

Freshwater pearl crop: an emerging enterprise in the Indian subcontinent

Misra, G., Jena, J. and Kumar, K.

Aquaculture Production and Environment Division, Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar-751 002, India, email: gayatri.misra@gmail.com

Pearls one of the most ancient of gems, are esteemed around the globe because of their cool and soft emergence, pastel hue and recognition to diverse disposition as compared to the other jewels. Previously Japan, China, Australia and French Polynesia have had exclusive authority on pearl culture techniques. During the early period of the last century Japan dominated in the frontier of pearl cultivation, later joined by the Australians in 1950's and French Polynesians a decade later, both through technical exchange from Japan, which gradually lost its monopoly on technical grafting skills.

The grafting process is the crux to success in any pearl culture operation, and in the early stages of the industry the techniques were closely guarded secrets by Japanese technicians, who were often brought in to conduct the grafting work in other countries. Currently, Australian, Chinese, Tahitians, American and Indian technicians are engaged in the grafting process. Earlier in the marine segment three oysters fundamentally ruled the pearl world. The Japanese and Indians employed *Pinctada fucata* for akoya pearls ranging from 4mm to 8mm. Australians employed their indigenous species *P. maxima*, the gold lipped pearl oyster, for production of 12 to 18 mm sized pearls and in French Polynesia *P. margaritifera* to produce a wide range of black, grey or greenish tinge pearls were produced of 10 to 14 mm size range.

Pearl culture is a billion dollar business and one of the world's largest aquaculture activities in terms of value. Until recently, opportunities for investing in this specific area have been limited. The hatchery and indoor production of juveniles have created an avenue for taking up this venture even in regions where pearl mussel resources are depleted, as established in Indonesia. India is in the process of establishing its own 'niche market' employing indigenous mussel fauna.

Freshwater pearl farming opportunities in India

In the early 1990s another dimension to pearl culture was added with the emergence of Chinese freshwater pearl crops. China has stood as a major contender for Japan as far as quantity of pearl product is concerned, although the value of marine pearls is generally much higher, and freshwater pearls are considerably different in character and do not necessarily occupy the same market niche.

The Indian subcontinent is bestowed with a rich and diverse group of mussel fauna. The genus *Lamellidens* is represented by nine species and two sub-species, while the genus *Parreysia* is represented by 35 species and six sub-species under two sub-genera¹. The most popular wealth of mussels are *Lamellidens marginalis*, *L. corrianus*, *L. consobrinus* and *Parreysia corrugata*. Their worth has been elevated of late because of their role in indigenous production of freshwater

pearls². Most other species also possesses nacre, but their potential for culture pearl production are yet to be realised. Every mussel has the ability to produce a pearl of some sort, however only those possessing a lustrous mother of pearl layer can form a gem quality pearl. Hence, though two thirds of the available species possess magnificent inner nacreous deposit, their success in pearl production through surgical practice is yet to be under taken.

Natural pearl formation is instigated when a foreign particle such as a piece of sand, shell piece or parasite make its way into particular region of mollusc and cannot be expelled. As a defense device, the animal secretes a calcium carbonate material known as nacre to coat the foreign body. Layer upon layer of this coating is deposited on the irritant, resulting in a shimmering and iridescent creation of a pearl. Cultured pearls are formed essentially by the same process, except that the irritant, otherwise called a nucleus, of desired shape and size is surgically implanted into the body of bivalve mollusc where it is difficult to be expelled. The animal does the rest, creating this prized biological gem. Thus, the nature's hand has not been completely eliminated; in fact it is the animal that determines the character of the pearl produced. According to the size and colour of pearl desired the appropriate mussel species is selected. *Lamellidens marginalis* and *L. corrianus* produce a maximum of 6mm sized pearl with a pinkish hue in former and silvery in latter. In *Parreysia corrugata* 3mm sized pearls can be retrieved with a golden yellow tone.

Freshwater pearl culture practices

Collection of mussels

Mussels are handpicked and collected from the wild in buckets, baskets or crates with water for short distance transportation. The collected mussels are preferably transported during the cooler early morning hours, where possible.

Pre-operative conditioning

The indigenous pearl mussel species are collected from freshwater bodies and are subjected to pre-operative conditioning for two days. They are kept in ferro-cement tanks (200 litre capacity) with aged tap water at a stocking density of one mussel per litre of water. Pre-operative conditioning ensures proper relaxation of adductor muscles in preparation for surgery. This aspect is important in view of limited application of narcotising procedures as followed in marine pearl culture operation.

Surgical implantation

Surgical implantations are of three types, made in three different regions of the mussel depending on the pearl type targeted. Individual mussels are taken up for a particular

type of implantation. The mantle cavity insertion method is a simple technique. Prior to surgery, mussels of required shell length and weight are collected. They are carefully opened by means of a speculum, 0.5 cm wide, without causing injury to the adductor muscle and soft parts of the mussels. A small area of the mantle from the anterior side is carefully detached from the upper shell valve and a nucleus of the desired size and shape (up to 1 cm in size for designed pearl) is inserted slowly into the mantle cavity and is further pushed in deep to avoid rejection. Both the valves of a single mussel can be implanted with the preferred foreign body.

In the mantle tissue method the mussels surgery are segregated into two groups before surgery, the mussels to be operated upon (the recipient mussels) and those to be sacrificed (the donor mussels). The live donor mussels are sacrificed and the pallial mantle ribbon extracted and cut into appropriate sized graft pieces and implanted alone or along with a small nucleus (2 mm diameter) into the mantle tissue of the recipient mussel. Such grafting is done on both the side of the mantle lobes. The number of implantations can vary between 2-8 depending upon the size and mantle thickness of the recipient mussel.

In the gonadal method of implantation once the live graft pieces are ready, the recipient mussels are carefully opened with the shell opener to about 0.5cm. A small measured incision is made by means of a special knife placed at the other end of the graft needle, under the outer membrane of the gonad. Care is to be taken not to cut deep into the gonadal tissue to avoid damage to the coils of the intestine. One implantation is made per animal.

Post-operative care

Post-operative care is an important step in freshwater pearl culture operation that is required for the implanted mussels to recover. The implanted mussels are placed at the rate of two mussels per bag in a ventral side up position for a period of 10 days. Sufficient care is taken to allow free opening and closing of the shell valves for respiration. The units are daily examined; dead mussels and those that reject the nucleus are removed.

The food requirements of most of the bivalves are still poorly understood. Most of the commercially important species of bivalves are plankton feeders. However the examination of the gut content does not give any precise idea of their feeding habit. It contains organic materials, colloidal substances, particles of organic detritus and living organic particles (bacteria, planktons, eukaryotic cells). The size of the particles plays an important role as well as their concentration on the rate of retention. *Chlorella*, *Chlorococcum*, *Kirchneriella* and *Spirulina* are considered to be their preferred diet³.

Pond culture of implanted mussels

Ponds are generally 2.5 metres deep with a clayey soil base and slightly alkaline waters. A rectangular shaped pond with proper inlets and outlets is ideal for implanted pearl mussel rearing. Ponds without aquatic macrophytes and algal blooms such as *Microcystis* and *Euglena* are suitable for pearl culture operations. The ponds are provided with P.V.C tubing (5 cm diameter) platforms (16 x 8 m) as rafts for hanging the pearl mussel culture units. The implanted mussels are placed

in nylon bags (1.0 cm mesh, 12 x 14 cm) at two mussels per bag and reared. The physico-chemical parameters and water level of the ponds are monitored throughout the culture period. The optimum temperature regime lies between 20° to 30°C.

Harvest of pearls

India being a tropical country, the culture period of pearl is narrow compared to other temperate countries. The pond culture of operated mussels varies from twelve months or more depending upon the size and number of nuclei implanted, the health of the mussels and the condition of the pond environment. In the case of mantle tissue and gonadal implantation methods the colour of the pearls varies from silvery white to golden yellow and deep pink depending upon the mother mussel and the nature of the donor mantle grafts employed⁴. At the end of the culture period (12 to 14 months), harvesting is done. The mussels are either individually sacrificed, or individually pearls are taken out from the pearl sac of the live mussels without sacrificing. Some freshwater mussels are capable of producing gem quality pearls. As the pearls are produced through a natural process they show a wide range of variation in their appearance and quality. To maintain uniformity in coloration and quality, pearls after harvest are subjected to value addition through surface cleaning or bleaching and dyeing or both cleaning and bleaching which may enhance their value.

Concerns

The biological parameters that need to be checked before initiation of pearl culture include water quality, water source, water depth, substratum type, nutrient load, temperature and superior quality of recipient as well as donor mussels. Site selection has to be convenient for operational activities. Mussels collected from the wild are ideal, however pathological parameters of the indoor produced animals need attention prior to selection. Pearl culture demands various ancillary activities that require appropriate attentions viz. mussel collection, implantation, nucleus preparation, culture unit fabrication, farm management and harvesting. The product should have a steady market avenue for better remuneration.

Acknowledgements

The authors are thankful to the Director of CIFA for the infrastructure facilities provided for this work and to the Department of Science and Technology, New Delhi, for financial assistance.

References

1. Subba Rao, N.V. 1989. Handbook-freshwater molluscs of India. Zoological Survey of India. (Calcutta) India, 289 pp.
2. Misra, G. (2005). Pearl farming – avenue for women entrepreneurship. In Ninawe, A.S. and Diwan, A.D. (eds.) Women Empowerment in Fisheries. Narendra Publishing House, Delhi, India, pp 201 –212.
3. Misra, G. Kumar and Ram, K.J. (1998). Role of selected feeds in captive culture of Indian pearl mussel *Lamellidens marginalis* (Lamarck). In: Current and Emerging Trends in Aquaculture, Thomas, P.C. (ed.). Daya Publishing Housing, Delhi, pp 241-243.
4. Ram, K.J., Kumar, K. And Misra, G. (1994). Possible use of different graft donors in freshwater pearl mussel surgery. Journal of Experimental Biology 32:366-368.