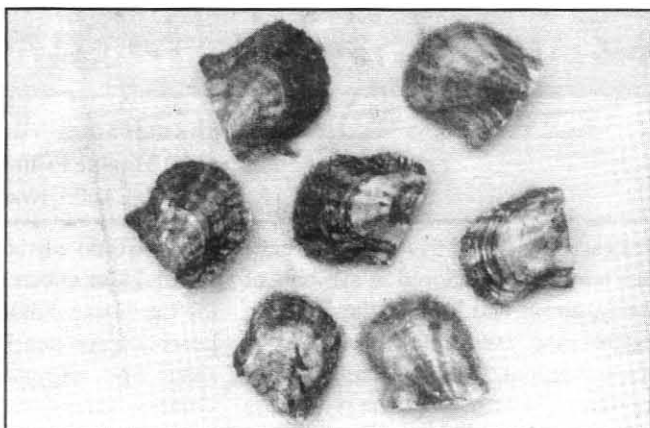


Fig 1. The Indian pearl oyster *Pinctada fucata*

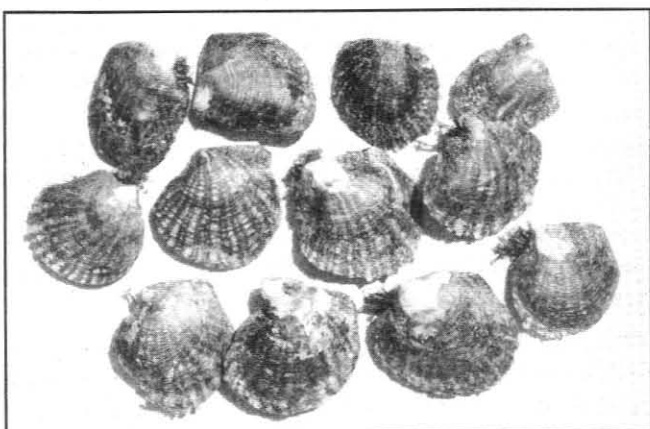
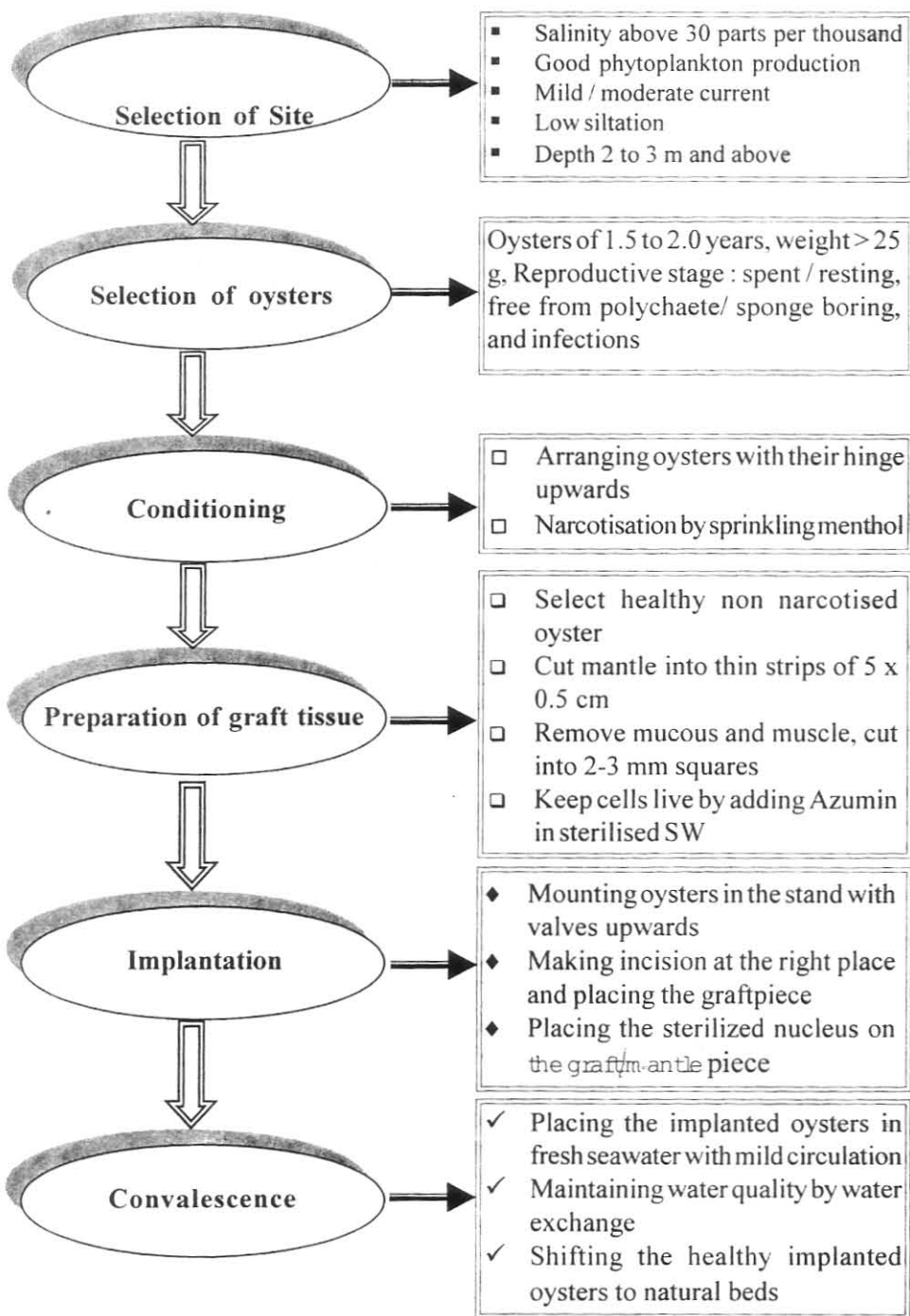


Fig 2. The Black-lip pearl oyster *Pinctada margaritifera* found in the Andaman and Nicobar Islands

able indigenously, the natural beds of pearl oysters were 'barren' and there were apprehensions that the technology could not be put to use due to the dearth of pearl oysters. In this context, the CMFRI launched another research project for the production of pearl oysters through hatchery system. The experiments conducted to induce spawning in *Pinctada fucata* through thermal stimulation and variation of pH were successful. In October 1981, the pearl oyster larvae were reared successfully to veliger stage followed by spat setting. This answered the critical predicament of paucity of resource for carrying out cultured pearl production. The flagellate *Isochrysis galbana* is used as larval feed and the mean size of spat at setting, which is usually after 22 days, is 330 x 330 Mm. The hatchery reared spat are transferred at an early stage (about 4 mm) to iron (6 mm dia) framed boxes covered with nylon mesh and lined on the inside with a fine



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hollows and secured to coralline projections. As expected, these young pearl oysters grew in the natural habitat and propagated by spawning, thereby augmenting the pearl oyster population in the *paars*. Subsequent dives made in the beds clearly indicated replenishment of the pearl beds as seen in the number of oysters collected in one diving hour (Fig.5)

Methods of Pearl Farming

1. **Rack Method:** This method is especially suited for shallow seas. Bamboo or casuarina poles are driven into the bottom spaced 1-2 m apart. These stakes are connected horizontally with poles. The horizontal poles should be above the level of water at high tide. Cages with pearl spat / pearl oyster are hung from these. The pearl farm of CMFRI at Mandapam is a typical rack system (Fig.3)

2. **Long Line Method:** This method is considered ideal for unprotected open sea conditions. Synthetic rope of 16-20 mm diameter is used for the long line (main line). The main line is supported with 220 litre barrels tied to it, spaced at 5 m. The long line and barrels are anchored in position at either ends using concrete blocks and nylon ropes. Pearl oyster cages are hung from this long line. The experimental pearl oyster unit at Cochin used longline, which showed good performance.

3. **Raft Culture:** This kind of culture is ideal for open sea conditions which are not rough. Square or rectangular rafts are made with sturdy bamboo or casuarina poles. Buoyancy for the raft is given by tying 5 barrels of 200 litre capacity (metal oil barrel painted with anticorrosive paint or synthetic barrel). Ideal size of the raft is 5x5 m. The rafts are to be positioned at suitable site in the sea using anchors (grapnel, granite, concrete).

meshed synthetic fabric. They are kept until they can be transferred to square cages with rigid mesh. When the spat measure 25-30 mm dorsoventrally, they are grown in iron cages (40 x 40 x 10 cm) webbed with 15 mm mesh nylon webbing.

The CMFRI thus became the nerve centre for pearl culture research and development in India. With the technology and capability to produce large number

of spat in the hatchery, a programme on sea ranching to revive the pearl beds was launched in 1985. Pearl oyster spat were reared in the hatchery (Fig.4) until they reached 3 - 5 mm and then transferred to the harbour. When they attained a size of 10 - 15 mm, they were allowed to settle on synthetic webbing and taken to *paars* in the Gulf of Mannar where they were lowered to the sea bottom, placed in the



Pearl cages are suspended from the raft. At Tuticorin, rafts have been used for pearl farming since 1972.

Transfer of Technology programmes through training

The CMFRI, over the years, has adopted an open policy of providing training targeted at pearl culture not only for Indian nationals but also to foreign technicians who are sponsored through their governments. In consonance with the policy of the Indian Council of Agricultural Research for the transfer of technology, the Institute has been conducting training courses in (1) technology of pearl culture, and (2) technology of hatchery production, since 1976. Apart from these, the Trainers' Training Centre (TTC) and Consultancy Cell of CMFRI also conducts training programmes in pearl culture and SCUBA diving. Officials from the fisheries departments of maritime states and from the Union Territories of Lakshadweep, and the Andaman & Nicobar islands have participated in the training programmes conducted by CMFRI (Fig.6).

Technicians/officials/students sponsored from other countries like Bahrain, Philippines and Belgium have been trained in Pearl culture by CMFRI. In 1991, CMFRI was the venue for the training programme on Pearl culture under the FAO/UNDP/NACA project on Sea Farming in which 26 trainees from nine south-east and Asian countries (Bangladesh, China, Indonesia, Korea, Malaysia, Myanmar, Philippines, Thailand and Vietnam) participated. Recently CMFRI has given a training programme on pearl surgery and seed production to scientific staff from Bahrain upon their request. Yet another programme is being finalised for Sharja Airport Authority at Sharja.

Pearl culture programmes in different maritime states of India

The awareness on pearl culture fostered through the training programme encouraged some maritime states to initiate their own projects on pearl culture. Along the east coast, M/s Tamil Nadu Industrial Development Corporation Ltd (TIDCO)

and M/s Southern Petrochemicals Industries Corporation Ltd (SPIC) took up a joint commercial project on pearl production in 1983 with technical know-how from CMFRI. This was a laudable pioneering effort by the government of Tamil Nadu and the industry. In recent years, several private entrepreneurs have started pearl culture in the maritime states of Tamil Nadu and Andhra Pradesh. The pearl farm of Indian Tropical Agro Products at Tuticorin was regularly producing marine pearls. One of the significant developments made by these large enterprises was that they were capable of producing pearl spat and which could meet their requirement of implantable oysters without depending on the wild population. Initially, the CMFRI gave tech-

nical help to these pearl farmers and supported them to develop their own facilities.

The Department of Fisheries, Gujarat started a research and development

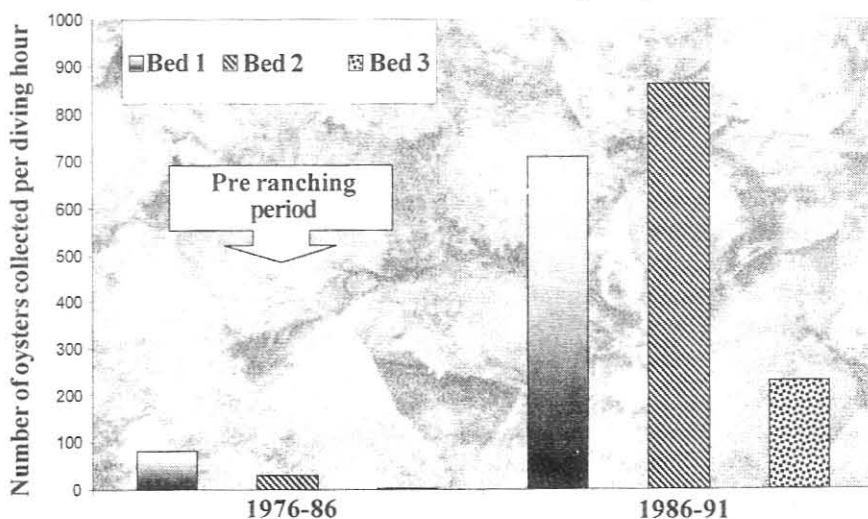


Fig 3. Pearl culture demonstration farm of CMFRI at Mandapam



Fig 4. A view of the larval rearing section in the Pearl oyster hatchery of CMFRI at Tuticorin

Fig 5. Revival of pearl oyster beds along the southwest coast of India after sustained ranching of spat



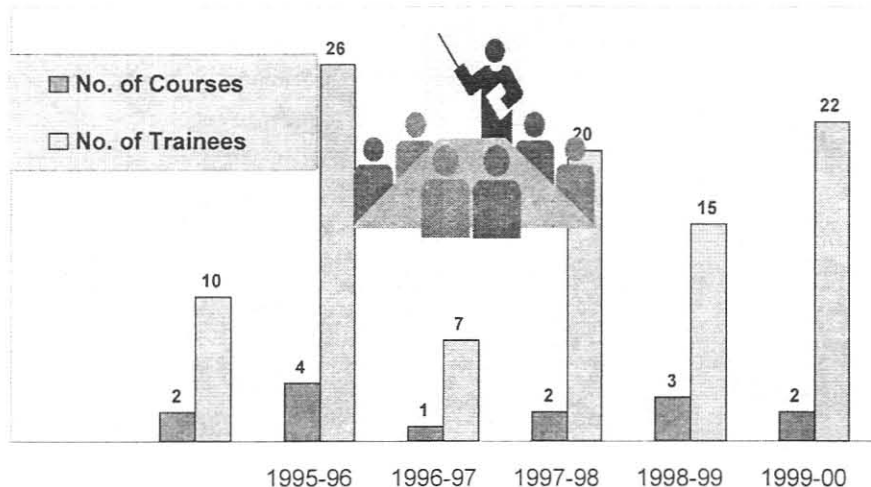


Fig 6. Pearl culture training courses conducted by CMFRI.

programme along the Gujarat coast based on the natural pearl oyster resource. Later, to enhance the depleted stock, the CMFRI offered a helping hand by supplying pearl oyster spat produced in the shellfish hatchery at Tuticorin. With the approval of a World Bank aided project (NATP) on Pearl mariculture, CMFRI has started collaborative programmes on transfer of pearl culture programmes in Gujarat and A&N Islands.

Along the Kerala coast, when there was wide spread alarm about the barrenness of Tuticorin *paars*, it was observed that pearl oyster spat could be collected from the natural beds by hanging suitable material from the rafts in the Vizhinjam Bay off this coast. The Government of Kerala executed a pilot project on pearl culture in Vizhinjam in the seventies. However this had to be abandoned due to technical problems. In 1990s attempts were made again to collect pearl spat from the Vizhinjam Bay. Results of some of the experiments show that spat settlement is profuse in the Bay and these spat can be collected by placing appropriate spat collectors. Growth studies on pearl oysters have also given encouraging results. Feasibility of pearl production along the west coast in the Arabian Sea during the post- and pre-monsoon period (December to May) has been experimentally proved by conducting pearl culture with longlines along the Cochin coast. The formation of nacre was observed to be faster than that seen along the east coast. The quality and lustre of

the pearls are comparable to those produced in the natural pearl beds in the Bay of Bengal. However, the strong upwelling currents and the turbid sea was seen to cause disturbance to the farm structure and the oysters during June to September. Commercial ventures in the Arabian Sea are yet to be developed.

The Union Territory of Lakshadweep started a project at Bangaram Island. Recently efforts were made to grow pearl oyster spat produced in the Shellfish Hatchery of CMFRI in the Island ecosystem. The Central Agricultural Research Institute of the ICAR at Port Blair, Andaman & Nicobar Islands, attempted a project on the black-lip pearl oyster. Resource assessment surveys conducted in the 1980s and also during the end of last century have indicated only sparsely populated beds of *Pinctada margaritifera* in these islands.

Pearl Culture as a Village Level Programme

The feasibility of developing pearl culture as a rural upliftment programme with active participation of fishermen was tested in the early nineties at Valinokkam, a small coastal village of Tamil Nadu in southeast coast of India. Twenty-five fishermen of the village were selected and educated about the importance and economic returns of the pearl culture. The fishermen and their family mem-

bers were involved in all the activities right from the fabrication of grow-out structure to pearl harvest. Part of the pearls produced was given to the fishermen as an incentive (Table.1.) The scope for large scale pearl production through village level community participatory programmes with proper technical and financial support from developmental organisations was clearly indicated by the 'Valinokkam Bay Programme'.

Industrialisation of Pearl Culture

Production of high quality pearls by some industrial enterprises has proved beyond doubt the soundness of the technology. Pearl culture is a composite industry, with different components viz., hatchery production, mother oyster culture, pearl production, processing and marketing. Each component is a specialized area requiring appropriate technology, skill and equipment.

The Indian pearl industry has progressed in the recent years. What started as an experiment in 1972, has supported the growth and development of an upcoming industry. While India has been a net importer of raw pearls during the early nineties, from 1996 onwards it has also been able to export cultured pearls, albeit in small quantities.

Recent Research Programmes in Pearl Culture

In 1996, ICAR provided Rs.30 lakhs to CMFRI through a revolving fund to demonstrate the profitability of pearl culture ventures to the industry. At the Mandapam Regional Centre of CMFRI, a pearl oyster hatchery with a production capacity of 2.0 million spat per annum

Table.1. Pearl production / culture programme at Valinokkam Bay

Valinokkam Pearl Culture A group farming success	
Number of oysters implanted	9414
Total expenditure incurred	Rs. 55,000
Total pearls harvested	1849
Pearls distributed to fishermen	250
Revenue earned from sale of pearls	Rs.76,238



was set up. The Department of Ocean Development also has financed pearl culture programme of CMFRI. It was during the same period that pearl culture was taken up by large industrial enterprises. To cater to their requirement of pearl oysters, CMFRI provided hatchery produced spat. Even now, pearl oyster spat are regularly supplied to the industry from this project. As a spin-off to this activity, young women in the locality were trained in grafting. Along with this, efforts are being made to develop a technique for pearl production through mantle tissue culture. Preliminary success has been achieved in the culture of some tissues separated from the mantle region. Selective breeding and triploidy productions are also tried. Efforts are also made to develop techniques for on-shore pearl production.

Price structure (in Rs.) of Pearl oysters and Pearls produced in CMFRI

1. Pearl oyster spat	0.5
2. Implantable size oyster	4.0
3. Nucleated Oyster	8.0
4. A grade pearls (per mg)	1.50
5. B grade pearls (per mg)	1.00
6. C grade pearls (per mg)	0.65

After a complete reappraisal of the problems facing the pearl industry, it was decided to tackle these with financial assistance from World Bank, obtained through the National Agricultural Technological Project and in collaboration with different Fisheries Institutions and Agricultural Universities. Currently efforts are on to popularize pearl farming in the coastal villages and also the technology of genetic manipulation relative to quality pearl production. Apart from pearl oysters, preliminary success has also been achieved in half pearl production and development of hatchery technique for raising the abalone *Haliotis varia*. However repeated trials and standardization at each level is required before the technology can be made open for commercial operations.

Prospects for Marine Pearl Culture in India

The past two decades have witnessed an influx of cultured marine pearls

Chronological events in the development of pearl culture research in India

Significant achievements in Pearl Culture in India

1972	Initiated a project on Pearl Culture at Tuticorin Research Centre of CMFRI along the southeast coast
1973	Production of first cultured marine Pearl in India
1981	First batch of pearl spat produced in Hatchery
1985-87	Initiation of Pearl culture programme in different maritime states
1985-90	Sea ranching of pearl oyster larvae and spat to revive the natural stock
1991	India hosted the FAO/NACA* training programme on Pearl culture at CMFRI—imparting training on pearl culture to trainees from other South, South East and East Asian countries
1993	Village level Pearl production through direct involvement of small-scale fishers. Pearls worth US \$ 2178 were produced
1994	Pearl produced along west coast through farming operations in the Arabian Sea
1996-99	Signing of Memorandum of understanding with private entrepreneurs
1997	Development of an indigenous pearl nucleus upto 18 mm size by a private entrepreneur
1998	Initiation of genetic manipulations in pearl culture (tissue culture, selective breeding etc)
1999	Reassertion of technological feasibility of pearl culture technology through successful implementation of Revolving Fund Project sponsored by ICAR at Mandapam Regional Center of CMFRI
1999	National Level Pearl culture programme under National Agricultural Technological Programme. Objectives set to refine the pearl nacre colour, develop indigenous shell bead nuclei and to widen the pearl farming areas. Collaborative programme with other fisheries Research Institutes and Agricultural Universities
2000	Intensification of training programme, also training to candidates from Bahrain in Pearl culture and seed production.
2000	Survey of A&N Island by CMFRI to assess the feasibility of black pearl culture

* Network of Aquaculture Centers in Asia

in the international market mainly due to increase in pearl farms in Australia, French Polynesia, Indonesia and Japan. Australia and French Polynesia are the major pearl producing countries and these two nations have different regulatory and marketing systems catering to their pearl industry. Though India was

one of the first nations to develop the pearl culture technique, progress of Indian marine pearl industry has been slow due to several reasons. Chronological events in the development of pearl culture as an industry are given above.

To create a profitable marine pearl industry in India concerted effort should be



made by the Research Institutions, Fisheries Departments of different maritime states and the export promotion agencies. The rural development agencies also should join hands with CMFRI to give thrust to transfer of technology programmes of this nature.

The proposed plan for development of pearl Industry in India

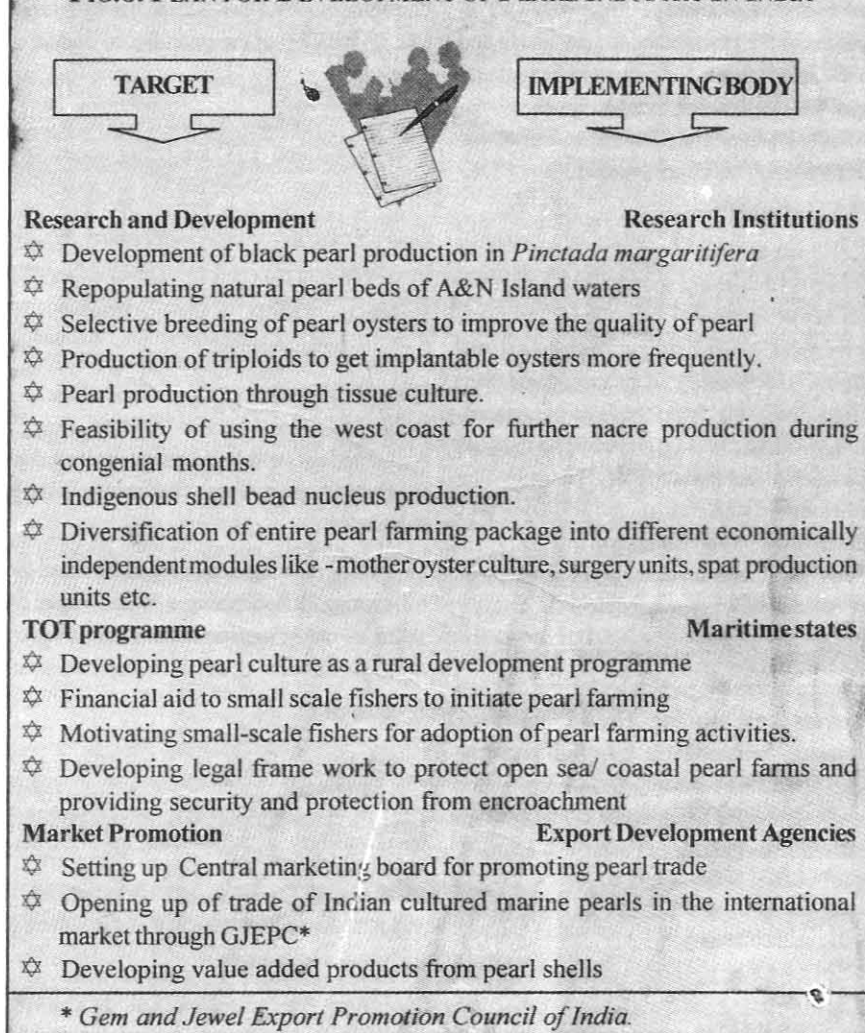
Lack of availability of pearl oysters of implantable size was the main problem two decades back. With the development of hatchery technique for seed production of *Pinctada fucata* this problem has been partly overcome. Pearl culture has been taken up by few large-scale operators along the east coast. However, the lack of a legal framework for providing

security to the farm stock is one of the problems faced by the industry. Similarly, the international market for these oriental pearls has not been explored widely. Compared to the South Sea pearls, the Indian oriental pearls are small and this may have its own drawbacks. Hence a clear marketing plan consistent with the quality of these pearls has to be developed.

Pearl culture has been demonstrated to the small-scale fishers of southeast coast (Valinokkam Bay Programme) as an income-generating scheme in 1991. Though the programme was implemented with participation of fishers they have not been able to continue this activity on their own. This is mainly because of lack of finance to set up pearl farms. Moreover, constant motivation and assurance

that a pearl culture programme will be profitable is needed to enable the small-scale fishers to take up a pearl venture. The local governing bodies have to take action to resolve issues related to leasing of open sea pearl farming parks to promote pearl culture activities. Pearl farming schemes with financial aid to fishers to initiate pearl farming have to be developed by the fisheries departments of maritime states. During the initial phase fishers/farmers have to be financially and technically guided to undertake pearl culture. In French Polynesia one of the reasons for the success of pearl industry is that small-scale co-operatives have been promoted through a cooperative organization which helps with finance, technical advice on culture aspects and marketing through loans secured from development banks.

FIG.8. PLAN FOR DEVELOPMENT OF PEARL INDUSTRY IN INDIA



Another pearl oyster resource of India is the black lip pearl oyster, *Pinctada margaritifera* of the Andaman and Nicobar Islands. Except for a few experiments on the seed production techniques, this resource has not been studied in detail. In the coming years, focus will be to develop technique for black pearl production in the A&N Island waters. Concerted efforts will be made to rebuild the natural population both through planting of seed produced in the hatchery and by developing natural spat collection techniques.

India is now preparing to enter the world pearl market through a well planned research and a developmental plan formulated to support the growth and production of two types of pearls, the golden pearl from *Pinctada fucata* and the black pearl from *Pinctada margaritifera*. The CMFRI is in the process of providing a focal slant to research on *P. margaritifera* and the day is not far off for India to emerge as a major player in the marine pearl industry in the international market.

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