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TECHNOLOGY OF PEARL CULTURE

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The cultured pearl is a pearl which is produced in the pearl oyster by the deliberate attempt of man providing the two basic conditions: i) in the place of accidental entry of an foreign substance, the core material called nucleus is implanted in the oyster's body; and ii) in the place of chance formation of pearl-sac by mantle epithelial cells, a piece of mantle called graft tissue is planted on the nucleus to ensure formation of the pearl-sac. Under these conditions the pearl-sac is formed around the nucleus and the epithelial cells secrete and deposit nacre on the nucleus which finally turns into a pearl. As the initial act of providing the basic setting is done by man and the oysters are cultured under controlled conditions, the pearl produced by this process is called the "cultured pearl".

SPECIES EMPLOYED IN PEARL CULTURE

Among the pearl oysters, of which several species occur in the world, three are of great importance in pearl culture. Pinctada fucata is numerically the most significant species producing the finest cultured pearls. P. maxima, the largest among the pearl oysters produce exceptionally large cultured pearls of a fine quality. P. margaritifera, the black-lip pearl oyster produces fine black cultured pearls. The winged oysters Pteria penguin and P. macroptera are used in pearl culture in some areas. The abalone Haliotis discus is used in a small measure in pearl culture.

In the fresh water system, the mussels Hyriopsis schlegeli and Cristaria plicata are used to produce fine salmon pink pearls.

TECHNIQUES OF PEARL OYSTER FARMING

Raft culture is the standard method for the farming of pearl oysters. Rafts are constructed of bamboo or wooden poles, placed length-and breadth-wise appropriately and lashed with ropes. The dimensions of rafts and number of units per line vary from place to place. The raft is buoyed up by using cylindrical barrels, wooden,

metal or synthetic, and moored with anchor and chain. Oysters collected from the wild or grown from spat are placed in frame nets or boxes and suspended from the rafts at chosen depths. Calm bays are preferred for pearl culture for maintaining the rafts throughout the year. The desirable minimum depth is about 10 metres, although it is possible to culture oysters in shallow waters of about 5 metres depth.

Maintenance of farm required periodic cleaning of oysters. A large number of fouling organisms such as barnacles, bryozoans, ascidians etc. settle and grow on the oysters in the farm and these have to be cleaned at regular intervals depending on the intensity of fouling. Besides competing with the oysters for food, they cause stress on the oysters. Heavily fouled oysters do not produce good quality pearls. Boring organisms such as the sponge Cliona and polychaete Polydora cause extensive damages to the shells and need tobe controlled. Simple methods such as dipping in fresh water or in brine, or smearing of 1% formalin can kill the boring osganisms. In the tropical inshore waters the biofouling and boring problems are quite severe.

The interest of pearl culturists is slowly reverting back to bottom culture and experiments are being conducted in Japan and Australia to culture oysters in cages placed on or close to the sea bottom.

TECHNIQUES OF PEARL PRODUCTION

After the oysters have grown in the farm and reached the size required for initiating pearl production, they are brought to the laboratory. Pearl production can be divided into two phases, the laboratory phase and farm phase. The former is of a very short duration and the latter is an extended one, the duration depending on the size of pearls programmed.

Laboratory phase

Selection: Proper oysters for the surgery as also for graft tissue preparation should be selected. Diseased oysters and those with extensive attack by borers should be discarded.

Cleaning: The oysters should be cleaned of all external growth of fouling organisms and encrustations.

Conditioning: This is done by narcotising the oysters in menthol. The oysters are kept in sea water in vessels and menthol crystals are spread on the water. Approximately in 1½ hours the oysters are ready for use in surgery. The Japanese use physical exhaustion and thermal variation methods for "egg extraction" and conditioning purposes.

Graft tissue preparation: Both the mantles of an oyster are cut, cleaned and trimmed. The ribbon obtained is fractioned into several pieces each of about 2-3 mm x 2mm. The pieces are kept moist on clean soft wood boards until used. Smearing of the tissues with a weak solution of eosin helps to keep them without deterioration for some time.

Nucleus: Spherical beads of 2-8 mm diameter are used as the nuclei. These beads are generally made of fresh water mussel shells which are hard and white and have the density about equal to that of mother-of-pearl. For the Japanese pearl culture industry the supply of the mussel shells comes from U.S.A. These are processed by machines into spherical beads of required diameters. In India, the chank shells which largely meet the specifications have been processed into beads and used in experimental pearl production.

Before commencing surgery, the programme for proposed pearl production must be decided and the size of oysters, nucleus and graft tissue should be selected on this basis.

Surgery: This is a delicate operation for the implantation of the graft tissue and the nucleus within the tissues of the oyster. Specially designed instruments are used in the surgery. The conditioned oyster is mounted on the stand. An incision is made at the base of the foot of the oyster and a canal is cut through the gonad below the epithelium without damaging the stomach or the intestine upto the predetermined site of implantation. In the case of single implantation the site is close to the turn of the intestinal loop. In double implantation a second site is chosen close to the hepatopancreas. In multiple implantation several other sites between the above two are selected. A piece of mantle is inserted through the canal and left at the site in proper orientation. This is followed by the implantation of the nucleus at the site in contact with the graft tissue. After the surgery the oysters are left in tanks for recovering from the effects of necrotisation and the surgery.

In the production of half-pearls, the nuclei, which are made of alabaster, are stuck with a glue which can cure in water on the inner aspect of the shells of the pearl oyster. Depending on the size of the oyster, a number of such alabaster beads are used on both shells.

Convalescence: Where the sea adjacent to the laboratory is calm, the operated oysters are placed in cages and suspended from the rafts immediately after the surgery. Where such conditions are not available, the oysters are kept in the laboratory with continuous water supply for a period of 2-3 days. The operated oysters must be handled very carefully causing minimum disturbance. Exposure to violent conditions will result in the slipping of nuclei.

Farm phase

After convalescence, the oysters are taken to farm for the post-operative culture. The outer epithelium of the graft tissue grows over the nucleus and forms the pearl-sac within a week. The nacre

secreted by the pearl-sac epithelium is deposited on the nucleus and the nacre grows in concentric manner in thin lamellae.

During this phase the oysters are disturbed the least. The duration of culture varies depending on the programme of production. In the Gulf of Mannar, in the case of pearls 3 or 4 mm diameter the harvest is done at the end of 3 months (from surgery). Inthe case of larger pearls of 7 or 8 mm the duration is about 18 months. In the Japanese waters, for similar sizes of pearls the duration ranges from 6 months to 3 years. In the tropical waters, the rate of deposition of nacre is much faster than in temperate seas and secretion is almost continuous.

Harvest is done usually when the temperature is on the lower side so that thinner layers of nacre are obtained on the periphery of the pearl. The oysters are brought to the shore and cut open to remove the cultured pearls.

PEARL PRODUCTION

Normally about 60-65% of the seeded oysters surviving to harvest produce pearls. In double and multiple implantations, the rate of production in respect of number of oysters used is much greater. Rate of slipping of nuclei can be reduced and kept to the minimum by careful surgery. Mortality and slipping rate are relatively greater when larger nuclei of 7 or 8 mm diameter are employed. Observance of proper care at all stages can improve production rate.

The pearls produced are a mixed lot in terms of quality. Production of about 40% of round, lustrous pearls of top quality can be considered a good performance. The rest will have blemishes and some may be misshapen. The colour of pearls also varies. Factors such as genetic characteristics, depth of culture, physiological condition of the oyster, site of implantation, nutrition, chemical composition of sea water and plankton, trace elements and the laminar structure of pearl contribute to difference in colours of pearls. Colour adjustment or improvement is possible within certain limits through bleaching and dyeing.

STRUCTURE OF PEARLS

The cultured pearl has a core shelly material over which concentric layers of nacre have been formed. The nacreous layer essentially consists of two materials - an organic proteinous substance called conchiolin and a mineral substance of calcium carbonate. About 92% of nacre is composed of calcium carbonate and conchiolin forms about 4%. The organic substance forms the matrix on which the mineral substance is deposited. The latter, in the form of aragonite crystals gives rise to good quality pearls, but in calcite form would result in dull porcellanours pearls. The organic and mineral substances are deposited in very thin layers, the thickness of each layer of the former being about 0.02 microns and that of the latter being about 0.29-0.60 microns. A regular laminar structure of nacre gives the pearl the iridescence and lustre.

TRENDS IN TECHNOLOGY

The current trends in pearl culture researches in Japan aim at improving quality of pearls rather than increasing production. From about 130 tonnes of cultured pearls in 1966, it has fallen to around 35 tonnes and the Japanese culturists would like to stabilise production around this level but to improve quality. Genetic improvement of stocks, hatchery production of seed, and improvements in the culture environment, are some of the areas in which research efforts are directed. Tissue culture of mantle epithelium for pure culture of fine aragonite secreting tissues is another area receiving attention. Ground culture of oysters has evoked interest in the recent years both in Japan and in Australia. Attention has been turned on P. margaritifera for improving the production of fine steel black free pearls at several centres. In India, where a consierable amount of technical knowhow has already been built up the present concern is on developing hatchery seed production technology to ensure a stable production of pearl oysters, refinements in pearl production to improve quality of pearls, development of techniques for large-scale production of nucleus and pearl culture environment management.