

# **PROCEEDINGS OF THE GROUP DISCUSSION ON PEARL CULTURE**

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# DEVELOPMENT OF PEARL CULTURE IN INDIA AND SCOPE FOR A PEARL CULTURE INDUSTRY

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## INTRODUCTION

The first free, spherical cultured pearl of India was produced on July 1973 at the Pearl Culture Laboratory of the Central Marine Fisheries Research Institute at Veppalodai, near Tuticorin. This marked the development of a technology for producing cultured pearls in the Indian pearl oyster *Pinctada fucata*. Subsequently, several pearls of different sizes and colours have been produced by culture technology. In a series of recent communications, the results of these experiments have been discussed (Alagarswami, 1974; Alagarswami and Qasim 1974a, b; Velu, Alagarswami and Qasim, 1974).

Cultured pearls were produced for the first time in Japan in 1893; these were half-pearls attached to the shells. Spherical pearls were produced in 1907. Since then, Japan has enjoyed an exclusive position with regard to the technology, production and marketing of culture pearls in the world. Australia started pearl culture with the collaboration of Japan in 1956 and Philippines and Burma too have similar arrangements with Japan. Cultured pearls are also produced in Hong Kong, Palau Island, Celebes and a few other islands in the South-west Pacific on a small scale. In these joint ventures, normally the Japanese partner supplies the technical staff and

is responsible for marketing the cultured pearls and by-products and the host company plays a minor role in establishing and maintaining the farm. In an earlier paper, the author has dealt with Japanese technology and indicated the prospects of producing cultured pearls in India (Alagarwami, 1970)

The pearl fisheries of India for natural pearls in the Gulf of Mannar and Gulf Kutch are of ancient origin. But the production of oysters in these regions is irregular and several unproductive seasons intervene between successful fisheries. From 1900 onwards, there have been only 12 fishing seasons, including the grand series of seven years from 1955 to 1961, in the Gulf of Mannar. After 1961 in the Gulf of Mannar and after 1966-67 in the Gulf of Kutch there has not been any fishing for pearls in India.

The Department of Fisheries, Government of Madras (now Tamil Nadu) initiated experiments on pearl culture in 1933 at Krusadai Island. A few cages of oysters were maintained in the farm up to 1963, when they were washed away by strong currents. These efforts were not fully successful in producing free, spherical cultured pearls (Devanesen and Chacko, 1958). In Gujarat too, some experiments on pearl culture seem to have been undertaken without any success.

#### DEVELOPMENT OF PEARL CULTURE TECHNOLOGY

Research project on "Experiments on pearl culture" was taken up at the Central Marine Fisheries Research Institute in 1972 at the instance of the Director-General of the Indian Council of Agricultural Research. The Pearl Culture Laboratory and Farm were set up at Veppalodai in December 1972. The two main objectives of the project were (1) to establish a pearl culture farm on modern lines and (2) to develop a technology for the production of cultured pearls in India.

##### *Pearl culture farm*

For the first time in India, raft culture was employed in the open sea for growing the pearl oysters. Unit raft system was adopted and so far six rafts of different designs have been used in the farm.

These have withstood the rough sea conditions of both the north—east and south—west monsoons. It has been established that raft culture is the most suitable method of farming pearl oysters in the Gulf of Mannar (Alagarswami and Qasim, 1974a, b).

Oysters were collected from the pearl banks off Tuticorin by SCUBA -diving and skin diving. They were taken to the farm, cleaned and measured. The oysters were arranged in sandwich—type frame nets and suspended from the raft. The oysters were periodically brought to the laboratory for cleaning and measuring their growth. Fouling by barnacles was found to be a major problem in the farm resulting in the mortality of some oysters. Otherwise, the oysters showed a general state of well being. The sea off Veppalodai appeared to be suitable for the growth of the oysters as could be deduced from the presence of growth processes on the shell margins during most part of the year. The discharge of freshets from the Kallar river in the north-east monsoon period caused a slight drop in salinity in the farm area, particularly off the sea bottom, but did not affect the oysters. The clarity of water was poor during most part of the year and light penetration was confined to about 1.5 metres in a total depth of 4 metres, at its best.

Settlement of pearl oyster spats took place in the farm on the suspended frame nets and the oysters. Over 600 spats were collected in this incidental manner without any special efforts for spat collection. This is a significant observation for augmenting the stock for mother—oyster culture.

#### *Pearl production by culture technology*

Before discussing the technology, it may briefly be mentioned here how are pearls produced. The pearl oyster has a mantle, which is the skin covering the soft tissues, on either side and lies beneath the shell. The nacre of mother-of-pearl found on the inner aspect of the shell is formed by the secretion of epithelial cells of certain parts of the mantle. When some particles floating in the sea accidentally get arrested within the tissues of the oyster, they cause an irritation to the animal. As a means of defence against the irritant, the oyster embeds

the foreign particle in a sac so that the irritation is reduced. If the sac happens to be formed by the epithelial cells of the mantle it secretes nacre around the foreign particle. This stage marks the beginning of the formation of a pearl. The sac is called the "pearl sac" and the foreign particle the "nucleus", which may be a parasite, larva, of mineral composition, silt, grain of sand etc. The pearl sac keeps growing with the growth of pearl inside. The pearl thus produced is called a "natural pearl". The natural pearl generally takes the shape of the nucleus and hence is seldom uniformly round.

"Cultured pearl" is also produced by the pearl oyster by the same biological process as the natural pearl. But here, the nucleus is introduced by skilful operation within the tissues of the pearl oyster, and to enable the formation of the pearl sac, a piece of mantle is grafted to lie close to the nucleus. The graft tissue grows and covers the nucleus completely forming the pearl sac. The epithelial cells of the pearl sac now secrete nacre around the nucleus which finally turns into a pearl. In cross section, a natural pearl will reveal a minute nucleus of foreign origin and the whole pearl is composed of nacre. In a cultured pearl, the nucleus is large and nacre forms only one-fifth to one-third of the pearl in thickness. To reduce the difference to the minimum the nucleus itself is made from mother-of-pearl shells. Generally spherical nuclei are used in the production of cultured pearl, although other shapes are used for specific requirements.

The present experiments on the production of cultured pearls were initiated in May 1973 after the oysters had grown in the farm for about six months. The oysters were brought to laboratory and conditioned. On the day of operation the oysters were anaesthetised using chemicals. The oysters, were one at a time clamped on a stand and the opening of the valves was regulated by a pair of special tongs. Through an incision, a piece of mantle cut from another oyster was grafted within the tissues of the oyster and a shell-bead nucleus was implanted. Imported as well as indigenously produced shell beads of 3-6 mm diameter were used as nuclei in these experiments. Both the nucleus and the graft tissue were manipulated to get the correct orientation. One or two sites

were chosen for the nucleus implantation. The oysters were then placed in the sea water for recovering from the effects of operation. Later they were kept in a running sea water system in the laboratory for about a week for recouping and thereafter returned to the farm. The operated oysters were examined at intervals for the results of success of the technology.

In the first series of experiments, a total of 150 oysters were operated between May 12 and August 18, 1973. Of these, 68 oysters have been examined in five batches in July, October and November 1973 and January 1974. The first cultured pearl of India was produced on July 25, 1973 just after 43 days from the date of operation. The pearl was produced by the twentieth oyster in the series and marked the breakthrough in the development of cultured pearl technology in India. Confirmatory evidence was obtained from the October-batch when six oysters had produced pearls and full confidence in the reliability of the technology was gained when more pearls were collected in the other batches (Alagarwami, 1974). Pearls have been produced both with the imported and indigenously produced nuclei.

The pearls were free and spherical. They were white, ivory or golden yellow in colour. Although a steel grey pearl was produced it was not spherical. Commencement of pearl formation was observed in 30 days; in a month and a half the lustre was distinct; in three months the pearls were remarkably brilliant and a few had very nearly doubled their initial nucleus weight. The rate of growth of cultured pearls has been found to be faster in our waters than in the temperate waters of Japan. This would indicate that the duration of culture could considerably be reduced in the Indian waters. In Japan, the duration ranges from 6 months to 4 years, depending upon the size of the pearls desired. The results confirm the statements earlier made by the author that "The Gulf of Mannar pearl oyster.....should no doubt yield good quality cultured pearls" and "In tropical conditions .....deposition of nacreous layers can be expected to be faster than in the Japanese waters.....and it may take relatively less time in our waters to get good sized pearls" (Alagarwami, 1970).

## PROBLEMS IN PERSPECTIVE

Having achieved an early breakthrough in developing the technology, we concern ourselves now with the different problems relating to commercialisation of pearl culture. The gap between the development of the technology and its commercial exploitation should be made as short as possible. Refinements in technology and advance in research could go side by side with commercial exploitation so that the advantages could be mutual. However, it would be necessary to have a clear view of the problems involved even at this stage.

The foremost problem is the one relating to the pearl oyster resources in our waters. The next two papers at this discussion will throw light on the present status of the pearl oyster resources in the Gulf of Mannar and Gulf of Kutch. For a pearl culture industry it would be necessary to ensure a steady supply of oysters in required quantities. The fluctuations of the natural populations of oysters are well known and it cannot be said with any certainty that the conditions obtaining in one year will repeat themselves in the succeeding year. We can augment the supply of pearl oysters by two methods. (1) The young stages of oysters called the spat, could be collected on cultches suspended from rafts in the subsurface waters of the pearl banks and the pearl oyster farms. These spats should be farmed separately until they grow to sizes suitable for pearl culture farms. This method of raising pearl oysters is called "mother-oyster culture". It has been mentioned earlier that spat settlement takes place in the Veppalodai farm. This experience will help in designing our future experiments on spat collection. (2) Pearl oyster stocks could also be raised in hatcheries through artificial fertilisation and rearing. This would involve creation of proper laboratory and field facilities on a large scale. We were once fortunate in getting the pearl oysters spawn in the laboratory and this line of investigation has to be intensified.

For hundreds of years the natural pearl fisheries have been conducted in the same locations and no new grounds have come to our knowledge. There is need for a detailed survey along our coasts, including the islands for locating unexploited and new pearl oyster grounds.

An assessment of suitable areas available for pearl culture must be made. In Japan and Australia, the farms are established in calm bays among groups of islands with remote access to the sea. The contour of the Indian coastline does not appear to favour us with these ideal conditions. However, successful maintenance of the farm at Veppalodai even in turbid waters at a shallow depth of 4 metres against their natural habitat of about 15 to 20 metres suggests that pearl culture farms on a commercial scale could be located at several places. Detailed investigations on the geological, physical, chemical and biological parameters of the environment should be taken up in prospective areas so as to select the most suitable locations.

The problem of pollution requires careful consideration. In Japan and Australia, the levels of production have fallen down in the recent years due to increase in the mortality of oysters in the farms caused by pollution of the environment. The important pearl banks of Tamil Nadu coast lie between Vaipar and Manapad. This also happens to be the region where a concentration of chemical and petrochemical industries, a major harbour, a thermal power station, heavy water plant etc. is found. The effect of chemical and oil pollution from these sources has to be monitored carefully. The cooperation of the industries in this respect is necessary to keep the level of pollution at the barest minimum.

The different aspects of biology of the pearl oyster have to be studied in detail, particularly their food, growth, spawning habits and larval history. Our present knowledge of these aspects is very little.

The severe problem of fouling, boring and parasitic organisms has to be studied intensively and possible measures of protection against these must be developed to ensure a high survival rate of the oysters in the farm.

The culture technology itself needs constant improvements to produce pearls of high quality. Besides genetic factors, the quality of pearls is influenced by the chemical content of the sea water, particu-



larly some of the salts and trace elements, the quality of food taken by the oyster, hydrogen-ion concentration etc. Pearls collected during different times of the year may also show differences in quality. In Japan, the final phase of culture called "make-up culture" is carried out for short periods under conditions ideal for the deposition of desired thickness of nacreous layers. These aspects deserve detailed considerations in investigations.

A procedure for the X-ray examination of the operated oysters, particularly in the case of larger pearls, must be developed to determine the retention of nuclei and growth of pearl.

The process of pearl collection has to be mechanised for quicker and efficient extraction of pearls without injuring the nacreous layers.

Among the pearls cultured, only a certain percentage could be marketed as gems. The rest because of malformation of nacreous layers, will not have much value in jewellery. In the system of Indian medicine, pearls are used in the cure of many diseases. In Japan, the rejects are used in the pharmaceutical industry. The pearl oyster meat, particularly the adductor muscle, is edible. The shells can find many uses as fertiliser, poultry feed, ornamentation articles, shell medicine etc. Researches on the utilisation of the by-products of pearl culture have to be taken up.

Optical, spectral and chemical properties of the Indian cultured pearls have to be studied with reference to the technology of production so as to effect improvements in the techniques.

The success we have already achieved in the experimental production of shell bead nuclei from the conch shell will have to be pursued so that suitable beads are produced at economic levels. Fabrication of tools of surgery must be achieved in a short time.

A phased programme for training technicians in the operation of oysters and other aspects of pearl culture should be taken up.

This probably will be the first time in the Indian waters when any such structures as rafts in large numbers will be floated in the open sea. Unless these areas under pearl culture are declared as "protected", problems of poaching will be severe. We have to develop a system of leasing out areas in the coastal waters to private entrepreneurs, as is done in other countries, for setting up culture farms. Besides, the navigational aspects will require consideration. The areas under pearl culture will have to be marked appropriately in the navigational charts for the guidance of ships.

The more sophisticated researches on genetic improvement of stocks by cross-breeding, and production of high quality pearls by tissue culture of mantle epithelial cells in the laboratory could be taken up after we have made some progress in the more urgent problems.

The research and development problems enumerated above are interconnected and should be tackled by simultaneous efforts. For the research programmes the facilities will have to be enlarged more than that has been contemplated under the "Scheme on pearl culture". There must be well-developed laboratories for the different disciplines of pearl culture research. On the development side a pilot project is necessary. The prerequisites for the pilot project will be finding adequate resources of pearl oysters, availability of trained technicians, fabrication of surgical tools in required numbers and production of nuclei on a large scale.

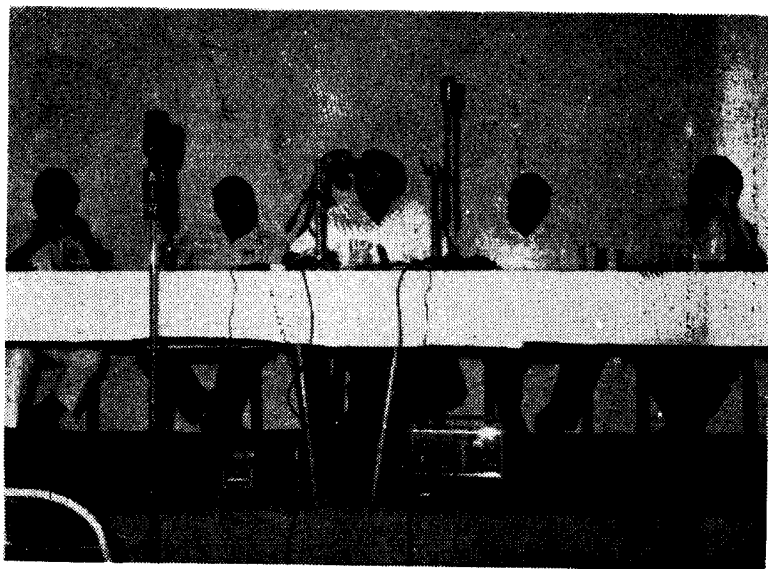
#### SCOPE FOR PEARL CULTURE INDUSTRY

The pearl trade in India is of considerable magnitude. There is a regular import and export trade for both natural and cultured pearls. Table 1 gives the official figures of imports and exports.

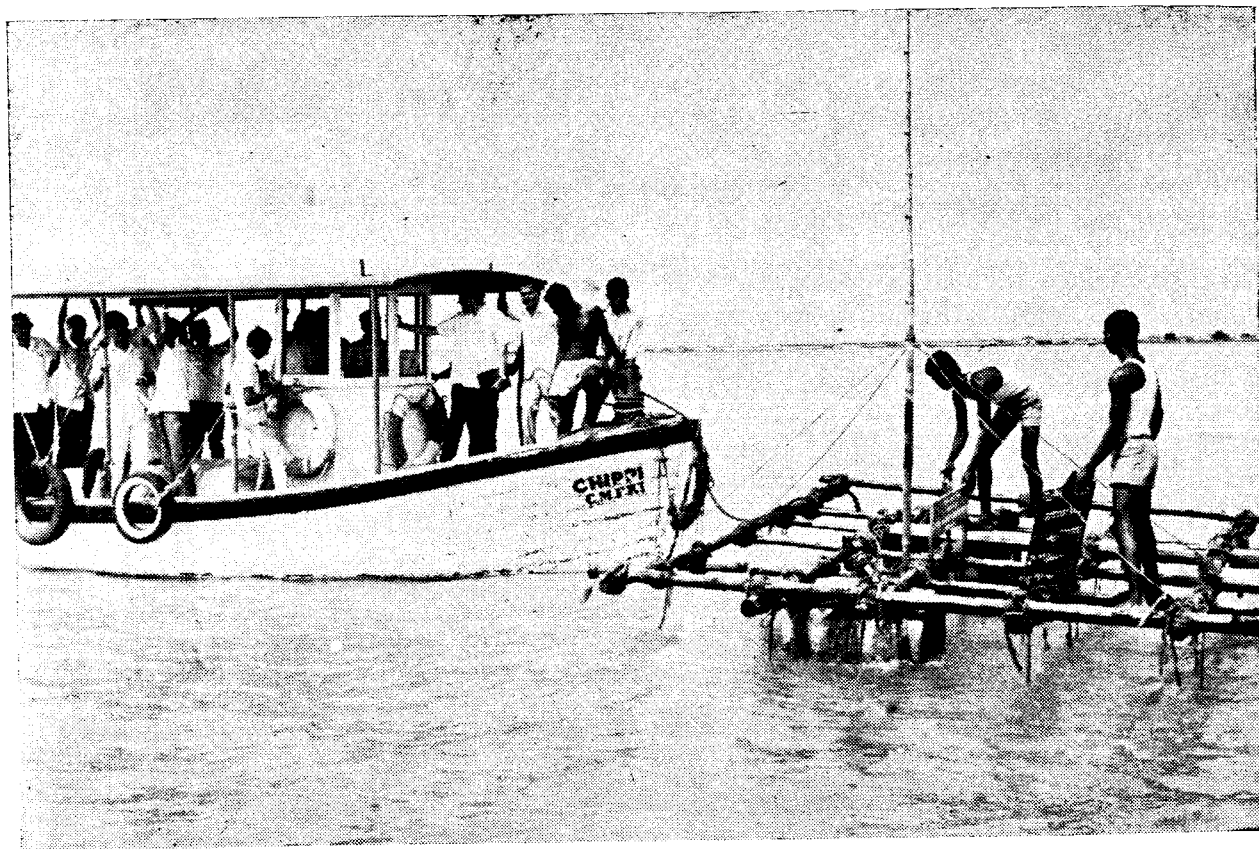
As could be seen from the Table, the average value of import is Rs. 8.204 million against an export value of Rs. 10.253 million. But a closer analysis of the figures shows that our advantage lies in the trade of natural pearls, with an average export figure of Rs. 9.826 million against an import worth Rs. 3.583 million. In the case of cultured pearls the average import value is Rs. 4.621 million against



Dr. R. V. Nair, Director, C. M. F. R. I. welcoming the participants.



Dr. M. S. Swaminathan, Director-General addressing the gathering.



Dr. M. S. Swaminathan, Director-General and others inspecting the pearl oyster raft.



A general view of the audience.



Dr. M. S. Swaminathan, Director-General at the Press Conference.



Dr. K. Alagarwami demonstrating the implantation of the nucleus in the pearl oyster to Dr. M. S. Swaminathan, Director-General, and others.



Dr. K. Alagarwami explaining the culture technique.

TABLE 1. *Imports and Exports of pearls into and from India.*

(Values in 1000 Rupees)

Commodity	Imports					Exports				
	1968- 69	1969- 70	1970- 71	1971- 72	1972- 73	1968- 69	1969- 70	1970- 71	1971- 72	1972- 73
<i>Natural pearls</i>										
Unworked	1,973	5,312	3,679	3,080		5,992	7,483	5,158	6,293	4,892
Worked	214	74	Nil	Nil		884	1,560	4,535	7,398	4,833
<i>Cultured pearls</i>										
Unworked	6,538	3,942	4,599	3,295		221	153	398	124	506
Worked	Nil	7	68	36		34	62	173	543	165
<b>Total</b>	<b>8,725</b>	<b>9,335</b>	<b>8,346</b>	<b>6,411</b>		<b>7,131</b>	<b>9,258</b>	<b>10,264</b>	<b>14,358</b>	<b>10,396</b>

Source: "Monthly Statistics of the Foreign Trade of India" published by the Directorate General of Commercial Intelligence and Statistics.

an export value of only Rs. 0.427 million. It becomes clear that, but for a nominal export, all the cultured pearls imported into the country go to meet the local demands. Further it is seen that we have a significant pearl processing industry in the country from the fact that against an average import of worked natural pearls of value Rs. 0.72 million the export is Rs. 3.594 million.

Japan accounts for 91% of the imports of pearls into India. The cultured pearls that we import from Japan are mostly those produced by the freshwater mussel *Hyriopsis schlegeli* in Lake Biwa. These pearls generally are of irregular shape. Our exports of pearls reach more than 35 countries, of which the U. S. A., Hong Kong and the Persian Gulf countries are important.

The two major pearl producing countries in the world are facing several problems in pearl culture. The production of pearls in Japan reached the maximum of 130 tons in 1966 after which there was a setback. In 1970, the numbers of cultivators and rafts had decreased to less than 22% and 27% of those in 1966 respectively (Wada, 1973). The causes of decline were environmental problems, insufficient supply of labour, wage increases etc. In Australia, the pearl production was valued at 4.5 million dollars in 1969. In 1971 it had fallen to 3.5 million dollars. Over-supply of half-round pearls, an exceptionally high level of mortality of oysters in the farms and decline in the labour force were mainly responsible for the fall in production. Under these circumstances, the development of pearl culture technology in India appears timely for making a thrust into the cultured pearl market. Our advantages are that the pollution problem is not severe as in the above two countries, labour force is available at comparatively less wages and the rate of growth of pearls is faster which would enable a reduction in the duration of culture and thereby a reduction in the cost of production.

The employment potential in pearl culture industry will be for different categories of personnel, that is unskilled and skilled farm labour, technicians, supervisors, crew of vessels and establishment and managerial staff.

It is said in Japan that pearl culture offers the highest returns among all the products of culture in the coastal waters (Wada, 1973). It is hoped that India would soon be able to reap the benefits of a pearl culture industry.



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