

THE INDIAN MARINE PEARLS

A CULTURE TECHNIQUE FOR PEARL PRODUCTION



CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

Indian Council of Agricultural Research

Post Box No. 2704, Cochin - 682 031, India

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Front cover : A few Indian Marine Pearls displayed on *Pinctada fucata* shell.
Back cover (outside) : Just harvested pearls in a petridish waiting for processing
Back cover (inside) : Necklace with luxuriant pearls.

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PREFACE

Pearls have been much sought after gems from time immemorial. The 'oriental pearls' were exported to countries like Rome and Greek in ancient days. For several decades, pearl oysters were fished for extraction of the natural pearls. Japan was the first country to succeed in producing cultured pearls from pearl oysters by implanting a foreign particle and making the oysters secrete the 'mother of pearl layer' over it. This technology was used extensively in that country and in 1987, she produced pearls worth of 378 million US Dollars. India has been importing nearly Rupees 10 crores worth of pearls every year.

Eventhough experiments on production of cultured pearls were initiated in India in early 1930's, success was achieved only in the 70's when the free spherical pearls were produced. The *Central Marine Fisheries Research Institute (CMFRI)*, after successfully producing the spherical pearls, has developed a technology to produce the pearl oyster seed by the hatchery method and farming the oysters at sea. Training was imparted on these important technologies to technicians both at national and international levels.

More recently, the CMFRI surveyed a few coastal areas of Tamil Nadu along the southeast coast and selected the

Valinokkam Bay as the most suitable place for establishing pearl culture farm with the involvement of the villagers. All aspects of pearl culture were taught to them. It is expected that with the guidance of the Institute's Scientists, the villagers should be able to manage the farm and produce cultured pearls on a commercial scale. Through this type of exercises, the CMFRI creates awareness among rural folk to venture into pearl culture practices in due course wherever possible.

This brochure outlines the different aspects of the technology of breeding of pearl oyster, spat production, farming and pearl production with suitable illustrations. It is hoped that this publication would be useful to those who intend to launch on pearl production in the country.

Cochin 682 031,
4th May 1992.

P. S. B. R. James
Director



A good collection of cultured pearls.

INDIAN PEARLS - THE BEAUTY OF NATURE

Pearl, one among the nine gems, is the only gem obtained from a living organism. It is adored for its beauty in its natural form whereas other gems are cut, shaped and polished to bring about beauty. India is endowed with the natural resources of pearl oysters in the Gulf of Mannar in the southeast coast and in the Gulf of Kutch in northwest coast of India. Natural pearls of these two regions enjoyed a glorious reputation in the world trade from time immemorial. The pearls from the Gulf of Mannar are famous throughout the world as 'Orient pearls'. Production of Indian marine pearls came to a standstill since the closure of pearl fishery in the Gulf of Mannar in 1961 and in the Gulf of Kutch in 1966. The marine pearls in India are obtained from the pearl oyster *Pinctada fucata*.

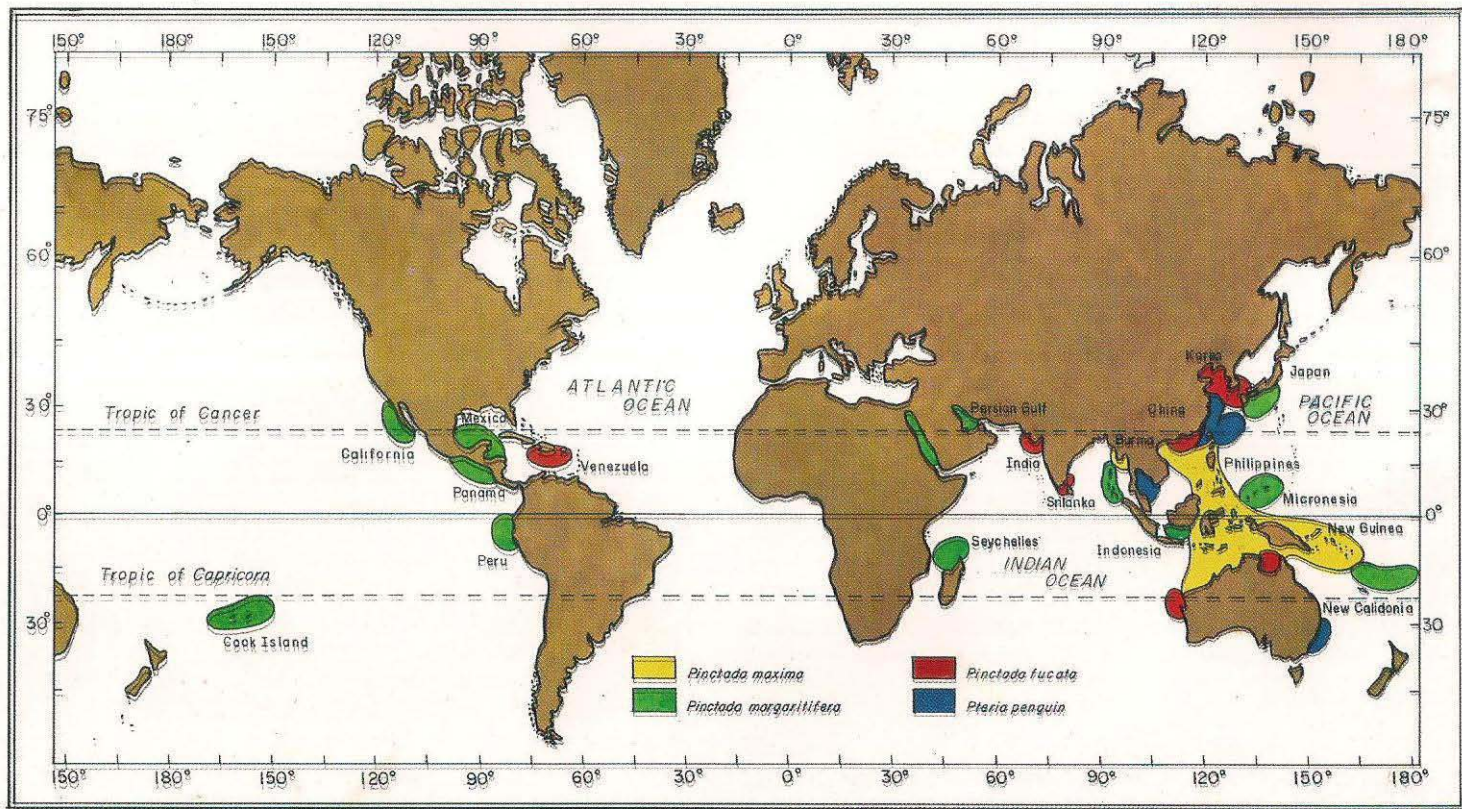
In the natural pearl, the inner core or nucleus may be a sand grain, parasite, shell-piece or a silt particle. The pearl oyster on receiving the foreign body, produces a pearl sac around the foreign body by the epithelial cells of the outer mantle. The pearl sac in turn secretes a pearly substance called 'nacre' which is deposited over the foreign body and in course of time the 'natural pearl' is produced. Natural pearls are rare in occurrence, small in size and generally irregular in shape. The insatiable demand for natural pearls led to the exploitation of pearl oysters, eventually resulting in the destruction of most of the natural pearl oyster beds. Natural pearls are also produced in some freshwater mussels. But their quality is somewhat inferior when compared with the pearls produced by the Indian pearl oyster *P. fucata*.

The cultured pearls produced from *Pinctada fucata* are of high quality. To produce a cultured pearl, two oysters - a donor and a recipient, are needed. A small piece of mantle from the donor oyster is grafted into the gonad of the recipient oyster together with a nucleus by a skilful surgery. The outer



The Indian golden pearls from *Pinctada fucata*.

epithelium of the mantle piece grows around the nucleus to form a pearl sac. The pearl sac secretes and deposits the nacre around the nucleus which eventually becomes a 'cultured pearl'.



Geographical distribution of pearl oysters.

'Artificial' or 'imitation pearls' are produced by coating iridescent guanine obtained from fish scales.

The diameter of the pearls produced from *P. fucata* ranges from 3 to 8 mm. The quality of nacre determines the colour



The Indian pearl oyster *Pinctada fucata*.

and lustre of cultured pearls. The pearls produced from young oysters are always of good quality when compared to those from the old oysters.

DISTRIBUTION OF PEARL OYSTERS

The pearl oysters occur in almost all the seas of the tropical and subtropical regions of the world. In Indian waters six

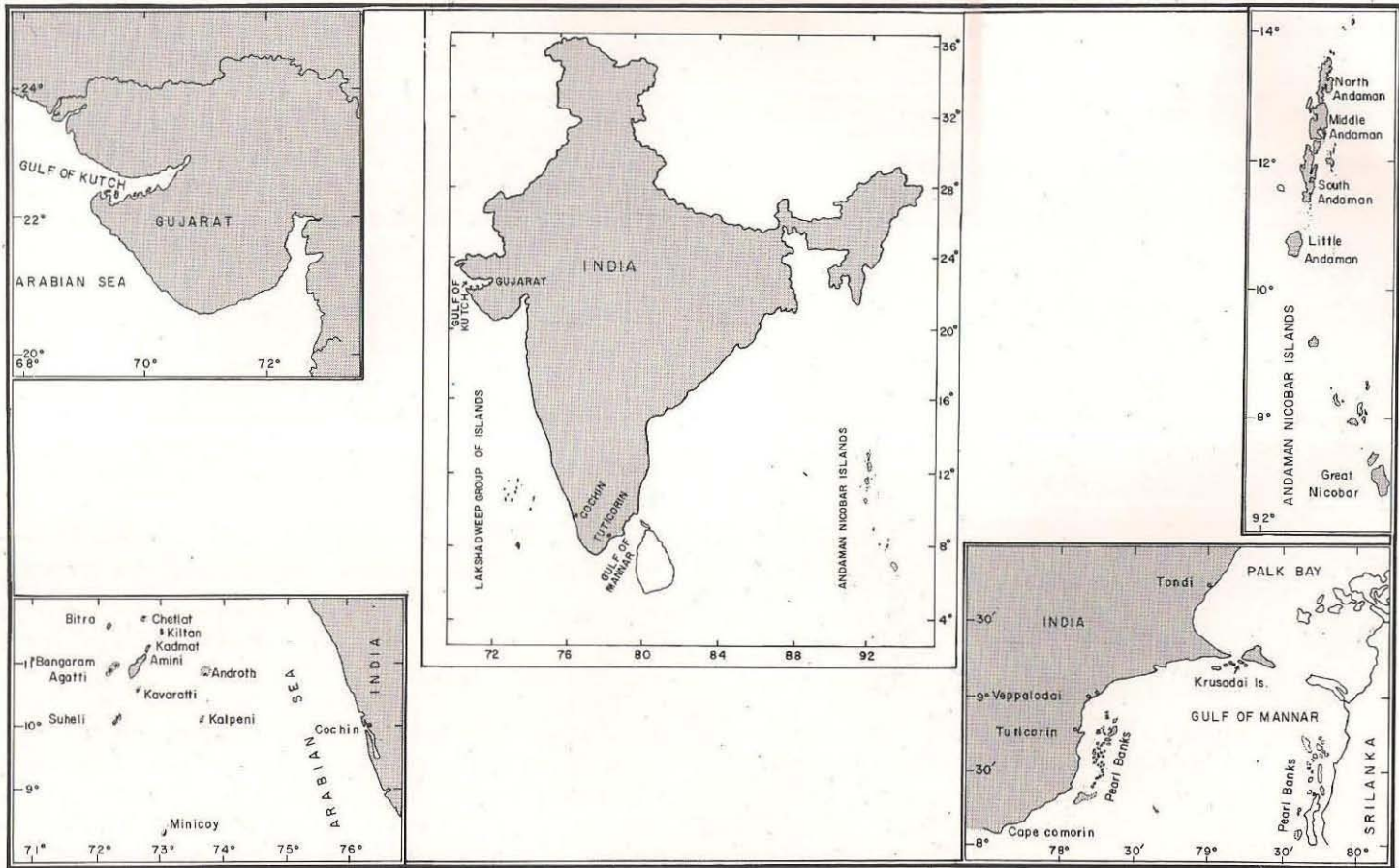
species of pearl oysters have been recorded. They are *Pinctada fucata* (Gould), *P. margaritifera* (Linnaeus), *P. chemnitzii* (Philippi), *P. sugillata* (Reeve), *P. anomioides* (Reeve) and *P. atropurpurea* (Dunker). Among these, *P. fucata* is the most dominant species. It occurs in large numbers in the pearl bank called 'paars' in the Gulf of Mannar and in less numbers in the intertidal reefs known as 'Khaddas' in the Gulf of Kutch. *P. fucata* is the only species which has contributed to the pearl fisheries in these two Gulf regions. It is also distributed in the Red Sea, Persian Gulf, China, Korea, Japan, Indonesia, Australia, Margarita and Cubagua (Venezuelan Islands).

The Black-lip pearl oyster *P. margaritifera* is well known for its production of fine steel black pearls. In India, this species is confined to Andaman & Nicobar Islands. Its world wide distribution is worth mentioning. It occurs in the Persian Gulf, Red Sea, Seychelles, Philippines, Thailand, Malaysia, Indonesia, Micronesia (Palau Islands), South Sea Islands (Fiji, Samoa, Cook Island, Tahiti, Tuamotus), French Polynesia, Papua New Guinea, Gulf of California, Gulf of Mexico, Panama Bay and Peru.

The other 4 species of pearl oysters are not of any importance as the pearls produced by them are not considered as gems.

PEARL BANKS

In the Gulf of Mannar, there are about 65 well-known pearl oyster beds (paars) located between Rameswaram and



Pearl banks in the Gulf of Mannar, Gulf of Kutch, Andaman & Nicobar Islands and Lakshadweep.

Kanyakumari. The term 'paar' can be defined as patches of hard ground formed from the comminuted remains of shells and corals, sand and organic materials cemented to a continuous mass by calcium carbonate. The 'paars' are located almost parallel to the main land. They lie at a distance of about 12 to 20 Km away from the coast at a depth of 15 to 25 m. The extent of these paars varies from a few hectares to several square kilometres.



The black-lip pearl oyster *Pinctada margaritifera*.

The pearl banks are divided into 3 divisions viz. the Northern, the Central and the Southern division. The northern division paars are relatively shallower in depth from 10 to 14 m. These paars have never yielded pearl fisheries in the past. The central and southern paars are very extensive and deep (19 - 25 m). These paars are the most productive ones in the past.

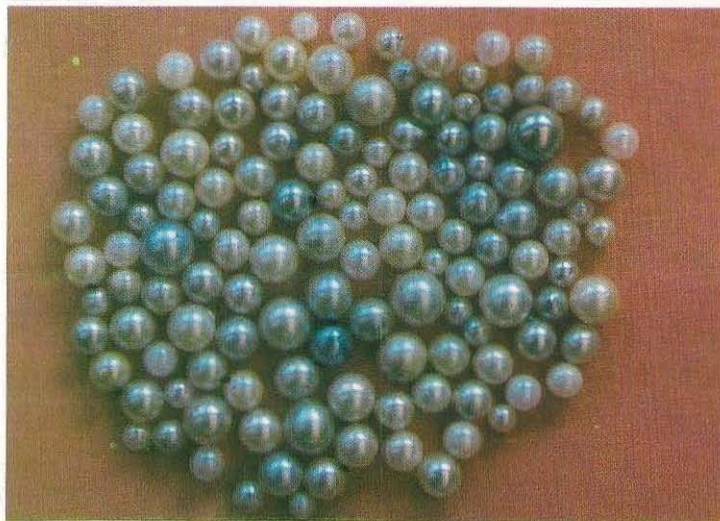
On the paars, pearl oysters are found attached to live or dead corals, rocks, other molluscan shells such as *Pinna*, calcareous algae, sponges or other hard substrata with their byssus. Where they form extensive beds, they are seen attached to one another forming bunches. The weaving



Juveniles of *Pinctada fucata*.

mussel *Modiolus* spp., *Octopus*, predatory fishes like *Balistes*, serranids, rays and skates, boring polychaetes and sponges, seastars, predatory gastropods, crabs and lobsters are some of the enemies of pearl oysters in the natural beds.

In the Gulf of Kutch, the pearl oysters are found sporadically on the intertidal coral reefs between Sachana and Azad. There are about 42 pearl oyster reefs covering an area of 24,000 ha. A typical 'Khadda' consists of a hard bottom formed of coral and rocky substance mixed with mud and



Lustrous cultured pearls.

sand. *P. fucata* attaches itself to the rocky substratum with byssus threads. The pearl oyster beds are located in the intertidal zone which extend upto 5 m below the low water mark.

PEARL FISHERY

The history of pearl fisheries in the Gulf of Mannar dates back to 16th century. So far 38 pearl fisheries have taken

place between 1663 and 1961. They were governed by Nayaks of Madurai, Nawab of Carnatica, the Portuguese, Paravas, Moors and later by the erstwhile Government of Madras under the British rule. The pearl fisheries were irregular with long gaps of unproductive periods between short spells of productive fisheries. This was due to the periodical decline of fishable quantities of pearl oyster population in the pearl banks.

In the Gulf of Kutch, the pearl fishery was under the control of the Jam Saheb of Nawanagar. With the merger of the Nawanagar with the Indian Union in 1948, it came under the control of the Government of Gujarat. There have been 25 pearl fisheries during 1913 - 1967.

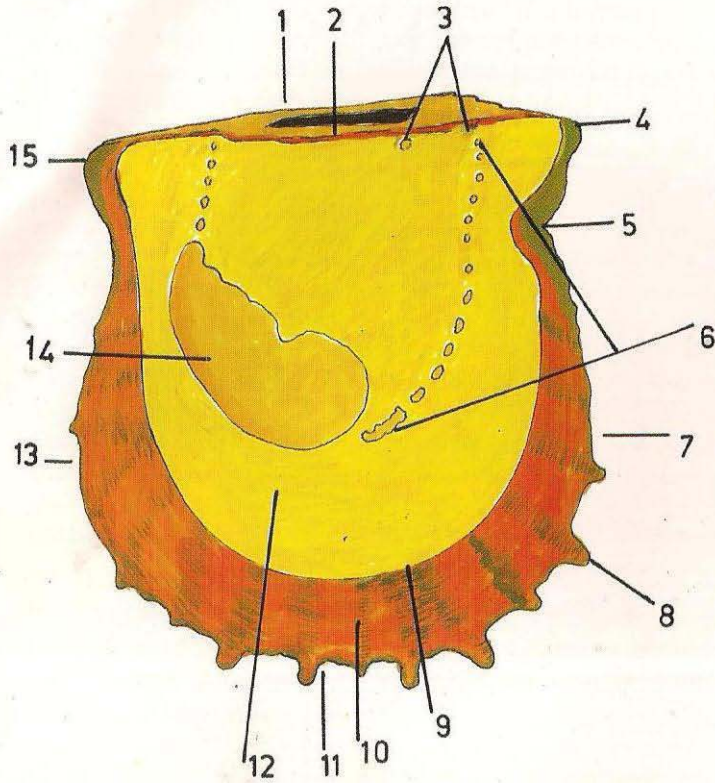
MORPHOLOGY, ANATOMY AND BIOLOGY OF THE INDIAN PEARL OYSTER *PINCTADA FUCATA*

The Class Bivalvia includes molluscs having a bilaterally symmetrical body covered by a pair of mantle and calcareous shell. The true pearl oyster belongs to the Genus *Pinctada* (Roding) which comes under the Family Pteriidae, Order Dysodonta. The Family Pteriidae includes the Genus *Pteria* too.

In India, six species of pearl oysters as mentioned earlier, have been recorded. Of these *P. fucata* is the most dominant one. Each species has distinct morphological characteristics. However, the morphology and anatomy of *P. fucata* alone is given below.

Shell : features and structure

The shells of the pearl oyster *Pinctada fucata* from Tuticorin Pearl Banks, are reddish brown in colour. Externally 6 - 8



Internal features of the shell of *Pinctada fucata*.

- | | | |
|----------------------------|-----------------------------------|---|
| 1. Dorsal margin | 6. Impressions of pallial muscles | 11. Ventral margin |
| 2. Hinge line | 7. Anterior margin | 12. Pearly layer |
| 3. Impressions of levators | 8. growth process | 13. Posterior margin |
| 4. Anterior ear | 9. Pallial line | 14. Impression of adductor muscle and retractor |
| 5. Byssal knotch | 10. Calcified prismatic layer | 15. Posterior ear |

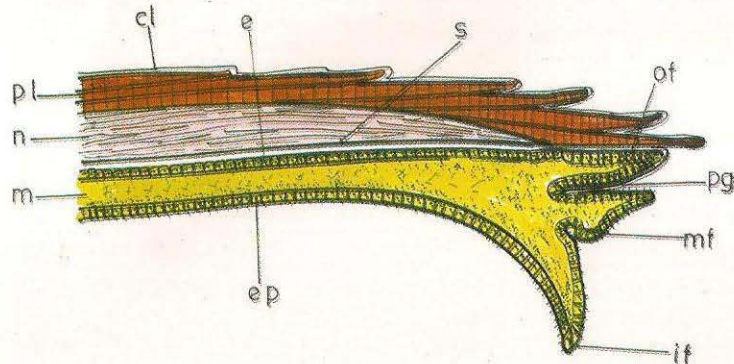
radial bands of reddish brown colour emerge from the umbo and run downwards upto the free margin of the shell. The shell is about 1.5 mm thick over the greater part. The shell is composed of three layers. The outermost layer is called periostracum. It is formed of a horny organic substance called conchiolin. The middle layer is called prismatic layer which is composed of minute prisms of inorganic calcium carbonate in the form of calcite crystals separated from each other by thin layers of conchiolin. The innermost layer is the nacreous layer or mother-of-pearl layer. It is composed of numerous fine lamellae of aragonite crystals. These three layers are formed by the secretion of the epithelial cells of the mantle.

The left valve is deeper and more concave than the right one. The shells are joined together on the dorsal side by the hinge which facilitates the opening and closing of the valves. The non nacreous border of the inner surface of the valves have brownish or reddish patches which coincide with the external radial markings. The remaining portion of the inner surface of the shell is very lustrous which is formed of nacre. A large adductor impression is noticeable subcentrally. Small scars of 12 to 15 are present for the attachment of pallial muscles.

Mantle

Mantle is a fold of skin covering the soft body below the shell. It is formed of two lobes on either side. The two lobes are fused together dorsally below the hinge line, from which point they hang down on both sides of its body. The most important function of the mantle's external surface is the secretion of shell's organic matrix and deposition of calcite crystals. The edge of the mantle has three folds viz. the ciliated inner fold, the middle fold and the outer fold. The outer fold

is shorter and flattened against the valve's interior face. It is separated from the middle fold by the periostracal groove, from the bottom of which arises a translucent organic membrane, the periostracum. This covers the edge of the shell and isolates the liquid between the mantle's external epithelium and the valve's interior, from the sea water. The peripheral cells of this epithelium secrete a glycoprotein substance, formerly called conchiolin, which serves as an organic grid for crystallization of prismatic calcite. The matrix



Radial section of shell edge and mantle margin (Diagrammatic).

Cl. Conchiolin layer	s. Site of mineralization	mt. Middle fold
Pl. Prismatic layer	Of. Outer fold	if. Inner fold
n. Nacreous layer	Pg. Periostracum	ep. Outer epithelium
		e. Inner epithelium

controls the crystal's shape and distribution by enclosing them in an organic wall. The prisms have a polygonal section and are oriented perpendicularly to the mantle surface. They ensure the longitudinal growth of the valves, which is sporadic, due to periods when growth stops, when temperature and nutritional conditions are unfavourable. The centre of the mantle precipitates aragonite as polygonal tablets.

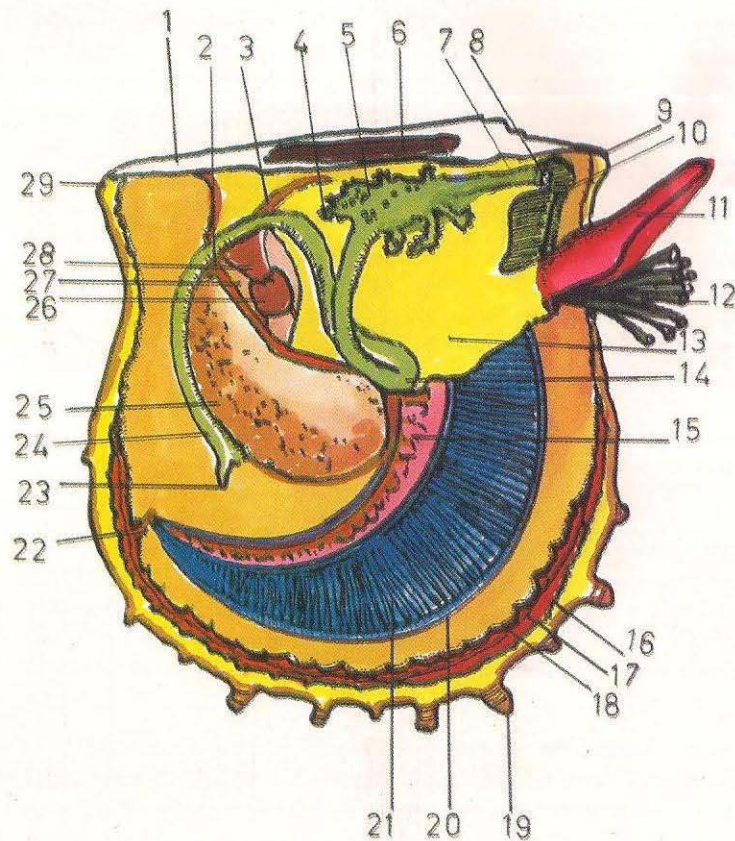


Fig. 1. Anatomy of the pearl oyster *Pinctada fucata*.

1. Hinge line	10. Labial palps	17. Middle fold of left mantle	22. Pallial fold
2. Posterior aorta	11. Foot	23. Inner fold of left mantle	23. Anal process
3. Anterior aorta	12. Byssus thread	24. Rectum	24. Rectum
4. Liver diverticula	13. Gonad	25. Adductor muscle	25. Adductor muscle
5. Stomach	14. Intestinal loop	26. Auricle	26. Auricle
6. Ligament	15. Muscular ctenidium axis	27. Pericardial cavity	27. Pericardial cavity
7. Oesophagus	16. Outer fold of left mantle	28. Ventricle	28. Ventricle
8. Mouth		29. Posterior ear	29. Posterior ear
9. Anterior ear			

which add to the thickness of the shell. It is in this part that the graft tissues are cut. If graft tissues are taken from the mantle edge, the pearl sac will secrete prismatic layers and the pearl will not be a nacreous one.

Gills

The branchial organ, the ctenidium is an active filter which takes from the water the animal's needs - oxygen and organic matter and rejects anything that hinders the filtration. The gills are a paired structure attached to the visceral mass at the front and its distal end is free in the pallial cavity. The gill consists of a longitudinal axis from which hang down two lamellae of ciliated filaments. Each blade is folded in a V-shape which increases the length and number of filaments. These thousands of filaments develop an immense exchange surface with sea water. The inhaled water current enters the shell anteriorly and reaches the gills. The ciliary movements redistribute the water by channeling it along the filaments.

Two veins follow the branchial axis; the afferent vein brings blood coming from the kidneys and the efferent vein takes it away towards the auricle. The two veins are linked by a network of capillaries which follow the filaments where blood is oxygenated.

Heart

The heart consisting of a ventricle and two auricles enclosed by the pericardium (Fig.1; 27). It is located ventral to the intestine. The auricles (Fig.1; 26) are covered with pericardial glands, which function as excretory organs. From a single ventricle, (Fig. 1; 28) arise the short posterior aorta (Fig. 1; 2) which supplies blood to the rectum and the adductor muscle and the anterior aorta (Fig. 1; 3) which continues as

arteries and arterioles. These minor arteries open into lacunae of conjunctive tissue, where blood circulates freely before reaching some large spaces called sinuses. The deoxygenated blood is collected in veins and carry into the kidneys where it is purified before it reaches the gills.

Filtration

Sea water contains suspended particles of varying sizes, shape and nature. The gills must expel them immediately upon contact or suffocate. They sort out the organic and inorganic materials and passes them towards the digestive tube. Larger particles are discharged at the rear end of the shell through the exhalent current. The ciliary movements of the filaments bring small plankton and other nutrients to the mouth. Bacteria and mud are aggregated by mucus secreted by the gills before they are sent to the labial palps. When the water is highly turbid, the filaments become choked and cannot maintain oxygenation; they therefore stop filtering.

Labial palps

The mouth is framed by labial palps (Fig. 1; 10) which are two superposed curved leaves whose opposing faces are stripped with grooves. The small plankton brought in by branchial currents undergo another selection. Some organisms are undesirable, because of their spiny ornamentation or chemical character. They are directed along the furrows to the end of the palps, where they fall into the pallial cavity and are periodically ejected as pseudo-faeces into the sea water. The accepted food is passed to the mouth and oesophagus and finally into the stomach. In the stomach the food particles are mashed, impregnated with enzymes liberated from a gelatinous rod known as the crystalline style.

The larger particles are directed towards the intestine; while the other nutrients are despatched to the digestive diverticula which surround the stomach. The intestine extends through the visceral mass and forms a loop, ascends above the heart, ends to a long rectum along the adductor muscle. The anus is encircled by a funnel shaped anal appendix which ejects the faeces outside the mantle.

Sensory organs

The nervous system consists of 3 pairs of ganglia viz. cerebropleural, pedal and visceral from which the nerves arise. The mantle is innervated by a complex network, the pallial plexus which make it react at the least tactile or chemical stimulus. The gill responds to stimuli. A branchial eye is present on the first left hand branchial filament. It can detect variation in light intensity.

Reproduction

In pearl oyster, the sexes are separate, but the males and females cannot be distinguished from the characters of the shell. The reproductive system consists of a pair of gonads which spreads superficially over the hepatopancreas and intestine in mature state. It is pale yellow in colour in male and is of a deeper shade in the female. The eggs or sperms are spawned through the paired gonoducts ending in the genital openings located at the anterior ends of the gills. *P. fucata* attains first sexual maturity when it is about 15.5 mm, i.e. when about 3-4 months old. Pearl oysters spawn twice in a year. In the Gulf of Mannar, the spawning season is June - August and November - January coinciding with the southwest and northeast monsoons respectively. The male

and female oysters release their spermatozoa and ova respectively into the sea and the eggs are fertilized.

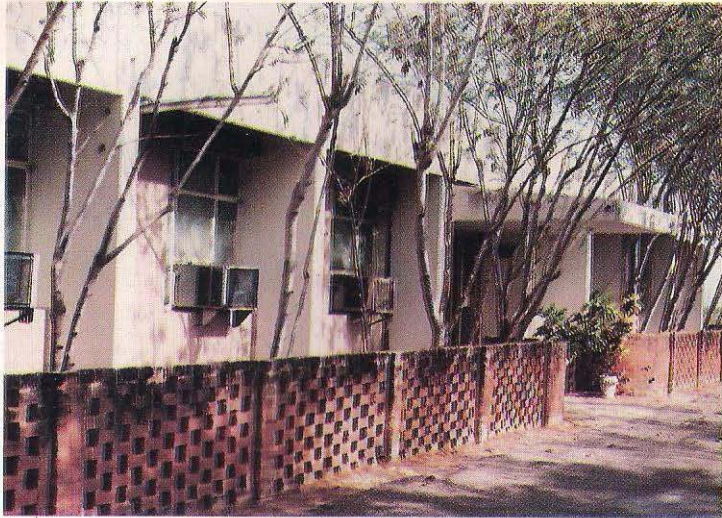
Age and growth

The age and growth of pearl oysters in the Gulf of Mannar have been studied in detail. Observations made on cultured pearl oysters collected near Krusadai Island and at Tuticorin show that the oysters can grow to a height of about 35-45 mm at the end of the first year, 50-55 mm at the end of the second year, 55-60 mm at the end of the third year, 60-65 mm at the end of the fourth year and 65-70 mm at the end of the fifth year. The weight of the oysters was 10, 30, 45, 60 and 70 g at the end of the first, second, third, fourth and fifth years respectively. Tracing the growth history of *P. fucata* produced in the hatchery and grown in the farm at Tuticorin Harbour revealed that the species attains a modal size of 47.0 mm at the end of the first year, 64.5 mm at the end of the second year and 75.0 mm at the end of the third year. The corresponding weights at ages 1 to 3 years were 8.3, 31.6 and 45.4 g respectively. The pearl oysters have been estimated to have a longevity of 5.0 - 5.5 years in natural beds, but have been observed to live upto seven years when reared in the farm.

PEARL OYSTER HATCHERY

The dwindling nature of the pearl oyster population in the natural pearl banks in the Gulf of Mannar warranted a hatchery to be set up for the production of pearl oyster seed. Accordingly a pearl oyster hatchery was established in 1980 at the Tuticorin Research Centre of the Central Marine

Fisheries Research Institute and a breakthrough was achieved in the production of pearl oyster seed in 1981. Refinement of the hatchery techniques has enabled the scaling up of operations to a production level of 1.2 million seed per annum. The success guaranteed a sustained supply of seed for mother oyster culture. The development of hatchery technology at



Front view of Pearl oyster hatchery.

Tuticorin has given impetus to Gujarat State and Lakshadweep Administration to initiate programmes on pearl culture based on the seed supplied from Tuticorin hatchery.

The hatchery operations involve spawning, larval rearing, spat setting and rearing. Fully ripe male and female

oysters spawn in the laboratory by thermal or chemical stimulation. The male and female oysters release gametes simultaneously in the filtered seawater and fertilization takes place immediately. The fertilized eggs with a polar body undergoes cell division in about 45 minutes. Three hours later the morula stage is reached, which develops into blastula



Inner view of pearl oyster hatchery.

and gastrula in about five hours. The trochophore is a swimming larva which is reached in 7 hours after fertilization. The veliger larva having a shell is reached in 18 hours and measuring 0.065 mm in shell height. The veliger larvae are stocked at 2/ml of filtered sea water in rearing tanks. The unicellular microalgae *Isochrysis galbana* is given as food to

the veliger. The ration is increased from 10-50 cells/ml upto spat settlement. The veliger larva develops into umbo stage (size 0.13 mm) in 12th day. An eye-spot appears at the base of foot primordium in about 15th day (size 0.17 mm). A foot is developed on 18th day and the stage is called pediveliger (size 0.19 mm). The pediveligers set as spat called plantigrade on 20th day and are attached on to the substratum initially by foot and later by byssus threads (size 0.20 mm). The plantigrade, on further growth of the shell becomes typical spat measuring 0.30 mm.

From the veliger stage onwards the sea water is changed once in two days. Food is given once in a day. No aeration is provided during larval phase. The water temperature varies from 28 to 30°C and the salinity from 33 to 34 ppt.

The spat are allowed to settle inside the tank. Two months after settlement the spat reach 3-5 mm. The mixed microalgae mainly constituting *Chaetoceros* spp. specially cultured and given as food for the spat. The spat are transferred to farm site in velon screen covered box cages of appropriate mesh size. The initial stock of veliger larvae result in 20-30 % of spat production in the hatchery.

PEARL OYSTER SURGERY - A DELICATE OPERATION

Among the six species of pearl oysters, *P. fucata* is the only species that occurs in abundance in the Gulf of Mannar and is widely used in cultured pearl production. The oyster reaches to a shell height of 45 mm at the end of first year. Nucleus implantation is carried out from this size onwards. A technician can implant as many as 200 to 300 nuclei in a

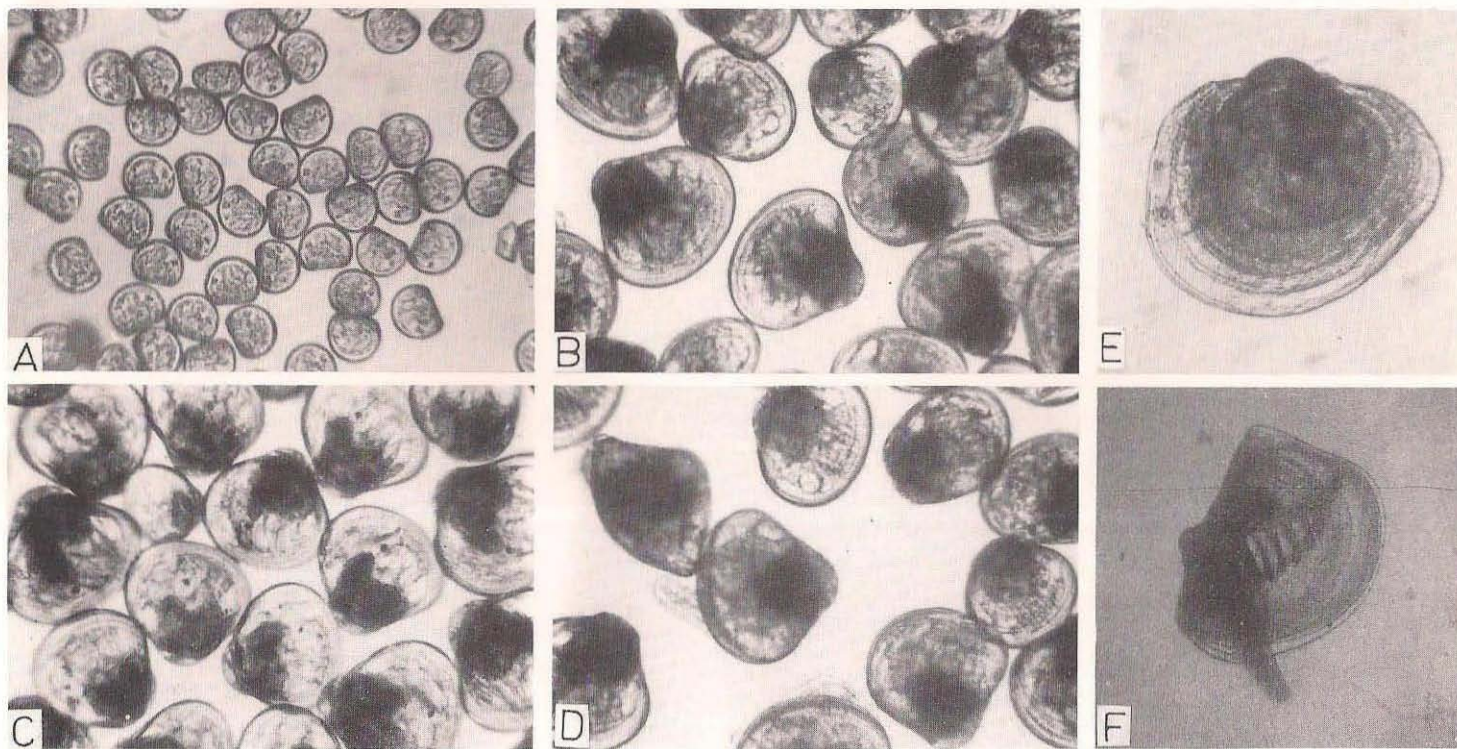
day. Depending on the size of oysters, single, double and multiple implantations are carried out.

When the valves of the oysters are opened forcibly for implantation of nuclei, their adductor muscles get cut and

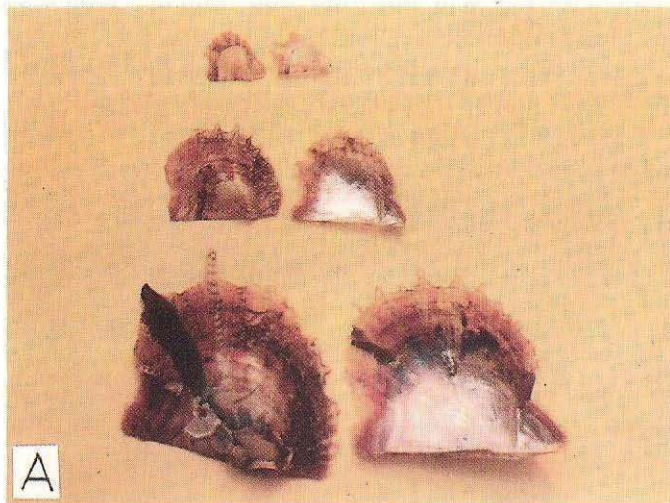


Surgical instruments used for nucleus implantation.

the oysters die immediately. Hence the oysters are allowed to open their valves gently by themselves. This is done either by raising the water temperature or by applying chemicals like menthol. The oysters are arranged in a plastic basin with their hinges pointing downwards. Sea water is slowly poured into the basin till the oysters get immersed in the water.



Developmental stages of *Pictada fucata* : A. Veliger larvae, B. Umbo stage, C. Eyed stage, D. Pediveliger stage, E. Plantigrade and F. Spat.



A



B

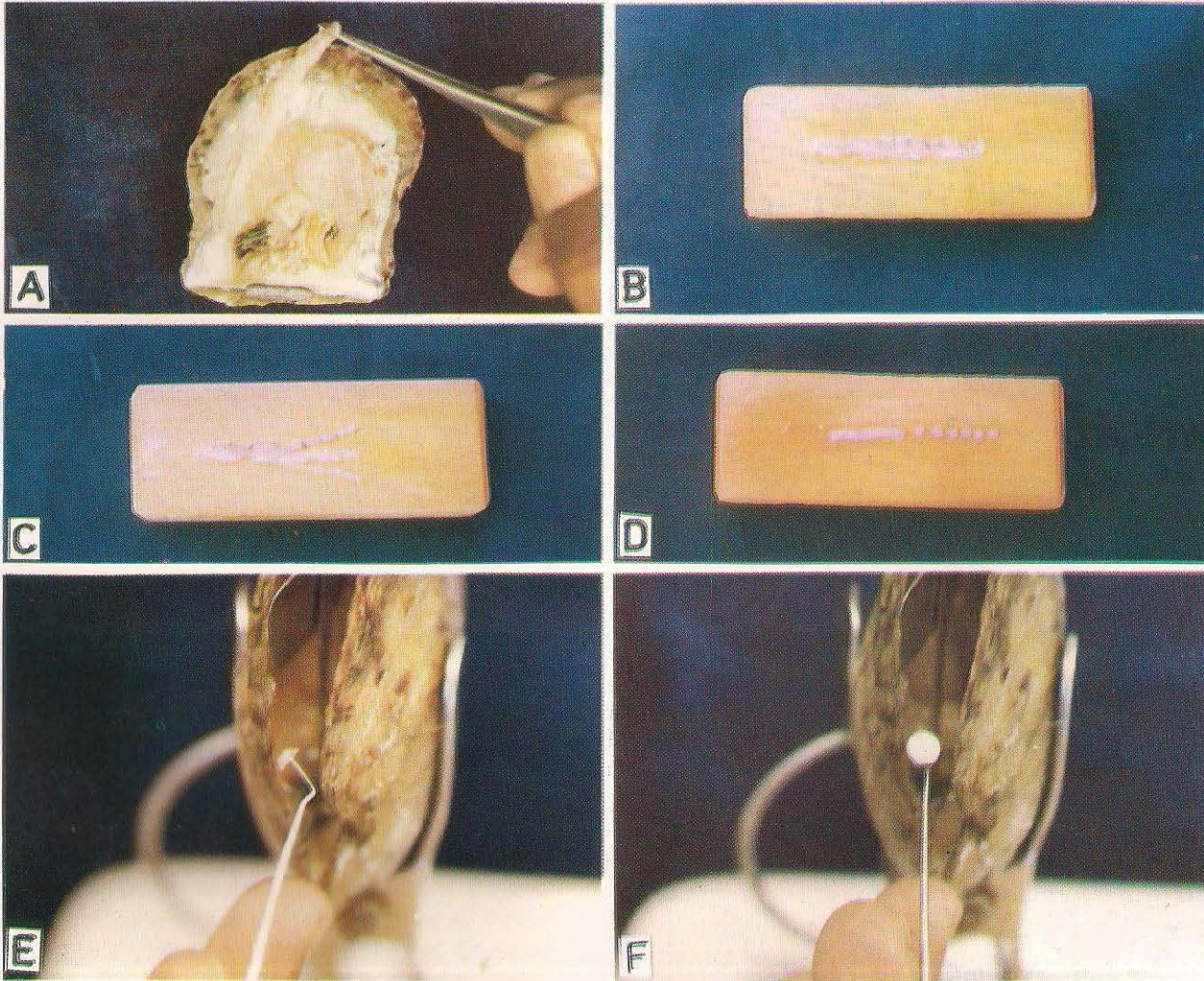


C



D

Shells of pearl oyster *Pinctada fucata* : A. 2 months, 3 months and 5 months old pearl oysters, B. 6 months old (magnified), C. 8 months old and D. 10 months old.



Pearl oyster surgery : A. Removal of mantle piece from a donor oyster, B. Mantle as removed from the oyster, C. Trimming the mantle edges, D. Pallial mantle piece cut from the strip, E. Insertion of graft tissue and F. Implantation of nucleus.

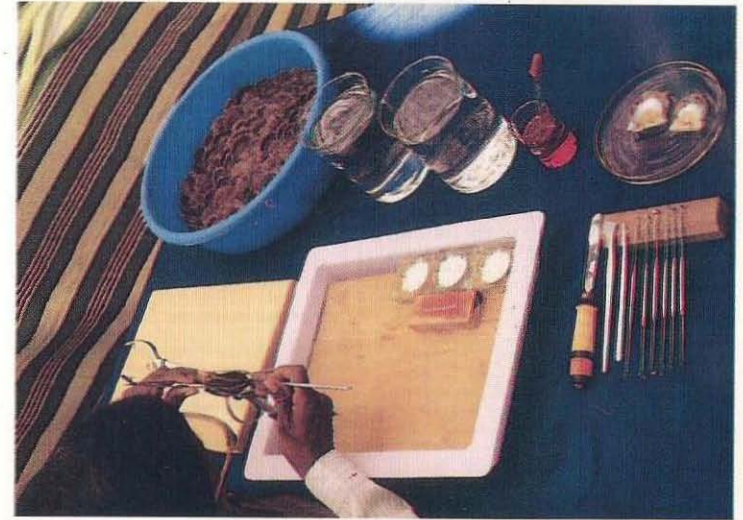
Sprinkle a little amount of menthol powder over the water. In about 60-90 minutes, the oysters begin to open their valves due to the effect of menthol. Immediately a small wooden peg is inserted in between the two valves to keep them open and thus the oysters are conditioned.



Conditioning of pearl oysters using menthol.

The conditioned oyster is mounted on the oyster stand. A sharp incision is made at the base of the foot of the oyster and a passage is cut subcutaneously through the gonad up to the spot selected for nucleus implantation. A small mantle piece of size 2 x 2 mm taken from a live donor oyster is inserted through the passage. The shell bead nucleus is inserted through the same passage so that it is in contact

with the outer epithelium of the mantle piece. Then the oyster is removed from the oyster stand and the peg is removed from between the valves.

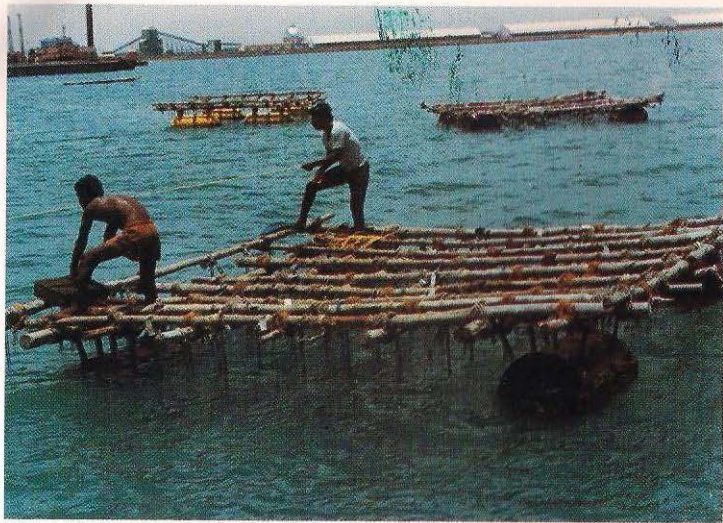


Pearl oyster surgery.

POST-OPERATIVE CARE

After the surgery, the oysters are placed in a plastic tub filled with fresh sea water. The water is changed frequently until the oysters recover from the effect of menthol. Within 30 minutes, the oyster resumes its normal function of opening and shutting its valves. Then the oysters are placed in netlon baskets and hung in the one tonne FRP tanks containing sea water. A mild flow of sea water is always good and this is ensured by aerating the sea water. The faecal matters are

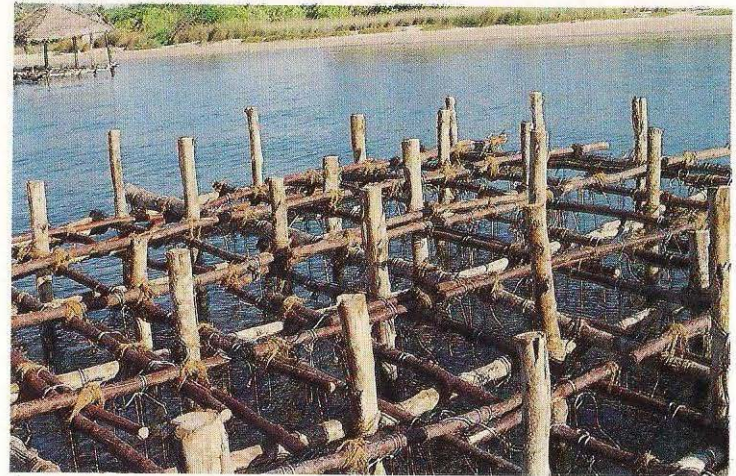
either washed away by the mild current or kept away from the oyster. The operated oysters are kept in the laboratory for 2-3 days under observation. The dying oysters and the oysters which reject their nuclei are removed from the netlon basket. Then these oysters are placed in box cages of 40 x 40 x 40 cm, transferred to the farm and suspended from the



Raft for farming pearl oysters.

raft at 5 m depth in the sea. All the cages containing implanted oysters are stitched with velon screen of 1.5 mm mesh at the bottom to prevent the rejected nuclei from falling into the water. In a box cage, 85-100 oysters of the size 40-45 mm can be accommodated. The cages are numbered with aluminium/plastic plates. The oysters are reared in the farm without much disturbance. Once in two months, the cages

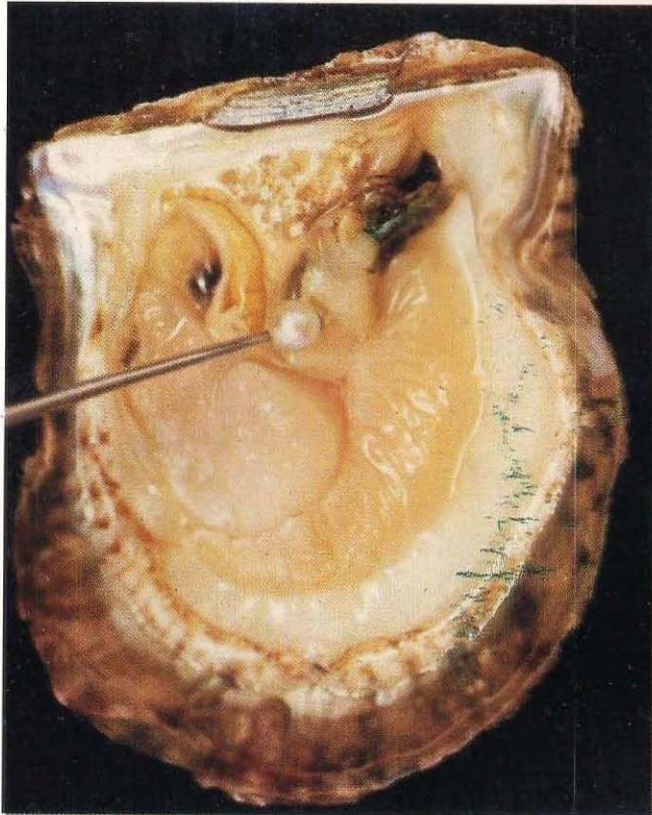
are lifted to remove the predators from the cages and to scrape off the epifauna from the oyster shells and cages. In Indian waters, the deposition of nacre on nuclei is much faster than in sub-tropical and temperate waters. The duration of post-operative culture varies from four to eighteen months depending on the size of nucleus and the maturity of pearl. When a 3 mm nucleus is introduced in an oyster, it takes a minimum of 4 months for the pearl to attain maturity and it is 5-7 months for a 4 mm dia nucleus.



Wooden racks with oyster cages in shallow water oyster farm.

Floating rafts are used for farming oysters in the open sea. In shallow sheltered bays, racks are employed. In rack system which is a fixed structure, teak wood poles are driven vertically into the sea bottom and a rack is constructed by

lashing horizontal and cross poles on them with coir ropes at a convenient height of 0.5 m above the water level so that

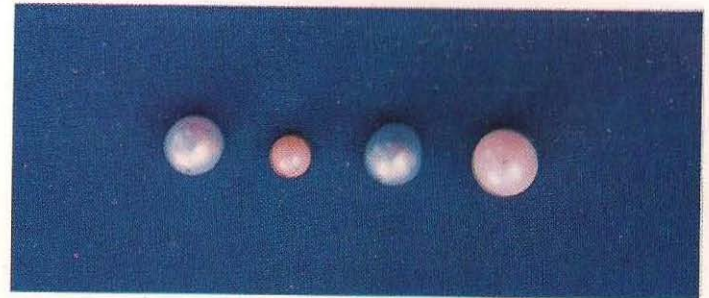


Removing the pearl from the gonad of the oyster. the rack thus erected remains always above the water. The oyster cages are suspended from the wooden frame.

The success of farming pearl oysters greatly depends on the environmental condition prevailing in the area. In India, the pearl culture is being undertaken in the Gulf of Mannar and the Gulf of Kutch. Cyclones, storms, strong currents and violent waves are not uncommon in these regions. Dilution of sea water during monsoon months and high saline condition during summer months are quite common in some parts of the east and west coasts of India and such areas are not suitable for farming pearl oysters.

PEARL HARVEST

For obtaining good quality pearls, the oysters should be grown at depths 5-10 m. Strong sunlight on oysters must be

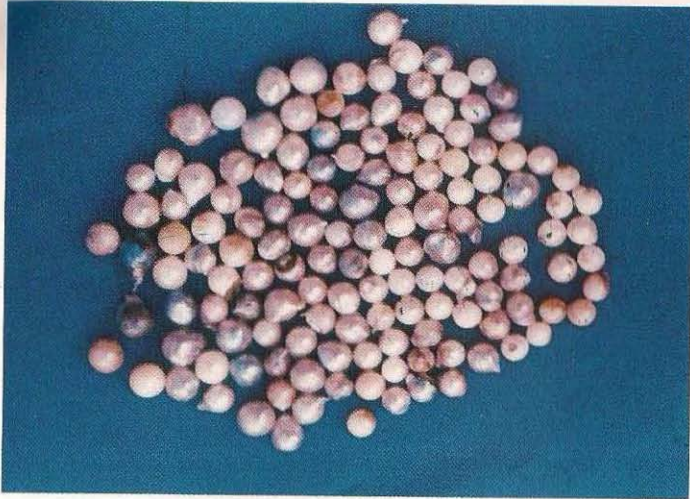


Pearls of different colours.

avoided since sunlight can induce the nacre secreting cells to produce calcite crystals to form prismatic layer over the nucleus resulting in poor quality of the pearl.

In commercial pearl culture farms, during harvest, all the seeded oysters are killed and the pearls collected. In small scale operations every oyster is examined to ascertain about

the retention of nucleus. This is done by pegging the oyster and examining their gonad. The oysters without nuclei/with nuclei but no nacre secretion, are reused for pearl production. The adductor muscles of pearl oysters can be used as a delicious food.



Collection of baroque pearls.

The shells are used as one of the ingredients for poultry feed, mosaic flooring chips, medicinal substance and for making buttons and other ornaments.

THE PEARLS

The quality of cultured pearls is much relevant to the economics of pearl culture. The quality of pearls is dependent

upon the thickness of nacre, iridescence, lustre, colour, size, shape and flaws.

Thickness of nacre

If the deposition of nacre on the nucleus is thick, then the pearl is more durable and beautiful and will give the required lustre and iridescence. The nacre is composed of thousands of very thin layers. A good quality pearl is decided according to the homogeneity, evenness and the thinness of these layers.



Twin and triplet cultured pearls.

Iridescence

The iridescence of a pearl is due to its optical characteristics. Light is refracted from the multitude of prisms of aragonite crystals. When the individual layer of organic

matrix is thin, the light penetrates good into the translucent crystals. It is refracted in each layer of nacre and the rays that re-emerge together make interference effects which decompose the light spectrum into rainbows. The faces of aragonite crystals form regular grooves - ripple marks - on the pearl's surface and enhance the iridescence with defraction fringes.

Lustre

The brilliance of a pearl depends on its lustre. The regular ridges on the surface reflect the light without diffusing it. Good lustre and refraction indicate that the nacre is composed of pure aragonite crystals. The pearls with some flaw are sometimes considered as gems if the lustre is good.

Colour

The Indian pearls show diversity in colours. Colouration of pearls is mainly due to the physiological condition of the oyster which donates the mantle tissue and the recipient oyster. The environmental factors also play a predominant role in determining the colour of nacre. Minerals and trace elements in the sea water also influence the colour of pearl. The pink and green colour pearls are considered as most valuable pearls.

Size

Cultured pearls from the Indian pearl oyster *P. fucata* are produced in the diameter range of 3 to 8 mm. The size is very important in deciding the price of a pearl. The bigger

pearl fetches higher price. For a 8 mm nucleus, the nacre coating period varies from 18 to 24 months.

Shape

The nucleus floats in the pearl sac. Nacre is secreted and deposited on the nucleus with regular concentric layers of aragonite. If the nucleus rotates on one axis, the resultant pearl would be hooped. Any stress on pearl sac leads to the deformation of pearls. If the nucleus happens to be near the muscle, the contraction of muscle creases the sac resulting in baroque pearls. Infection by micro-organisms on the sac results in pear-shaped or elongate pearls. A concentration of bacteria can lead to small gas bubble which is enclosed in nacre develops into a blister devoid of nucleus.

Flaws

Production of flawless pearls totally depends on the oyster itself. Due to its rareness the price is always higher. The price will be less if there are many flaws. If the orientation of graft tissue and the nucleus are not properly set, the pearl produced will have teats and black dots. The pearls formed near the adductor muscle will mostly be prismatic.

GRADING OF PEARLS

The pearls are sorted by size, shape, colour, lustre and surface quality. Some of the pearls may be perfectly round in shape and of outstanding colour and lustre, many are inferior in quality and some are totally valueless as gem. The

pearls are classified into three classes A, B and C. In India, the composition was class A 37.6%, class B 37.6% and class C 24.8%. Based on colour, pearls are grouped into pink, white, yellow, cream, golden, green, blue and black pearls. Apart from colour, lustre forms an important factor in grading the pearls.

PROCESSING OF PEARLS

To improve the quality, the pearls are processed. Bleaching the pearls is done by hydrogen peroxide in a fixed strength as bleaching agent. Only the drilled pearls are treated. The organic impurities in the pearl are removed with hydrogen peroxide.

Surface polishing of pearls is done with salt. The pearls are mixed with salt in equal volume and placed in a tub with small amount of water. The residual mucus on the surface of the pearl will be removed by rubbing with salt to obtain good lustre.

THE JEWELS

In India, there are several jewellery companies which make silver and gold ornaments inlaid with pearls and export them to Europe and America. Indian craftsmen are good in making ornaments such as pearl ear drops, gold rings inlaid with pearls, pearl tie pins, peacock shaped brooches, bracelets and double pearl necklaces. These Indian made jewellery has a great reputation both in India and abroad.

TRANSFER OF TECHNOLOGY

The Central Marine Fisheries Research Institute has developed the technology of pearl culture and hatchery

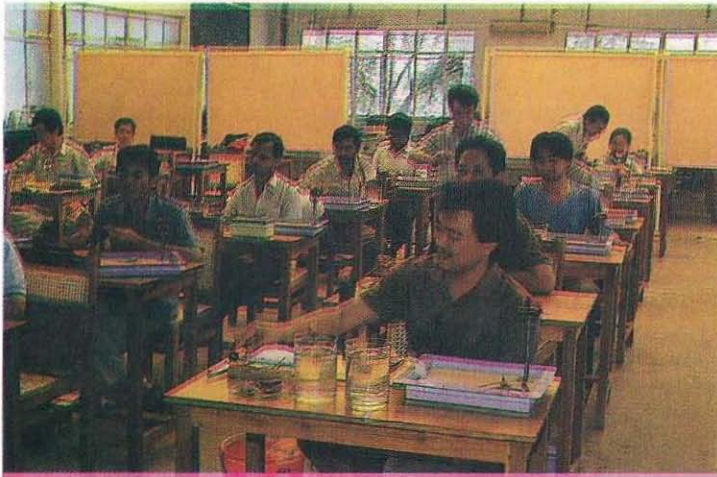
production of pearl oyster seed. The techniques have been tested for several years and the results are consistent indicating their viability. As a first step towards the transfer of technology, training programmes were organised by the Institute to develop man power in this specialised field. Officials sponsored by fisheries departments of Tamil Nadu,



A pair of ear studs, a ring and a bangle inlaid with cultured pearls.

Kerala, Karnataka, Gujarat, West Bengal, Andaman & Nicobar Islands and Lakshadweep numbering 34 were trained in six training programmes conducted by the Institute at its Tuticorin Research Centre. One candidate from the Southeast Asian Fisheries Development Centre (SEAFDEC) in Philippines, was also benefited by this training in 1979. The Regional Seafarming Development and Demonstration

Project of the Network of Aquaculture Centres of Asia (NACA), Bangkok has recognised the CMFRI as a Lead Centre to train the Aquaculturists of the Southeast Asian Countries



**FAO / UNDP Regional Seafarming Project Trainees
in a practical class at the laboratory.**

on pearl culture. Under this programme, an International Training Programme on pearl culture was organised at Tuticorin from 1.2.1991 to 28.2.1991. Twenty-six candidates from ten countries were trained.

Consignments of pearl oyster seed produced in the CMFRI hatchery were supplied to Gujarat and Lakshadweep Fisheries Department to support their R & D efforts in pearl culture.

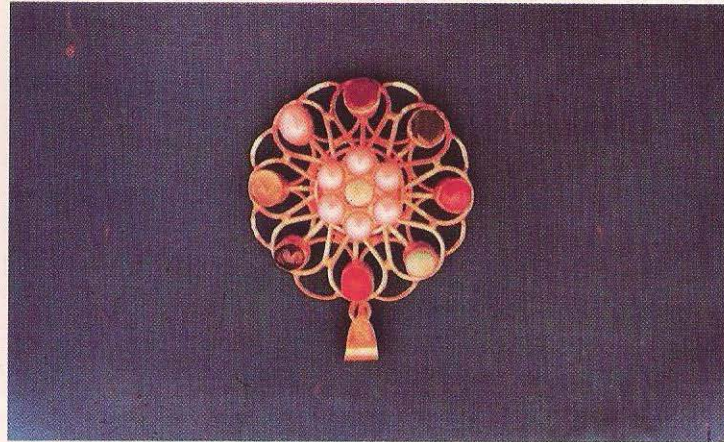


FAO / UNDP Regional Seafarming Project Trainees in the field.

In April 1991, the Institute has taken up a new research and development programme entitled 'Upgradation, location testing and transfer of technology of pearl culture'. In the Valinokkam Bay of Ramanathapuram District, this project is

being implemented. 25 fishermen of Valinokkam village are actively participating in the programme. They are being

trained in various aspects of pearl culture so that they can operate the project in course of time.



A pendant inlaid with pearls and precious stones.



Irregularly shaped "baroque" pearls are also used in ornaments.

