PROCEEDINGS OF THE GROUP DISCUSSION ON PEARL CULTURE

held at Tuticorin on 24th January 1974

Edited by

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ICAR

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
COCHIN

INDIAN COUNCIL OF AGRICULTURAL RESEARCH

PREFACE

India produced the first cultured pearl on 25th July, 1973. This came as a result of the experimental work on the Indian pearl oyster, Pinctada fucata, *initiated by the Central Marine Fisheries Research Institute at Veppalodai near Tuticorin in July, 1972. The early break-through in the technology of pearl production and the subsequent improvement in the techniques coupled with the indigenous manufacture of nuclei from the chank,* Xancus pyrum, *have opened up possibilities of large-scale production of cultured pearls in our country. To consider steps for the commercial production of cultured pearls, a Group Discussion was organised by the Central Marine Fisheries Research Institute at Tuticorin on 24th January 1974 under the Chairmanship of Dr. M. S. Swaminathan, F. R. S., Director-General, Indian Council of Agricultural Research and Secretary to the Government of India. Among the participants were representatives of the Governments of Tamil Nadu and Gujarat, the Fishing Industry, the Press, etc. who also visited the Pearl Culture Laboratory and Farm at Veppalodai and acquainted themselves with the progress of the pearl culture work of the Institute.*

The proceedings of this Group Discussion are reported in the following pages.

Dr. R. V. NAIR
Director
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WELCOME SPEECH

DR. R. V. NAIR,
Director, Central Marine Fisheries
Research Institute, Cochin.

Respected Chairman & Friends,

I have great pleasure in welcoming you all to this 'Group Discussion on Pearl Culture'. As you all know, pearl culture is a new development in this country and it is a matter of satisfaction that we have earned a place among the culture pearl producing countries of the world through the hard and dedicated work of the scientists attached to the Central Marine Fisheries Research Substation, Tuticorin. The technology for the production of the cultured pearl was developed in Japan about 75 years ago and since then Japan had the monopoly of world trade in it. The Japanese method of pearl culture was a guarded secret for a considerably long time, but after the publication of the Report on Pearl Culture in Japan by Dr. A. R. Cahn (issued from the General Headquarters of the Supreme Commander of the Allied Powers) in 1949, many details regarding the pearl culture operations became well known. However, it may be stressed that pearl culture involves elaborate techniques and the operations require a good amount of skill and experience. The Japanese pearl farms produce enormous quantities of cultured pearls for export to many countries. Japan has also collaborated with Australia, Philippines and Burma in developing pearl culture. India is now the first country after Japan to develop the pearl culture technology based exclusively on indigenous efforts.

According to official figures, India is importing pearls, both natural and cultured, of the value of around 8.2 million rupees a year, although much more may find its way into the country. Since the

beginning of this century a number of unsuccessful attempts were made by the Tamil Nadu Government to produce cultured pearls and the present breakthrough in the culture pearl technology augurs well for retrieving the past glory of the pearl industry.

As you are aware, Tamil Nadu and Gujarat are the two States which have direct interest in the development of pearl culture, as the pearl oyster resources are concentrated in the Gulf of Mannar and Gulf of Kutch respectively. The pearl fishery for natural pearls in these two regions dates back to ancient times. The pearls of the Gulf of Mannar formed one of the earliest items of India's trade with Rome, Egypt, Greece and China. But the fluctuations of the pearl oyster resources in their natural beds have been very disappointing. During the productive years, the revenue derived is large, but there are very long periods of unproductive years when oyster beds remain barren. The last continuous series of pearl fishery was held in Tuticorin from 1955 to 1961 and over 86 million oysters were fished fetching a revenue of 2.2 million rupees. Subsequently pearl oyster abundance on the pearl banks became poor and no fishery has been conducted during the last 12 years. In Gujarat also there has been no pearl fishery after 1966-67.

It may not be out of place to point out here a few aspects which deserve our consideration. Although we have been successful in developing the technology indigenously, our researches are hardly a year old now, and these have been conducted with the exclusive objet of achieving an early breakthrough in the technology for development of the cultured pearl. This has now been achieved in a very modest laboratory and farm at Veppalodai.

In this connection I wish to make a special mention of the Veppalodai Salt Corporation, particularly Shri John Motha who had given us help and encouragement to conduct the experiments at Veppalodai.

I am glad to inform that the ICAR has sanctioned the Scheme of Pearl Culture to be executed in collaboration with the Department of Fisheries of the Government of Tamil Nadu. This scheme was prepared by me three years ago when the know-how of pearl culture was not available. In the light of the present achievement the scheme requires a few modifications so that our researches could be founded on a firmer footing with an industry-oriented programme.

This scheme being of national importance we may have to consider investigations on pearl oyster resources, development of hatchery techniques and improvement of the culture practices and extension of pearl culture to other areas. It is also important to develop and perfect the techniques of spat collection so that the pearl culture industry can be assured of continuous supply of seeds at the proper time. With more than 75 years of experience behind, Japan is still in the process of making constant improvements in the pearl culture industry through their National Pearl Research Institute and the laboratories of the Universities and private firms. We should now develop a well-equipped laboratory for this purpose and adequate facilities for farm work in the sea. Certain areas must be marked for the pearl farms and declared as protected areas.

I have no doubt, that the special interest shown by Dr. Swaminathan, our distinguished Director-General of ICAR will give us the necessary encouragement to achieve our objectives. He has been very keenly watching the progress of our work on pearl culture for which we are very grateful. In fact the quick progress we have achieved so far has been mainly due to the abiding interest he has evinced in this work. The quickness with which he has acted upon the development of the technology by organising this forum for discussion shows his keenness and that of the ICAR to utilise the results of research for advancing the national economy. I am sure we will have a very useful discussion under the patronage of our distinguished Director-General.

Shri Venkataraman, Director of Fisheries, Tamil Nadu and Shri Chockalingam, Special Secretary of Tamil Nadu Government visited our pearl culture laboratory and farm at Veppalodai and showed a keen interest in the progress of the experiments and have extended their full co-operation. I am sure with the continued interest and co-operation of the Government of Tamil Nadu, this scheme on pearl culture is bound to produce significant results even before the stipulated time.

Dr. Prasad, Assistant Director General, ICAR and my predecessor Dr. Qasim, now Director of National Institute of Oceanography, gave constant encouragement and this had led to the present achievement.

On behalf of the ICAR and CMFRI and on my own behalf I once again extend a hearty welcome to you all.

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

DR. K. ALAGARSWAMI,

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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 1974*a*, *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 (Alagarswami, 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 to1961, 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, 1974*a*, *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 appeard 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 secretes 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 (Alagarswami, 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" (Alagarswami, 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 were a concentration of chemical and petro-chemical 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.

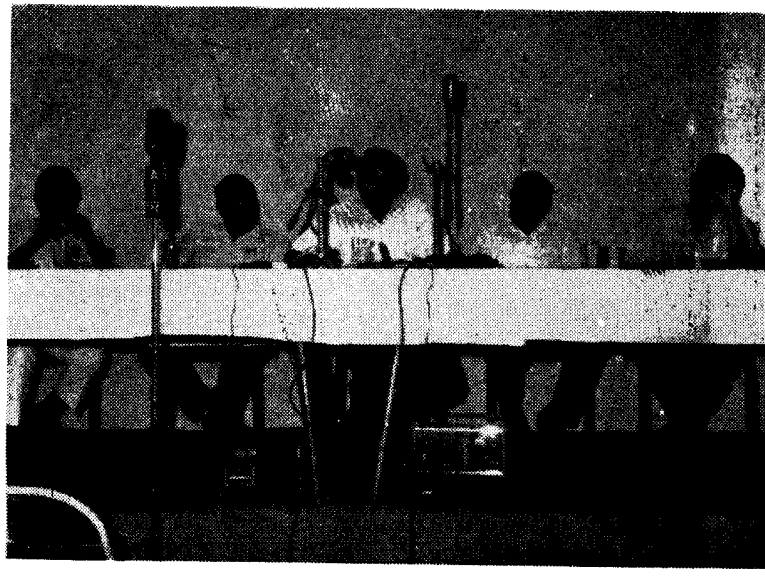
The research and development problems enumerated above are interconnected and should be tackled by simultaneous efforts. For the research programmes the facilities will have to be enlarged more than that has been contemplated under the "Scheme on pearl culture". There must be well-developed laboratories 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 Indutsry

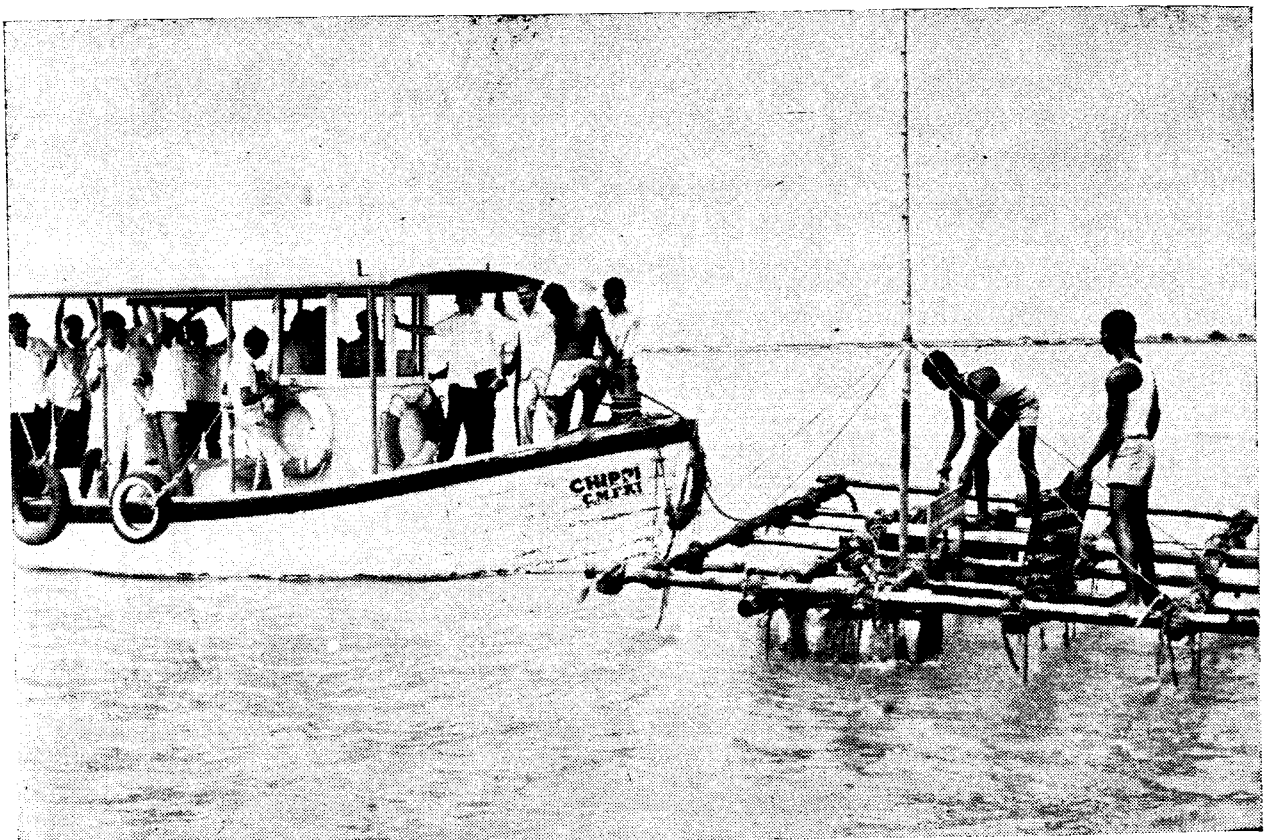
The pearl trade in India is of considerable magnitude. There is a regular import and export trade for both natural and cultured pearls. Table 1 gives the official figures of imports and exports.

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 fiigures 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

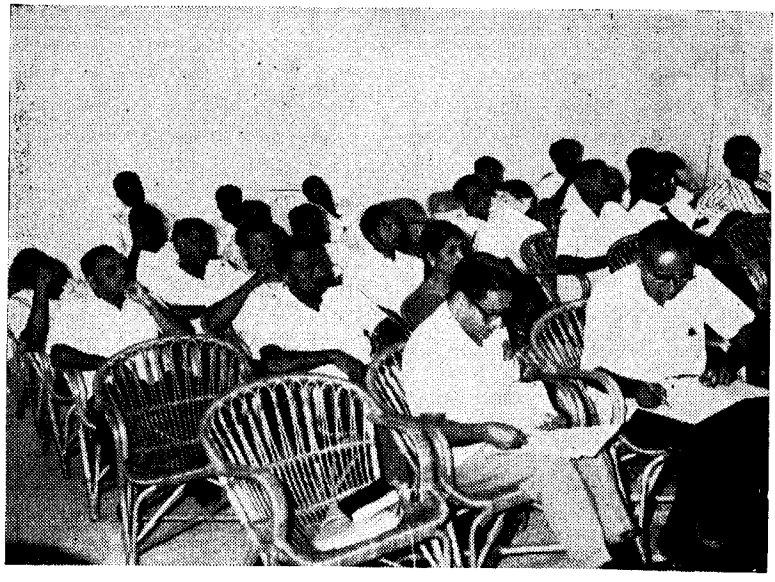
Dr. R. V. Nair, Director, C. M. F. R. I. welcoming the participants.



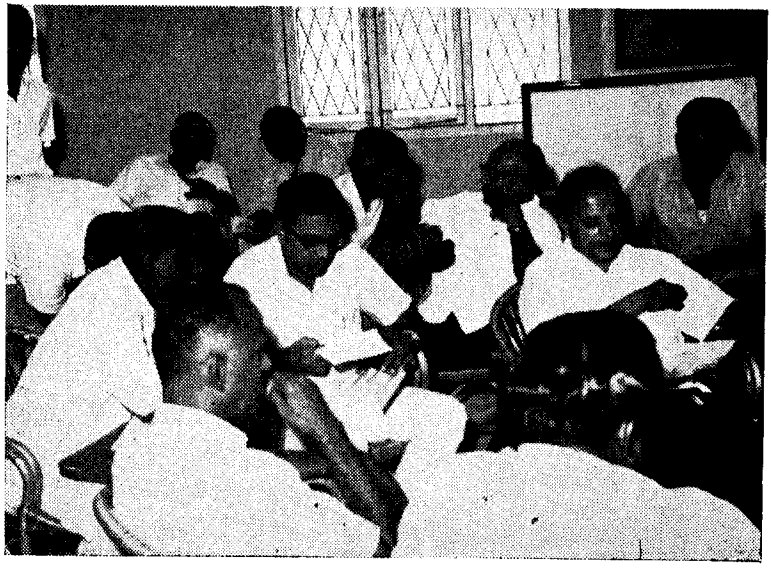
Dr. M. S. Swaminathan, Director-General addressing the gathering.



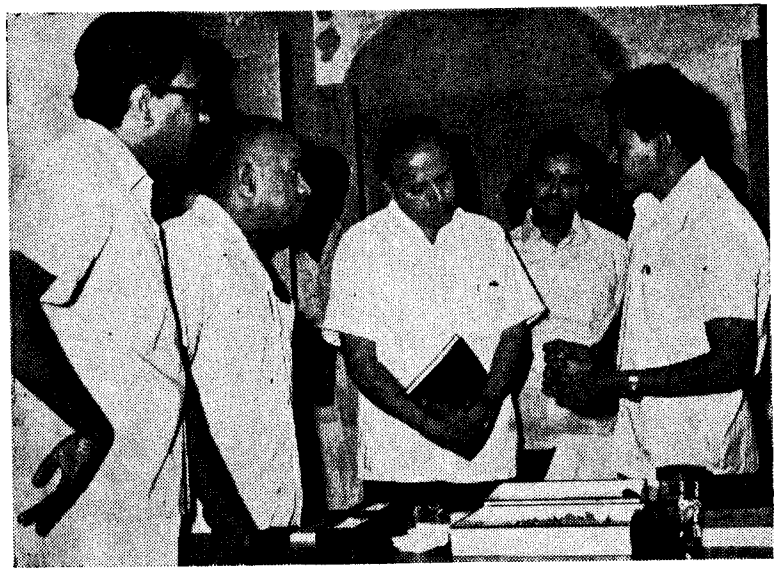
Dr. M. S. Swaminathan, Director-General and others inspecting the pearl oyster raft.



A general view of the audience.



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



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

Dr. K. Alagarswami 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
Natural pearls										
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
Cultured pearls										
Unworked	6,538	3,942	4,599	3,295		221	153	398	124	506
Worked	Nil	7	68	36		34	62	173	543	165
Total	8,725	9,335	8,346	6,411		7,131	9,258	10,264	14,358	10,396

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 hopped that India would soon be able to reap the benefits of a pearl culture industry.

ACKNOWLEDGEMENT

I am most grateful to Dr. M.S. Swaminathan, F.R.S., Director-General of the Indian Council of Agricultural Research for his deep concern and abiding interest in developing the technology of pearl culture in India and for the constant encouragement received. I am thankful to Shri T.V. Venkataraman, Director of Fisheries, Madras for his interest in this work and for providing facilities for the collection of oysters. I am grateful to Dr. R. Raghu Prasad, Assistant Director-General, Indian Council of Agricultural Research for his kind encouragement. Dr. S. Z. Qasim, former Director of Central Marine Fisheries Research Institute, was the guiding force behind this success and I am grateful to him for all the help and encouragement. I am grateful to Dr. R. V. Nair, present Director of the Institute, for his keen interest in further development and encouragement received. This work would not have been possible without the help and co-operation of all my colleagues at the Substation and I would like to thank all of them, particularly Shri Nagappan Nayar, Shri Mahadevan and Shri Chellam. I owe my thanks to the Veppalodai Salt Corporation, especially to Shri John Motha, who provided several facilities for setting up our laboratory at Veppalodai.

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THE PRESENT STATUS OF PEARL OYSTER RESOURCES ALONG THE TAMIL NADU COAST

THE TAMIL NADU
FISHERIES DEPARTMENT

The pearl banks on the Tamil Nadu coast extend mainly from Adam's Bridge in the head of the Gulf of Mannar to Cape Comorin in the south and a very few banks lying off Thanjavur District in the Palk Bay. According to the locations of the paars three divisions can be recognised in the Gulf of Mannar—the Northern Kilakarai division, the Central Tuticorin division and the Southern Comorin division. Of these only the Central Tuticorin division is productive. The beds lie at about 20 km from the shore, on the 10 fathom contour. The number of banks known to bear mature oysters is just 23. Only in nine banks was there a pearl fishery more than once. The beds are discontinuous varying in area from a few hectares to a few square kilometers. Tholayiram paar is the largest, most well known and most productive bed (14,500 ha). The rocky outcrops are generally coral reefs, on which the oysters settle. The species of pearl oysters in the Gulf of Mannar is *Pinctada fucata*, which was known for a long time under the name *P. vulgaris*.

The "Irregular cyclic nature" of the pearl fishery is well known but the causes are not yet elucidated. The erratic nature of pearl fishery can be seen from the fact that from 1796 to now, there have been only 27 pearl fisheries. Devanesan and Chidambaram (1956) felt that the short life span of 5 to 6 years of the oysters and the unprotected nature of the Gulf of Mannar are responsible for the long intervals between two pearl fisheries. The pearl banks receive by self-effort.

TABLE 1. *The number of pearl oysters fished during the longest pearl fishery series 1955-1961*

Year	Name of pearl bank				
	Tholayiram (T) and Koothadiar (K)	Kavval	Rajavukku Sippi-sothicha Paar	Kodamuthu	Saithu-kodamuthu
1955	3,200,000	—	—	—	—
1956	2,129,058	—	—	—	—
1957	—	272,263	2,037,012	4,611,597	3,984,800
1958	—	7,638,997	3,430,366	4,604,872	5,547,977
1959	—	4,154,250 219,093	403,806	19,040,945	3,387,054
1960	(T) 12,040,009 (K) 3,768,429	—	—	—	—
1961	15,073,838 (K) 323,094	—	—	—	—
Total	36,534,429	5,284,603	5,871,178	28,257,414	12,919,831

The pearl banks off Ramnad were surveyed in 1965 but did not yield encouraging results (Rajendran *et. al,* 1969). Only one or two oysters were collected in the dives. The longest pearl fishing operations from 1955 to 1961 were also the most productive years in the history, with an annual catch of 3.5 to 27 million oysters (total of over 91 million for the period.) The details of pearl oysters fished during the pearl fisheries of 1955-1961 are shown in Table-1. Tholayiram paar was fished moderately in 1955 and 1956 and left out during 1960 and 1961. The other paars viz. Karuwal, Rajavukku sippisothicha paar, Kodamuthu group, etc, were fished heavily during 1957, 1958 and 1959 and there were no fishable oysters in the succeeding years.

It is worth recalling here, that Devanesan and Chidambaram (1956) made two very valuable suggestions viz., creation of a sanctuary of 1 sq. m. in the pearl oyster beds which should not be fished at all, and creation of "Breeding Reserve", to resuscitate the populations. They predicted that depletion is bound to occur after every pearl fishery, and removal of age groups younger than three years old in the clumps would lead to depletion. Salvadori (1962) remarked that, if there is very limited number of mature oysters, it would be preferable not to organize any pearl fishery.

The Tamil Nadu Fisheries Department has been taking conservational measures to sustain the pearl fishery. The pearl fishery has been declared as State monopoly. Regular patrolling of the pearl banks is being done to prevent poaching. Oysters of less than fishable size are released in the beds alive, if caught by divers.

Hornell (1922) found predatory fishes affecting the oyster population. Chacko (1956) considered the starfish *Pentaceros lincki* the greatest enemy of pearl oysters and their suggested large scale removal from beds. Salvadori (1962) considered moray eels and octopus as the destructive agents of pearl oysters. He suggested "stock improvement" by development of "hollows" in beds by dumping rocks, removal of enemies etc.

Pearl bank inspections (Surveys) are made by Tamil Nadu Fisheries Department every year from March to May to assess the

fishable pearl oyster populations, spat fall etc. These annual inspections are mainly pearl fishery orientd and so the pearl oyster populations in each paar and their age composition are computed only when fair numbers of pearl oysters are obtained per dive during the inspection of pearl banks. Chacko (1956) surveyed Tholayiram paar and a few others in 1954 and predicted the population of pearl oysters and the results of the fishery proved the correctness of the forecast.

The Government of India obtained the services of an expert in aqua-lung diving to survey the pearl beds and Dr. Salvadori made three visits in 1959 and 1962. He trained some scientists of the Department and the Central Marine Fisheries Research Institute in diving and also made an underwater survey of pearl beds. Except providing some scientific data, the surveys did not lead to any worthwhile conclusions on the pearl fishery. Dr. Salvadori found Tholayiram paar to be the best, with a standing stock of 134 oysters per sq. m.

Recent inspections of pearl banks has revealed a very poor population. During 1972-73, in 434 dives, only 264 oysters were collected and of these only 12% were of the fishable age group. Very poor population was noted in 11 banks and none at all in five banks. Over-growth of *Modiola* sp. noticed in the pearl banks indicated that the pearl oyster spats that were present during the previous inspections had been completely destroyed by this over-growth. It will be worthwhile to conduct studies on the possibilities of controlling the *Modiola* population which may help the survival of the pearl oyster spats in their natural environment.

In view of the uncertainty and undependability of natural pearl fishery, it is essential that we adopt culture techniques to raise pearl oysters, for without a supply of oysters culture pearl operations cannot go far. As early as 1913-14, Hornell planned a pearl oyster park in Krusadai but it was left to Dr. Sundar Raj to commence the work. Dr. Devanesen (vide Devanesen and Chidambaram, 1956) started cage culture of pearl oysters in Krusadai in 1933 and continued till 1939. He kept the oysters alive for 7 years, thus establishing the possibility of controlled culture in cages. The pearls produced

in these experiments were not spherical. Subsequently work was done either in culturing pearl oysters or in producing culture pearls.

Consequent on the expiry of Mikimoto's patent, pearl culture techniques were made available to other Japanese entrepreneurs. Other nations also adopted the techniques of introduction of the nucleus and simulate pearl formation. Even if the technology of culturing pearls is perfected, there is need for the basic material viz., the oysters of proper age. In as much as the natural populations are inadequate and uncertain, culture of oysters in confined areas breeding them and populating the pearl oyster beds is the need of the hour. Modern aquaculture techniques have to be adopted to produce large number of pearl oysters besides attempting "stock improvement" in natural beds.

Suitable areas in the Gulf of Mannar and other places along the cost of Tamil Nadu will have to be located and culture of pearl oysters has to be done on a large scale. Though there are not at present enough fishable pearl oysters in the natural beds off Tuticorin for conducting a pearl fishery, it may not be difficult to get a few thousands of pearl oysters every year to serve as seed resources for the pearl oyster culture farms and for meeting the needs of experimental culture pearl operations.

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PEARL OYSTER RESOURCE AND CULTURE EXPERIMENTS IN GUJARAT

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Gujarat is one of the two maritime states of India, the sea coasts of which are endowed with pearl oyster populations. The history of pearl fishery in the Gulf of Kutch on the northern coast of Gujarat dates back to 13th century. But information on its exploitation is scanty. Gokhale *et al.* (1954) and Easwaran *et al.* (1968) have described the conditions of the pearl fishery. The pearl oyster reefs locally known as "Kaddas" are scattered along the southern part of the Gulf of Kutch bordering the coastline of Jamnagar District. There are 42 known pearl oyster reefs, totalling an area of about 24,000 hectares, situated between Sachana on the east and Ajad on the west. The oyster beds are not continuous but are separated by creeks, mud flats, mangroves and sandbars. A typical oyster bed consists of hard bottom of coral and sandstones with sand and mud. The beds are situated in the intertidal zone, the distance from coastline ranging from 1 to 5 km. The fishery in the Gulf of Kutch is contributed by a single species, *Pinctada vulgaris* (Schumacher) which is now considered a synonym of *P. fucata* (Gould).

Fishery is conducted on days of good ebb tides during the south-west monsoon, generally after one or two good showers. The fishermen wade through the bed and pick up oysters with bare hands. The population of oysters is sparse. A trend of depletion has been observed in recent years. Some important beds were surveyed in 1971-72 and 1972-73. The density of oyster population in different beds, as observed from these surveys, is given below.

Name of oyster bed	*Area in hectares*	*No. of oysters per hectare*
Narara	4200	5
Pirotan	350	2
Movada	3000	4
Deeda	1800	6
Dunny	600	2
Chhad	700	1
Kalumbhar	2300	3
Ajad	3100	5
Danady	900	2
Bhaider	950	1
Chankh	1450	3
Chankhadi	1175	4

Form the above data it will be seen that the density of population varied from 1 to 6 per hectare area. Oysters in age groups of three years and above constituted about 61% of the population.

Although the present fishery is confined to the tidal zone on the known beds there is a possibility of locating oyster population in other areas in the Gulf which have not been charted and exploited so far. There is also a possibility of locating them in deeper waters beyond tidal range.

Prior to 1947, a majority of the pearl oytser beds in the Gulf of Kutch was under the administrative control of the former Navanagar State. Natural pearls constituted one of the important sources of revenue to the State. After the merger of this princely State with the Indian Union the fishery is administered by the Fisheries Department of the State Government. Last pearl fishery was conducted in 1968 when about 30,000 oysters were collected. Reduction of popultation of oysters in recent years has rendered the fishery uneconomical for the government and unremunerative for the fishermen.

Experiments on pearl culture

Presumably on the advice of Mr. James Hornell (see Hornell, 1909), stone enclosures with sluices were constructed near Sikka for farming pearl oysters with an idea of conducting experiments to

produce cultured pearls subsequently. However, the experiments commenced only in 1956. Imported nuclei and ordinary dissection instruments were used in these experiments on 60 oysters. The technique employed was to drill a hole on the shell and slip a nucleus against the exposed mantle after scraping it gently and plug the hole. Of the 60 oysters, only 12 survived and in 8 oysters, the nuclei were found to have received a thin coating of nacre.

Attempts were made again during 1962-65, but had to be discontinued. In 1972 different materials like plaster of paris, beads of glass, freshwater shell, plastic etc. were used as nuclei on a very small number of oysters. A partial nacreous secretion was observed around the freshwater shell beads.

In 1973 a scheme was prepared after discussion with the scientists of Central Marine Fisheries Research Institute. The aspects which have been stressed in the scheme are conservation measures, farming of oysters, survey for charting the oyster beds, exploration for oyster populations in deeper waters in and outside the Gulf of Kutch and pearl culture work.

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SPEECH

DR. M. S. SWAMINATHAN, F. R. S.,
Director-General Indian Council of Agricultural Research, New Delhi.

Ladies and Gentlemen,

The visit to Veppalodai this morning has been extremely useful in understanding for ourselves the art of producing cultured pearls. As other speakers have said, it has been one of our dreams and hopes that we will also be able to produce pearls by culture techniques as Japan has been doing for many years now. I would like at the outset to convey, on behalf of all of you, our sincere congratulations to Dr. Alagarswami, Shri Chellam, all their colleagues here, and the Central Marine Fisheries Research Institute as a whole, for the speed with which they have been able to organise this work.

It has been demonstrated now that it is feasible to produce pearls and that we have certain natural advantages over the country like Japan; that is, the rate of growth of pearl is accelerated because of higher temperature of water and, we have so far no problem of pollution which the advanced nations face. I am sure that with the help of the scientists and the co-operation of indusries/factories we should be able to keep our seas fairly free and safe from pollution and exploit fully all the products that the sea can give.

Personally I am very happy that we have, at long last, entered an era of sea-farming. So far we have been capturing whatever is there in the sea. But now we have started thinking in terms of growing the crops of various sea organisms, like sowing a crop of paddy or wheat in agriculture. Cultured pearl is certainly a significant development in the entire field of sea-farming. It is obvious that,

as Shri Pandya pointed out, in the Gujarat area the natural pearl fishery does not have much of an economic prospect. In Tamil Nadu also the natural pearl fishery is very uncertain and we do not know when we will get the next good crop. Therefore, if we have to think in terms of producing pearls in our country, it is obvious that we have to go in for the production with culture techniques.

Dr. Alagarswami, in his comprehensive paper, has already identified some of the major problems which need to be tackled and some other speakers have supplemented them. He rightly classified the major efforts to be taken into three broad groups. One is research itself. Additional research is needed, also the survey of new pearl oyster banks. Hatchery techniques for artificial rearing of oysters have to be developed in order to build up adequate stock. Then there is need for standardisation of the entire process of culture — production and implantation of nucleus, removal techniques and so on—so that when we go into a commercial scale production, we have precise idea of how this can be done on an assembly-line basis.

A very valuable suggestion was made by Shri Chockalingam about transplantation of pearl oyster from the Gulf of Kutch to the Gulf of Mannar and *vice versa:* This is certainly an important line of research which was to be taken up immediately and I am grateful to Shri Pandya for his offer of 100 oysters for culture so that some work could be started immediately. Along with these genetic improvement and hybridization of oysters also should be taken up.

What I propose is that we might, in terms of research, have a Coordinated Programme, involving the Central Marine Fisheries Research Institute, and the Department of Fisheries of the Government of Tamil Nadu and Gujarat. Both Tamil Nadu and Gujarat have been the places of natural pearl fishery. The Coordinated Programme would involve certain amount of interchange of material and techniques. This programme could be started immediately with augmented resources, money, facilities and manpower, in addition to the scheme which has already been sanctioned, so that we can try to capitalise upon the advances made so far. This Coordinated Programme will certainly include identification of suitable new sites, other than

Veppalodai where we have lesser disturbance, intensive survey of pearl oyster banks, pearl oyster breeding farms and cross breeding experiments. The hybridization experiments are exceedingly important. It is entirely a new field and could open up considerable possibilities. Under this research programme I hope, with the collaboration of the Central Institute of Fisheries Technology and industrialists, we will be able to perfect the production of nuclei on a large scale.

The second aspect is development and as Dr. Alagarswami said, the commercial exploitation of the technique need not wait for more and more research because when research and development go side by side they mutually benefit each other. What I would like to see is the development of a suitable Pilot Project for a large-scale production of cultured pearls using the techniques already developed. The development of a pilot project, with the help of the Department of Fisheries of the Tamil Nadu Government, at Veppalodai where the work has already been done, by more extensive raft culture techniques would also help us to gain confidence in launching a larger commercial venture later on. Under this project, the economics will have to be worked out; the by-product industry that could be developed from the rejects will have to be studied; so also the large scale use of locally produced nuclei, and so on. So I will appeal to Dr. Nair, Dr. Alagarswami, Shri Nagappan Nayar, Shri Mahadevan and others, to develop a suitable pilot project with the help, advice and assistance of the Director of Fisheries of the Government of Tamil Nadu, where this would go into a larger, semi-commercial scale of production.

The third is training. This is exceedingly important and when we want to go into a large-scale production programme we must have a sufficient number of trained personnel. In this kind of work, it is not even necessary to have highly qualified persons, but those who will do it with care and dedication. So I would request the Director of Central Marine Fisheries Research Institute to think in terms of developing a suitable training programme for pearl culture.

Many times our scientists are accused that they do not have a concept of time. We are racing against time in our country because the

economic conditions are very poor and we have to try to increase the wealth of our people as fast as we can. Here is an excellent example of what dedicated scientific work can accomplish in a span of less than a year. Dr. Alagarswami started the work in December 1972 and the first pearl was produced on July 25, 1973, which means an effort of hardly seven months or so. This is a very good achievement. Now we will have to go about it with a great deal of care also, because there will be a large number of problems. Many of them have been pointed out and some new problems might arise. But given the effort, it should not be difficult to overcome these problems. I am sure our scientists will see to it that this small effort, a totally indigenous and a commendable one without any foreign collaboration or assistance, is taken to its logical conclusion, the first step being to stop completely imports of pearls into the country and the second, to try to develop an export market.

Before I conclude, I would like to say that in the last two days Shri Chockalingam and the Director of Fisheries have been good enough to take me round. Yesterday Dr. Nair took me to Mandapam and tomorrow I hope to have the opportunity to see something more at Pulicat and Madras. I think the time has come for us to try many of the scientific findings, which have been done on a small scale and wherein the feasibility has been demonstrated, in a big way, and exploit what seems to be potentially feasible. For example, Dr. Nair showed at Mandapam the eel culture techniques. We know that there is a big demand for elvers and eels and they are very expensive too. Apart from pearl culture, mussel, prawn, seaweeds and a large number of other natural products are being cultured artificially. What is meant by culture is that we take it under domestication. Formerly only the bigger animals and plants were domesticated. Now our marine biologists and inland fishery scientists are starting to domesticate in a big way the aquatic organisms that were collected originally from nature. This process has certainly a tremendous potential. The feasibility of rope culture of mussels has been demonstrated, so also possibilities of culturing prawns. At Kakdwip, the Central Inland Fisheries Research Institute is doing brackishwater culture in a big way. So both in mariculture and other forms of coastal aquaculture, including eel culture, where we have got enough initial knowledge, I would like

to suggest larger pilot scale production. By this I mean a production of at least half a million rupees worth of material, so that we have some idea of what is the cost involved in production, the market value of the product, the margin of profits, and so on.

Among the three Institutes, namely the Central Marine Fisheries Research Institute, Central Institute of Fisheries Technology and Central Inland Fisheries Research Institute, there is a tremendous amount of know-how. I think the time has come for us to start exploiting them, first in the form of pilot projects and, later on a commercial scale. I can assure you that from the headquarters of the Indian Council of Agricultural Research, whatever we can do to help our scientists, will be done expeditiously. I would like to thank Dr. Nair and others who organised this meeting and also, on my own part, I would like to thank the authorities of Southern Petrochemical Industries Corporation for their interest in our activities in this region by placing at our disposal the facilities of this Institution so generously. And, I wish all our marine scientists assembled here continued success.

VOTE OF THANKS

SHRI K. NAGAPPAN NAYAR,

Central Marine Fisheries Research Institute, Substation, Tuticorin.

To all those who have assembled here today and participated in the discussions, I am sure, the exchange of views and ideas have been very useful and valuable. Establishing the pearl culture industry in India had been the dream of many pearl fishery scientists in the past but their efforts did not meet with much success in that direction. The efforts of the scientists of the Central Marine Fisheries Research Institute have translated those dreams into a reality today. The very fact that Dr. M. S. Swaminathan, Director-General, Indian Council of Agricultural Research, Shri K. Chokkalingam, Special Secretary to the Government of Tamil Nadu, Shri T. V. Venkataraman, Director of Fisheries, Government of Tamil Nadu, Dr. R. Raghu Prasad, Assistant Director-General, Indian Council of Agricultural Research, Dr. R. V. Nair, Director, Central Marine Fisheries Research Institute and other high dignitaries have come to Tuticorin to participate in the discussions reflects the great importance attached to the development of pearl culture industry in our country.

But for the participation of all those assembled here, in the midst of their multifarious and busy official duties, it would have been impossible for us to have been appraised of the various problems connected with the potentialities of pearl culture industry, its organisation and future lines of development in India. On behalf of the Central Marine Fisheries Research Institute I wish to place on record my deep sense of gratitude and thanks to all who have contributed to the success of today's group discussions.

We will be failing in our duty if the Veppalodai Salt Corporation, particularly Shri John Motha, is not thanked for extending all facilities for our research work at Veppalodai. We are grateful to the Southern Petrochemical Industries Corporation management who were kind enough to place the premises of the Officer's Club at our disposal for the meeting and also for permitting us to avail of the catering facilities. Their participation in the discussions is also highly appreciated. The Press and the All India Radio have extended their co-operation in covering the events of the day and we thank them.

We all look forward to the day, not in the distant future, when the coastal areas of the Gulf of Mannar and for that matter many areas of our coastal waters will be studded with pearl oyster rafts carrying millions of oysters waiting to shed their lusture in the form of pearl and enrich the land of the oriental pearls.

Once again I thank you one and all.