

- (3) During the breeding season, oysters should not be disturbed by fishing, rather allowed to

breed freely. This period may be declared as close season for any fishing.

IMPORTANT QUESTIONS

» Long answer type questions

1. Give detailed account of the programming of pearl industry and artificial insertion of nucleus.
2. Give name of pearl producing molluscs. Describe in detail the pearl formation in nature.

» Short answer type questions

1. Describe in brief the phenomenon of pearl formation in natural conditions.

» Very short answer type questions

1. Give name of pearl producing molluscs.
2. Graft tissue preparation for artificial insertion of nucleus for pearl industry.

» Objective type questions

1. Which of the following is called as 'Mother of pearl' ?
 (a) Periostracum (b) Prismatic layer
 (c) Nacreous layer (d) Mantle
2. The women divers for pearl collection in Japan is called :
 (a) AMA (b) Mikimoto
 (c) Kokichi (d) Misaki
3. The piece of tissue which is inserted inside the mantle of pearl oyster is called :
 (a) Peg (b) Shell
 (d) Conchyolin (d) Graft
4. Which of the following is best quality of pearl ?
 (a) White pearl (b) Cream pearl
 (c) Pink pearl (d) Lingha pearl
5. The trained girl in Japan who operates oysters for the insertion of nucleus is called as :
 (a) Tomarine son (b) AMA
 (c) Lima (d) Nishikows

ANSWERS

1. (c), 2. (a), 3. (d), 4. (d), 5. (a)

into the main mass. Suddenly one graft tissue piece is placed into the channel and the nucleus is placed over the graft tissue which functions as a bed for the nucleus. Now the bamboo peg is quickly removed and oyster shells are closed automatically. For the insertion of the second nucleus similar operation is performed from the left side in the gonadial tissue and third insertion should never be tried. In Japan one trained girl can operate 25 to 40 oysters per hour and these girls are called as 'TOMARINE SON' means 'Miss Nucleus Pusher'. The operation period should not increase beyond 30 minutes and the oysters can not survive beyond one hour of the operation period. So operation and insertion of nucleus should be performed by experienced persons.

5. Post operational care : Nucleated oysters are placed into cages and suspended into sea water and attached with floating rafts to a depth of 2 to 3 metres for about 6 to 7 days to recover from the shocks due to operation. This period of 6 to 7 days is known as 'RECOVERY PERIOD.' Now oysters are examined properly and dead individuals are removed from cages. Sometimes, few oysters expel out the nucleus from the body due to heavy shock. Now-a-days it is examined by X-rays whether oysters are having inverted nucleus or not. About 3000 to 3600 nucleated oysters are kept in different cages suspended in sea water at 2 to 3 meters depth for 3 to 6 years and undisturbed except at the time of clearing and inspection. The pearl oysters grow best in warm shallow waters generally not more than 14 metre deep.

D. Harvesting of Pearl

Pearls are harvested in the month of December to February which may slightly vary according to the climatic conditions of the industrial area. After the completion of 3 years of the insertion of nucleus, pearl oysters are harvested from the sea and the pearls are taken out from the shell.

E. Clearing of Pearls

After taking out the pearls from the oysters shell they are washed properly, cleared with the soap solution, but pearls should not be rubbed much.

COMPOSITION OF PEARL

Pearl comprises of water, organic matter, calcium carbonate and the residue.

- (1) Water : 2-4%
- (2) Organic matter : 3.5-5.9%
- (3) Calcium carbonate : 90%
- (4) Residue : 0.1-0.8%

Quality of Pearl

The pearls obtained are of variable shapes and sizes. They may be white or cream red or pink red in colour. The spherical pearls of rainbow colour are rarely found. The best quality of pearl is known as 'LINGHA PEARL' and obtained from marine oysters. Pearl obtained from freshwater bivalves are not as valuable as those obtained from the marine oysters (Mishra, 1961).

PROBLEMS OF PEARL INDUSTRY

Theoretically pearl culture appears to be very much easy but practically several problems crop up during culture. Number of enemies like eel, octopus, devil fishes etc., destroy the oyster. The lethal cold water, low salinity of water, turbidity of water and high range of temperature variation hamper the pearl industry by affecting the proper rearing of the oysters.

SUGGESTIONS FOR PEARL INDUSTRY

- (1) During pearl fishing the nets used should be of such size from which smaller than a limited sized pearl may not be caught but should pass through the net to get a chance to grow.
- (2) The fishing of pearl oysters should not be much so as to exhaust the stock soon.

old oysters are sent to shallow water and in the months of April and May they are taken out. For pearl industry and proper supply of oyster, its eggs are incubated artificially which solves the problem of obtaining oysters for pearl culture.

Oysters are also caught by special type of cages ($84 \times 54 \times 20$ cm) by covering a heavy wire frame with two centimetre wire mesh. This cage is dipped into hot coltar as a measure against corrosion. Now this cage is dipped into the sand-cement mixture providing rough surface to the cages to which free swimming sopts get easily struck up. These cages are suspended at a depth of 6 metre from July to November where spots are easily available. These collected oysters are now transferred to rearing cages.

B. Rearing of Oysters

The collected oysters are stocked and reared in special type of cages called as rearing cage. These cages are almost similar to those of collection cages except that they are further divided into 4 to 6 smaller chambers and lack the diagonal sub-divisions. They are also covered with metal mesh and with netting of cotton. These cages are well protected from natural enemies of oysters like Octopus, Eel, Devil fishes etc. The collected oysters are first cleaned and then placed into the culture cages for a period of about 10 to 20 days to recover the strain due to excessive handling and for the physiological adjustment to the shallow water conditions.

C. Insertion of Nucleus

The insertion of nucleus as foreign particle is very much technical process and is of great importance for pearl industry. A number of methods are devised but most practicable and efficient method is one adopted by Nishikows. In this method a piece of mantle of living oyster is cut off and inserted together with a suitable nucleus inside the living tissue of another oyster. Following steps are taken for the insertion of nucleus.

1. Fitness of oyster for operation : The selected oysters for the insertion of nucleus should be healthy and strong enough to over come the shocks during operation. It is suggested that if the

ovary and testis of oysters are got rid off they would be more resistant to the shocks of operation. For this purpose oysters are dipped into cold and warm current of water alternately which initiates them to eject their sperms and eggs in case of males and females respectively. Before operation, oysters are kept under stress of suffocation as a result they start to open their shells and at once abamboo peg (piece) is inserted between the gap of two shells due to which shells may not be closed again.

2. Preparation of graft tissue : The piece of tissue which is inserted inside the mantle is called as 'GRAFT' tissue. A strip of about 7×0.75 cm is cut from the edge of mantle of healthy oysters by sharp knife. This piece is smoothed, cleaned and washed off the adhering mucus and again wiped off by wet sponge. The border of gill piece is removed by sharp scalpel. Now this tissue is trimmed to 2 to 3 cms long narrow strip and again cut transversely into small squares according to the size of the nucleus for insertion. These squares are kept in sea water at 22°C where they can survive for about 48 hours. The outer edges of these graft squares must be known because nacre secreting cells are found only on the outer surface of the mantle so it is essential to keep the outer surface in contact with the inserted nucleus.

3. Preparation of nucleus : Although any small particle may function as nucleus to initiate the pearl formation but it is reported that calcarious nucleus is the best because the deposition of nacre was found to be more satisfactory on calcarious nucleus as compared to any other particle. Best nucleus is formed by the shell of molluscs with heavy deposition of calcarious shells. Such type of molluscs are easily available in India but Japan depends on U.S.A. for good quality of calcarious shells. It is also notable that spherical nucleus is best for the formation of good quality of spherical peral.

4. Insertion of nucleus : For the insertion of nucleus, oysters are fixed in a desk clamp in the position of right valve facing upward. Mantle folds are smoothly touched to expose the foot and the main body mass, followed by an incision into the epithelium of the foot and a slender channel

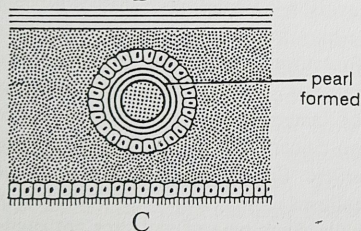
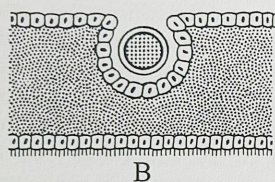
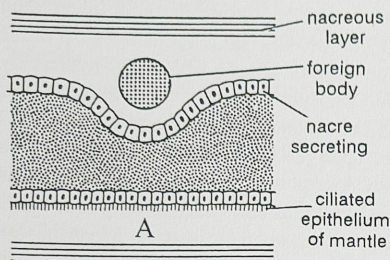


Fig. 2. Stages in pearl formation : A. Primary stage; B. Progressive; C. Final stage.

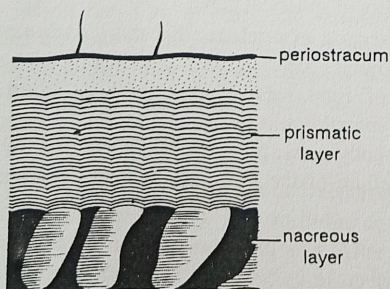


Fig. 3. Vertical section through the shell.

calcium carbonate and conchyolin arranged parallel to the surface. This nacreous layer is secreted by the entire outer surface of the mantle, while the first two layers are secreted only by the edge of the mantle.

PROGRAMMING OF PEARL INDUSTRY AND ARTIFICIAL INSERTION OF NUCLEUS

Although pearl industry may be established only on natural basis of pearl formed by oysters in the natural conditions but an artificial device to insert the nucleus as foreign particle in the shell of oyster has proved useful for the production of pearls in greater number. This whole process is very much complicated, technical and time taking and can be managed as given below :

A. Collection of Oysters

The oysters are collected from the bottom sea by the divers particularly women divers in Japan who are called as 'AMA' which in Japanese means 'the girls of Sea.' The divers usually have got training for proper diving into the sea water since their childhood for the search of sea shells or sea weeds. The well protected suits of cotton with cap are used at the time of diving. Each diver has a small hand net at the time of diving when she goes upto 5 metre depth. The net helps in the collection of oysters from the bottom. The oysters collected by nets are stocked in the wooden bucket attached to the diver's left wrist by a cord and the diver with bucket comes up on the surface of water. An experienced diver can remain under water up to about one and half minute and can collect 2 to 10 oysters per dive. The best time for diving is from the early morning to mid day. The best period for the collection of the oysters is of two months in the summer season when the water is nearer and the sea is calm.

During diving in deep sea water the divers operate directly from the side of boat and a rope remains tightly fitted to the diver's wrist through which the operating boatman pulls the diver out with force up to the surface after receiving any signal from the partner. Thus, the whole collected oysters are stored and stored out. The oysters of same age group are segregated and two years old are kept in shallow water for future. Three years

completely except for a batch of some oysters which survived. Subsequently on 11th July 1893, his wife Uma when opened an oyster shell to her surprise and joy she found a pearl duly formed in it. It was a memorable day for them. Then in 1896 he got a patent for pearl culture. Tokichi Nishikawa, a Govt. scientist of Misaki Marine Biological Laboratory of Tokyo University, was the first person to get spherical artificial pearl.

PEARL PRODUCING MOLLUSCS

Although a number of bivalves have ability to produce pearl under suitable climatic conditions but high quality of pearls are obtained from pearl oysters of Genus *Pinctada* roding belonging to class—Bivalvia, family—Pteriidae. A number of species of this Genus like, *P. vulgaris* (Schumacher), *P. chemnitzii* (Philippi), *P. margaritifera* (Linn.), *P. anomioidea* (Reeve) and *P. atropurpurea* (Dunker), are found in Indian water resources. *P. vulgaris* is a common oyster distributed in the gulf of Kutch, gulf of Mannar and the Pak bay.

Apart from the true pearl oyster belonging to the genus *Pinctada* a large number of other marine and a few fresh water molluscs are also found to produce pearls or pearl like concretions. These are Ear-shell (*Haliotis* Linn). Sea muscle (*Mytilus* Linn) and windowpane oyster (*Placuna blacenta* Linn). *P. margaritifera* and *P. maxima* are giant species and produce pearls of bigger size but of inferior quality.

PEARL PRODUCING SITES IN INDIA

Mostly the pearl oysters are inhabiting on the ridges of rocks or dead corals (secreted by many species of polyp), forming extensive pearl banks or at the depth of 18 to 22 metres at a distance of 19 km from the shore. The pearl oyster beds of the east coast are more extensive and productive than those of the west coast. These pearl beds produce best quality of pearls called as 'Lingha Pearl'. The pearl oysters are obtained from the reefs in the

gulf of Mannar, gulf of Kutch, Pak bay and Baroda.

PEARL FORMATION

Pearl formation is an interesting phenomenon for protection against foreign invaders, parasites, sand grain, small broken twigs of sea-seeds or a small insect accidentally entering the body of the oyster which happens to adhere to a part of its mantle (Fig. 1). The mantle epithelium at once encloses it like a sac and starts to secrete concentric layers of nacre around it from defence point of view and completely encloses it gradually. Nacre is secreted continuously by the epithelial layer of the mantle and deposited around the foreign particle in the form of several layers and ultimately the pearl is formed (Fig. 2).

For a detailed information, vertical section of the shell if cut, shows that it consists of three layers (Fig. 3).

1. Periostracum : It is an outer layer formed of a horny conchyolin which is a substance related to chitin. On its inner side the next layer is found which is known as prismatic layer.

2. Prismatic layer : It consists of a small prism-like deposit of calcite (Burnt ash) separated by thin layer of conchyolin. This layer is followed by the third layer known as nacreous layer.

3. Nacreous layer : It is the inner-most layer formed of calcium carbonate and called as 'Mother of the pearl'. It consists of alternating layers of

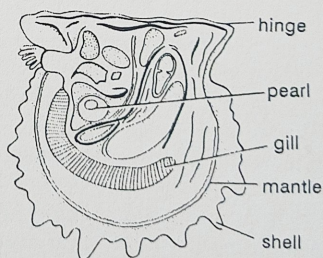


Fig. 1. Diagrammatic sketch showing site of pearl formation in *Mytilus*.

Pearl Culture

A large number of molluscs are found on the land and in the water reservoirs like sea, fresh water and brackish water. They are used for food, for shells and in pearl industries. Pearl is a white, highly shining globular concretion found within the shell of an Oyster (a kind of shell-fish). It is also called as 'Moti' or 'Muktaphal'. Since antiquity, pearl has been reputed as one of the rarest gems and was previously imagined as the tears of moon but the reality, is far away than imaginary flight of poets. In Sanskrit literature it is mentioned that during 'Swati Nakshtra' when a drop of water falls in between the mantle and the nacre layer, pearl develops which seems to be more reasonable. The rare occurrence of pearl in the nature is due to its peculiar mode of formation which may not happen frequently in the natural conditions. Pearl is known to Chinese since 2300 B.C. Kautilya and Shakespeare in their literature have mentioned about the pearl in detail. The researchers engaged in pearl culture organisation have planned to stimulate this natural phenomenon and have succeeded in producing cultured pearls exactly of the same substance as the natural pearl.

HISTORY OF INDUSTRY

For the first time the idea of pearl industry was evoked in Japan which was carried out in the Bay of Japan located at South coast of Hansoo. But in Japan, pearl culturists feel difficulty due to unfavourable climatic conditions. Kokichi Mikimoto (1858-1954) is referred to be the father of pearl industry in Japan. In 1890 an exhibition on Annual Domestic Industrial Promotion was organised in Tokyo where among a number of industrial products pearls were sold at very high prices. Mikimoto came to know that pearls can only be formed in nature and not by artificial devices. This exhibition encouraged him to manipulate the oysters to do what they did in nature. In 1890 he established a pearl farm on small Island of Taba and began to culture oysters but could not get success for two years. In the third year due to a red-tide his farm was destroyed