

Oyster Culture

Marine aquaculture may well have begun with oyster culture. It has been cultivated for centuries.

Two groups of oyster are cultured

1. Flat oysters – *Osrea* spp
2. Cupped oysters – *Crossostrea* spp

Oysters are distributed throughout the world. They are filter feeders feeding mainly on plankton and suspended detritus. In tropics they spawn throughout the year while in temperate regions they breed with rising temperatures. The larvae pass through trochophore and veliger and metamorphose to spat and settle on solid surfaces.

Culture techniques

In nature oysters grow on hard substratum found at the bottom or column of coastal areas and estuaries. Most primitive methods of culture involve spreading clean oyster shells called cultches on the bottom. The spat settle on the empty oyster shells and grow. This method is known as bottom culture and is still practiced in USA, Canada and France.

In 1673 a Japanese culturist Gorohachi Koroshiya discovered that oyster spat also settle on bamboo poles erected in water. This observation led to the development of off-bottom culture techniques.

Four methods of off-bottom culture techniques are being followed. They are

- Raft culture
- Rack culture
- Long line culture and
- Stake culture.

Growing to market size

Raft culture is practiced mainly in Japan. The sites selected for raft culture should have the following characteristics.

- The farming area should be in sheltered places like bays, fjords etc. free from strong wave action.
- Tides should be sufficient and frequent to change water.
- Salinity should be 23-28 ppt and temperature 15-30°C.

- They area should have sufficient phytoplankton as food for the growing oysters.
- The area should be free from industrial, agricultural and domestic pollution.

The rafts are made of bamboo poles tied together using strong polythene ropes. They are suspended using floats made of used empty cans or Styrofoam floats coated with cement. Rafts of size 16x25m are generally used.

One month old spat attached to oyster or scallop shells from collection areas are restrung on galvanised wires 20cm apart using bamboo/plastic spacers. 500 to 600 wires with spat can be suspended from each raft. The spat are allowed to grow to marketable size of 30-60g individual weight. Duration of culture will depend on water temperature. In Japan it takes around 6 months for the oysters grow to marketable size.

Long line culture

This method of culture is followed in Northern Japan where wind and wave action is heavy. Unlike rafts the long lines can withstand more water agitation. They are also cheaper than rafts.

14.2 Mussel Farming

Mussel farming has one of the highest potential for increasing protein rich food for aquatic environment. Mussels give the highest conversion of primary production (phytoplankton) to human food and production in water column enhances yield several fold.

The important genera of mussels farmed around the world are *Mytilus* and *Perna*. The major mussel producing countries are Spain, the Netherlands, France and Italy. 93% of the total world production of mussels through aquaculture comes from the above four countries. The species cultured in different countries are as follows:

- *Mytilus edulis* – the Netherlands, France and Spain
- *Mytilus galoprovincialis* – Italy, Yugoslavia and Russia
- *Mytilus smaragdinus* = *Perna viridis* – the Philippines.

Life History

Mussels filter feed on phytoplankton and suspended organic matter. Large quantities of seawater are filtered for this purpose. They reach sexual maturity in first year.

They spawn with rising temperature in the temperate region and almost throughout the year in tropics.

Grow-out

CMFRI has developed techniques to farm the green mussel *Perna viridis* using raft culture method. Rafts are fabricated using wooden/bamboo poles tied together with nylon/coir ropes. The poles are treated with coal tar to enhance their life. Raft of 6x5 or 8x8m are constructed. The rafts are mounted on 5 empty sealed drums of 200L capacity, painted with anti-corrosive paint. A few wooden planks are fixed on the raft to provide for working space. The rafts are anchored in the protected areas of the sea using 3 iron anchors each weighing 100 kg at a depth ranging from 8-10m in the sea 1-1.5Km way from the shore. Ropes with seed attached to them are suspended from the raft for growing to marketable size.

Seed collection

Seeds are collected from the natural mussel beds. They are cleaned in seawater to remove mud and epifauna. The size of the seed ranges from 20-30mm.

Growth and production

The seeded mussels grow to 36g in 5 months. Each rope will yield about 5.1- 12.3Kg/m. 100 ropes of 6m length in a raft of 8x8m will yield 4800Kg per raft assuming an average production of 8Kg per m of the rope. It works out to 150 tonnes per hectare in 5 months. Cultured mussel have better meat yield (35-40%) compared to wild mussels (27-32).

Management of rafts

- Collected mussels should be seeded within 24h.
- Periodic inspection of rafts to detect leakage in floats, damage to rafts or ropes
- Farm area should be demarcated with lights and flags to avoid damage by fishing boats.
- Periodical cleaning and thinning of mussels to improve growth rates

Fouling organisms

Fouling is a serious problem in mussel farming. Barnacles attach themselves to ropes and mussels with 30 days of seeding the ropes. More fouling takes place in the upper 2 m of the rope.

Heavy fouling by a bivalve *Mytilaster arcuatula* takes place in the months of November and December. Other fouling organisms are tubicolous polychaetes, Ascidiarians, Cnidarians and Bryozoans. Fouling organisms should be manually cleaned periodically to remove competition for food and space and to improve the growth mussels.

Predation

Predation by fish *Rhabdosargus sarba* has also been reported. Net enclosures around the rafts will eliminate predation.

14.3 Culture of Pearl Oysters

Pearls are the most universal and oldest of gems. They were the first gems to be used by mankind and need no polishing. Besides being ornamental they have medicinal value, they are used in cosmetics and tooth pastes.

The species of pearl oysters found in India are *Pinctada maxima*, *P. fucata* and *P. margaritifera*

Biology

- *Pinctada fucata* is commonly used for pearl production because it produces fine pearls. In nature it is found attached to hard substratum by means of byssus threads. It is stenohaline although it survives short term salinity fluctuations. It is a filter feeder, feeds mainly on phytoplankton, occasionally on bivalve eggs and copepods.
- Life span is 5-6 years, maximum size 10cm. Annual growth rate is about 50mm. environmental factors such as depth, transparency, temperature, salinity, currents, calcium content of water, food and foulers influence growth rates.
- Sexes are separate; however, hermaphroditism and change of sexes from one spawning season to another are not uncommon. It attains maturity at a size of 25-30mm. Has two peak spawning seasons, one during July to August, another from November to December. Individual oysters spawn more than once in spawning seasons.
- Eggs and sperms are shed in water, fertilization is external. Hatching takes place in about 4 hours. Spat settle when 0.3mm in size.
- Spat availability in the wild fluctuates, hence hatchery produced spat are used for culture.

Development of pearl

Natural pearl is formed when a foreign material enters the body of pearl oysters.

Epithelial layer of mantle forms a sac around the foreign body which secretes nacre over the nucleus (foreign body) layer after layer resulting in pearl formation.

Shape of the pearl depends on the shape of the nucleus/foreign body.

Nucleus/nuclei can be implanted along with a piece of mantle tissue as graft into the gonads oysters which results in formation of cultured pearls.

Culture methods

The suitable sites and culture methods are almost similar to edible oyster. Cages are stocked with seed oyster and suspended from the rafts or long lines in protected bays. Oysters are allowed to grow for four months when they become ready to receive nucleus.

The oysters from cages are brought to the laboratory for implantation of nucleus. They are kept in glass troughs containing filtered seawater. A few menthol crystals are sprinkled into the troughs to anesthetize the oysters. After one hour the oysters are ready to receive the nucleus.

Graft tissues are prepared by sacrificing a few oysters. Pieces of mantle are cut, cleaned and trimmed to 3x2mm pieces. They are smeared with weak eosin solution to avoid deterioration.

Nuclei are made from chank shells of shells of freshwater mussels. Nuclei range in size from 2-8mm.

The anaesthetized oysters are mounted on a stand. An incision is made at the base of the foot and a canal is cut through the gonad. A graft tissue is first implanted into the gonad through the canal followed by insertion of nucleus using special instruments made for the purpose. Depending on the size of the oyster and the nuclei, 1-8 nuclei can be inserted into the same oyster.

After implantation of the nuclei, the oysters are acclimatized in the laboratory and returned to the farming sites, but this time they are placed in frame nets which have compartments for individual oysters. The frame nets are suspended from the rafts/long-lines for development of the pearl.

The outer epithelium of the graft tissue grows over the nucleus and forms pearl sac in about a week. The pearl will form in about 3 months. The time of harvesting depends on the size of the pearl required. 3-20 months are required to produce pearls of 3-8mm respectively. Six months are required to coat nacre 0.2mm thick. The oysters are harvested after the formation of required size of pearls. They are sacrificed to recover pearls. The harvested pearls are bleached in hydrogen peroxide to remove any blemishes.

14.4 Culture of Seaweeds

Seaweeds are macroscopic algae growing in the sea. They are one of the important marine resources. They are found in shallow coastal areas many of them grow on substratum. They are grouped into green, brown, red and blue green algae. They have been harvested since many centuries. In Japan and China they form staple food. They are also used as fodder and fertilizers.

They contain 60 trace elements whose concentration is higher than terrestrial plants. Seaweeds are the only source of agar, algin and carrageenan – phytochemicals that have wide application in food, confectionary, pharmaceuticals, dairy and paper industries as gelling, stabilizing and thickening agents.

In India there are vast resources of seaweeds near many coasts and estuaries. Andaman and Nicobar Islands and Lakshadweep have rich resources of seaweeds. The total resources of seaweeds in India are about 70,000 tonnes.

Large scale sea farming of aquatic plants originated in Japan around three centuries ago with the culture of 'nori' or the laver *Porphyra* spp., which continues to be the most important cultivated species for human consumption. Culture of *Laminaria* has advanced rapidly in China. Their use as condiment or vegetable is limited to the oriental countries and among certain ethnic groups.

Their protein content is high (35.6% in dried nori), they also contain high levels of vitamins A, B, B2, B6, B12, C and biotin.

Main groups of algae cultivated for food

- Red algae (Rhodophyceae) – e.g. *Porphyra* spp.
- Brown algae (Phaeophyceae) – e.g. *Undaria pinnatifida*, *Laminaria* spp.
- Green algae (Chlorophyceae) – e.g. *Enteromorpha compressa*, *Monostroma*.

All the above are marine species but there is a difference in their salinity and temperature tolerance. Many cannot withstand exposure to wide variations in temperature and salinity. Many edible seaweeds require temperatures between 10- 20°C for rapid growth. They are largely intertidal and subtidal species.

They reproduce both sexually and asexually. Some red algae exhibit biphasic (gametophyte, carposporophyte) type of alternative generation. Others are triphasic (gametophyte, carposporophyte, tetrasporophyte).

Culture systems

Porphyra (Nori) culture consists of placing bundles of twigs or rocks or concrete blocks for monospores to settle on. These are then transferred to shallow areas for development of thali to desired size. The most common method now is the use of nets with large mesh (15x15cm) and blinds made of 10x15 cm to collect spores and transfer to suitable areas for grow-out.

Blasting rocks surfaces or rocky reefs to expose for additional surface area for propagation is common practice, particularly for *Laminaria* and *Undaria* culture.

In commercial culture of *Eucheuma* in China, cuttings of plants are inserted in sub- littoral reefs by divers. A new method in recent years consists of fastening cuttings to coral branches with rubber strings and dropping them onto reefs. Divers rearrange them if required.

Raft and rack culture are followed in Japan and China. Laminaria is cultured on long lines in China.

In some Asian countries like the Philippines and Taiwan, Gracillaria and Caulerpa are grown in ponds following procedures common to fish culture, such as pond fertilization, water management and disease and pest control. Culture of these species is largely for industrial use.

Large scale seaweed culture for waste recycling and industrial uses is practiced in North America. Unattached masses of algae are grown in raceways and greenhouses flushed with seawater.