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PROVEN TECHNOLOGY

2. TECHNOLOGY OF CULTURED PEARL PRODUCTION

Highlights: Cultured pearls of good quality are produced in the Indian pearl oyster *Pinctada fucata* by artificially inducing the oyster to secrete mother-of-pearl around an implanted spherical core material produced from shells. The pearl oysters are either produced through artificial breeding in hatchery (see Hatchery Technology of Pearl Oyster Production) or collected from the natural beds by SCUBA - diving. The oysters are grown in an open-sea farm under raft culture, being placed in baskets and suspended at appropriate depths from the floating rafts. Pearl oysters are a minimum one-year old when they are used in surgery and post-operative culture duration ranges from 3-24 months depending on the size of pearls. Multiple implantation technique enhances rate of production. Re-use of oysters for a second crop is possible under certain conditions.

Operational details: The pearl culture farm will have several rafts of 5 m × 5 m size or other dimensions, each constructed using teak poles lashed with ropes and mounted on cylindrical metal barrels to get appropriate buoyancy. The raft is moored by anchors at depths of 5-10 m or more. Pearl oysters are reared in baskets suspended from rafts and when they reach the right size (20-30 g weight) they are taken to the on-shore surgery. Healthy oysters are conditioned using the chemical menthol for operation. Shell-beads of diameter 3-8 mm produced from the shells of conch or other molluscs form the core material or nucleus for implantation. A special set of surgical tools is employed in surgery.

Fig. 1. An aspect of surgery for implantation of shell-bead nucleus in the pearl oyster.

Some oysters are used in preparing the graft tissues of 2-4 mm pieces from the mantles. At the operation, a graft tissue and a nucleus are implanted into the gonad of the oyster. In the case of multiple implantations 2-5 or more nuclei are used at various sites in the body of the oyster. An experienced technician can operate on about 20 oysters per hour. After surgery, the oysters are maintained in the laboratory under gentle flow of seawater for recovery and healing for 3 days. Later the oysters are returned to the farm. The graft tissue grows around the nucleus to form the pearl-sac which then secretes mother-of-pearl (nacre) depositing it on the nucleus. The process continues and when the cultured pearl attains sufficient maturity in terms of lustre, it is ready for harvest.

The rate of rejection of nucleus can be kept within 10% and overall mortality rate within 10% under good conditions. Pearl production rate is around 60% among surviving oysters. Harvest is done by hauling the seeded oysters ashore and opening them for collection of pearls. Sorting of pearls is done under 3 categories, namely grade-A of top quality, B containing medium quality pearls which can be used in jewellery and C containing more or less rejects. A ratio of 30:30:40 of these grades can be obtained under optimum situation.

Fig. 2. A cultured pearl produced in the pearl oyster. The tip of needle points towards the pearl.

Production: Pearl culture is an industrial scale operation. The estimated production in a five-year project employing a total of 2 million oysters would be around 1.2 million cultured pearls of Grades A and B. The production would come in stages commencing from about the 6th month after establishment depending on the schedules of surgery and the duration of post-operative culture which would range from 3-24 months. The bye-products of pearl culture are the pearl shells, seed pearls which are incidental and the

Fig. 3. A batch of cultured pearls of different sizes.

meat. Appropriate technologies for bye - product utilisation are yet to be developed.

Inventory and cost: The capital assets for a 5-year project would be boats, vehicles, SCUBA-diving Units, Compressors and buildings for on-shore work. Expenditure on these would be around Rs.1.5 million. Contingent expenditure on farm structures, shellbeads, instruments, maintenance of boats and vehicles and chemicals and glassware would amount to Rs. 1.7 million. Salary component would be Rs.1.8 million. The total estimated cost of the 5-year project would be Rs. 5 million.

Estimated cost of production: The estimated cost arrived at by certain projections is Rs.4.20 per cultured pearl. Actual cost of production remains to be worked out.

Prospects: India has a good scope for starting a pearl culture industry based on the knowhow available at the Central Marine Fisheries Research Institute (CMFRI). The hatchery production of pearl oysters should be linked up with pearl production which would help in reducing cost of production. The only constraint at present is dependence on imports of shell-bead nuclei. The technology for nucleus production is being developed at CMFRI. Potential areas for setting up pearl culture units for the present would be the Gulf of Mannar along Tamil Nadu coast, Gulf of Kutch along Gujarat coast, as also the Andaman & Nicobar Islands. The world pearl trade has been continuously on the ascent during the last decade and India is a steady importer of cultured pearls. This situation could be changed to the country's advantage when commercial projects are established. The CMFRI can extend the technical knowhow through training programmes at managerial and operative level.

3. TECHNOLOGY FOR HATCHERY PRODUCTION OF PEARL OYSTER

Major highlights: Given the uncertainty resulting from the wide fluctuations of populations of the pearl oyster *Pinctada fucata* in their natural beds in the sea (Gulf of Mannar and Gulf of Kutch), a pearl culture industry in India will have to depend largely on pearl oyster seed produced in hatcheries. Broodstocks are artificially spawned in the hatchery and the larvae are reared in tanks with supplies of appropriate live food. Around day 20, these larvae metamorphose and settle as spat on collectors. They are further reared in nursery tanks upto a size suitable for transplantation to open-sea farm. These young pearl oysters may be supplied to pearl production farms. Availability of good quality sea water and appropriate food would determine the success of spat production.

Operational details: The pearl oyster hatchery has six major functions towards production of spat, namely artificial breeding, larval rearing, spat collection, nursery rearing, microalgal food production and water management. Selected pearl oysters, males and females, are spawned in glass vessels and the eggs are fertilised. The fertilised eggs are transferred to larval rearing tanks and from the early straight-hinge veliger stage, which is reached 24 hours post-fertilisation, the

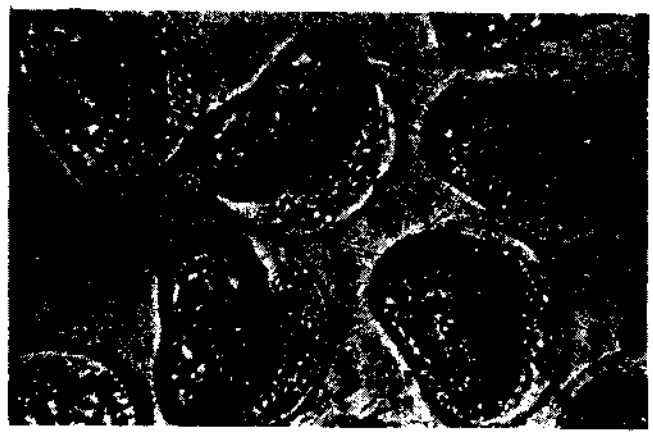

Fig. 1. The straight-hinge veliger larvae of pearl oyster.

larvae are fed with live microalgal forms, particularly *Isochrysis galbana*, which are produced on a large scale in the hatchery. The larval rearing tanks are of 100 litres capacity and larval density ranges 10-20/ml. Seawater filtered to remove particulate matter and treated with ultraviolet light and/or antibiotics to kill bacteria is used in the larval rearing system. Water change is effected on alternate days through careful screening of larvae. Aeration is used to keep the larvae in suspension and to maintain level of dissolved oxygen.

Under good conditions of water quality and feeding (80 - 120 cells/microlitre), the larvae grow progressively through umbo, eye-spot, pediveliger and plantigrade stages before they set as spat around day 20 post - fertilisation. Fibreglass plates of a matty finish are suspended in the setting tanks as spat collectors upon which the spat settle down to begin a sedentary life. The spat, which are as small as 330 micrometers in size, are later reared on a mixed phytoplankton diet in nursery tanks of 500 litre capacity till they reach about 3 mm. Subsequently they are removed from spat collectors, placed in special growing cages and reared in the sea till they reach the "thumbnail" size when they can be supplied to pearl culture farms. The whole hatchery operation would last about four months per batch of spat production.

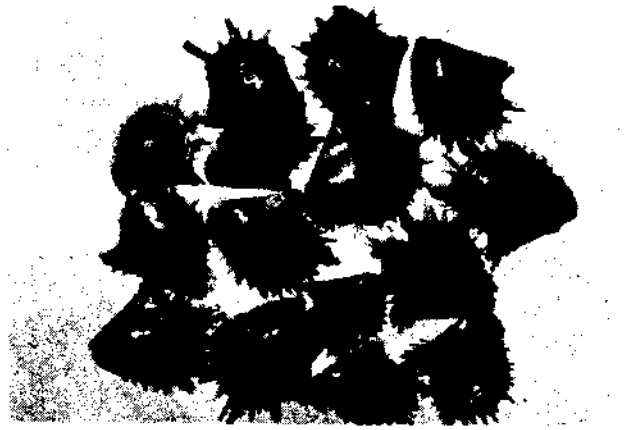

Fig. 2. Young pearl oysters produced by the hatchery technology.

Production: A hatchery with about 50 larval rearing tanks can yield a production of about 500,000 spat per spawning. In four spawnings a year, an annual production of about 2 million young oysters (thumbnail size) can be obtained from a pearl oyster hatchery.

Inventory and cost: The capital assets of a pearl oyster hatchery would be a semi-permanent hatchery building with laboratories of a total area of about 400 sq. m., larval rearing and nursery tanks, sea water sumps and overhead tanks, air compressors and pumps, and laboratory equipment. The total cost of all capital assets would be about Rs.650,000. Contingent expenditure on glassware, chemicals, U.V. equipment, filters, screens, rafts, cages and broodstock would amount to Rs. 175,000.

Fig. 3. A view of pearl oyster hatchery laboratory at the Tuticorin Research Centre of CMFRI.

Employment and cost: A pearl oyster hatchery for an annual production of about two million spat would provide employment to one scientist (in charge of the project), three technicians (one each for larval rearing, live food production and farm rearing), one mechanic, three supporting staff and two watch & ward staff. The annual cost on salaries would be about Rs.100,000.

Estimated cost of production: The estimated cost of production or the break-even price arrived at by certain estimates is approximately Re 0.22 per spat. Actual cost of production remains to be worked out.

Prospects: Establishment of pearl culture industry in India would to a very great extent depend on hatchery produced pearl oysters. The hatchery can work either as a composite unit of pearl culture or as an independent unit supplying spat, depending on the growth of the industry. The CMFRI can provide training in hatchery technology. The immediate scope would be for a hatchery in the Gulf of Mannar region and another in the Gulf of Kutch region, both areas having a potential for pearl culture.