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Freshwater Pearl Culture in Traditional Ponds: Andhra Pradesh

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Abstract

Lamellidens marginalis, a freshwater mussel, is widely used in pearl culture due to its anatomical and physiological adaptations. Its mantle secretes nacre, the material that forms pearls, and encloses vital organs like the gills, which function in respiration and filter feeding. Food particles trapped from water are sorted by labial palps and passed through a complete digestive system, while nutrients are absorbed and waste expelled. The mussel's muscular foot enables burrowing into pond sediment for stability. Circulation is maintained by a simple heart that pumps hemolymph to body tissues. Excretion occurs through paired nephridia, and the basic nervous system coordinates simple responses. Reproduction is typically dioecious, with internal fertilization producing glochidia larvae that briefly attach to host fish before developing into juveniles. These features make *L. marginalis* highly suitable for controlled pearl farming in freshwater ponds, where proper management ensures healthy growth and consistent pearl production.

Introduction

The freshwater mussel *Lamellidens marginalis* is crucial to pearl culture because of its capacity to provide high-quality pearls and its tolerance to pond conditions. It burrows into soft sediments in freshwater bodies such as lakes, reservoirs, and ponds that are stationary or move slowly. Because it is a filter feeder and naturally feeds on plankton and organic particles floating in the water, it is a good fit for low-input culture systems. Its internal structure, which includes digestive organs, gills, foot, and mantle, enables both pearl creation and survival. The larvae (glochidia) of this species, which reproduces by internal fertilization, briefly cling to fish before emerging as free- living organisms. For freshwater

pearl production in India, *Lamellidens marginalis* is a popular species due to its ecological compatibility and hardiness.

Taxonomy

Hierarchy	
Kingdom	Animalia
Phylum	Mollusca
Class	Bivalvia
Order	Unionida
Family	Unionidae
Genus	Lammellidens
Species	marginalis

Morphology of *L.marginalis*

The smooth, elongated oval shell of the freshwater mussel *Lamellidens marginalis* can reach a maximum size of 10–12 cm. Its inner layer is shiny and bluish-white or pinkish, while its outer layer is brown to dark olive-green. The shell features a long, straight, toothless hinge, a slightly elevated umbo close to the front, and weak growth lines. It is ideally adapted for freshwater pearl culture because of its huge, muscular foot, which it uses to burrow in soft pond sediments.

Biology

Lamellidens marginalis's interior structure makes it perfect for pearl farming. The shell and the material that makes pearls, nacre, are secreted by the mantle, a thin tissue lining the shell. Additionally, it creates a chamber that holds vital organs like the heart and gills. Both respiration and filter feeding are aided by the enormous, leaf-like gills, which are found in pairs and catch plankton and debris from the water. Prior to entering the mouth, these particles are sorted by labial palps.

The foot is a robust, muscular structure that provides stability and protection when burrowing into pond sediments. When disturbed, it retracts after extending for movement. The esophagus, stomach (including a digestive gland), intestine, and anus are the next steps in the digestive system, which begins at the mouth. Waste is released and nutrients are taken

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for growth. With a three-chambered heart (two auricles and one ventricle) pumping hemolymph to distribute oxygen and nutrients, the circulatory system is open.

A pair of nephridia filters nitrogenous waste during excretion. Simple reactions are controlled by the cerebral, pedal, and visceral ganglia of the nervous system. Internal fertilization and dioecious reproduction are the norms. Before becoming juveniles, the larvae, known as glochidia, parasitize host fish for a short time. This life cycle is key to hatchery-based pearl farming, ensuring a steady supply of healthy mussels for pearl implantation.

Culture of *Lamellidens marginalis*

Pre stocking

Site selection

- Calm, pollution free freshwater sources like tanks, ponds, and reservoirs.
- Slightly muddy or sandy bottom.
- In order to prevent household pollution, sites close to densely populated areas should not be chosen.
- Furthermore, the cultural zones ought to be situated far from places where industrial waste and agricultural pesticides and herbicides are dumped.

Pond preparation

- Drying
- Desilting to remove sludge and other organic load
- Liming to maintain the pH
- Pond fertilization with fermented cow dung mixed with DORB, DOGC and yeast
- Installation of culture nets with animal.

Collection of spat

- Healthy mussels are collected from natural water bodies or from the certified hatchery.
- They are subjected to conditioning with aeration and feeding with microalgae.

Stocking in nursery pond

Pond dimensions:

Depth: 0.75 to 1.5 meters

Area: 0.1 to 0.05 Ha

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Bottom: sandy or sandy-loam soil with some silt content is preferred.

Water quality parameters:

Water quality parameter	Range
Temperature	**25-30 ^{0}c**
pH	**7.0-8.5**
Salinity	**<0.5 ppt**
Alkalinity	**50-150 ppm**
Hardness	**70-400 ppm**
Dissolved oxygen	**>5 ppm**
Nitrate	**<0.01 ppm**
Nitrite	**<0.01 ppm**
Ammonia	**<0.02 ppm**

Nucleus insertion

A little portion of mantle tissue from a donor mussel is surgically implanted into the mantle or foot region of a healthy recipient in order to produce cultured pearls in the freshwater mussel Lamellidens marginalis. The gonad is not employed for implantation, in contrast to marine oysters. The process calls for specific instruments made for freshwater bivalves as well as sophisticated surgical methods. To improve graft acceptance, the mussels used for the procedure should be in good health, devoid of external fouling, and ideally in the post-spawning or early gametogenic phase. In more recent procedures, the tissue graft is combined with specially made artificial nuclei, which come in a variety of sizes and forms, to affect the final pearls' shape and quality. These designer nuclei, which are frequently composed of biocompatible materials, aid in the production of beautiful or unusually shaped pearls, which are becoming increasingly popular in the jewelry industry. To guarantee successful pearl growth, mussels must still be cleaned before surgery and well-conditioned.

Protocol for Insertion of Artificial Designer Pearls in *Lamellidens marginalis*

1. Donar mussel and graft tissue preparation

- Healthy, adult donor mussels are chosen without conditioning in order to prepare graft tissue for pearl culture in *Lamellidens marginalis.*

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- To protect the mantle lobes, the mussels are carefully opened.
- With the inner epithelium facing up, the pallial portion of the mantle is carefully separated and set on a damp wooden block using a spatula and graft knife.
- After cleaning the tissue with a damp sponge to get rid of any mucus or debris, the tissue is cut to remove the inner layer of muscle and the pigmented outside margin.
- The mantle is then cut into ribbons about 3 mm wide after being inverted so that the outer epithelium faces up.
- Depending on the size of the nucleus to be placed, these ribbons are subsequently chopped into tiny pieces (2–3 mm).
- For easy identification during surgery, the pieces are faintly dyed with a diluted water- soluble eosin solution.
- They are then maintained moist for usage within 30 minutes.

2. Selecting Artificial Nuclei

- Select designer nuclei composed of biocompatible substances (polymers, resins, plastics, etc.).
- Make sure the nucleus size (usually 2–5 mm) corresponds with the mussel size and the graft tissue.
- accessible in ornamental or shaped shapes (such as a teardrop, heart, star, etc.)
- Before using, sterilize and keep wet.

3. Conditioning of Recipient Mussels

- Choose conditioned, healthy mussels that are in the early gametogenic or post-spawning stages.
- To get rid of all silt and fouling organisms, thoroughly clean.

4. Procedure for Surgical Implantation

- Using surgical instruments, carefully open the conditioned mussel.
- Make a tiny cut in the foot or mantle area (not the gonad).
- Insert a single piece of prepared graft tissue such that the outer layer faces the nucleus.
- Securely position the designer nucleus next to or inside the tissue fold.
- Gently close the valves and give the mussel time to heal.

5. Post-Operative Care

- For recovery, immerse implanted mussels in sanitized, oxygenated water.
- Maintain with minimal disruption in pond or hatchery systems.
- Keep an eye on survival and nucleus retention for three to five weeks.
- Once stabilized, go to grow-out systems.

Sampling

Objectives of sampling:

1. Check survival rate after surgery
2. Asses pearl sac formation and response to implantation
3. Monitor health status such as shell condition, mantle color, behavior etc..
4. Check growth rate
5. Observe nacre deposition
6. Identify any stress or mortality causes

Sampling frequency

- During the initial phase of 2 months the culture once after 15 days is required.
- But after 2 months monthly sampling is enough during the entire grow-out period.
- Weekly sampling before 2 months of harvesting is preferred to note the final pearl quality.

Water management

- **Maintain Temperature:** For the best mussel growth, keep the water between 25 and 30°C.
- **pH monitoring**: Use lime if necessary to keep the pH between 7.0 and 8.5.
- **Assure Dissolved Oxygen** (DO): Use aeration to maintain DO levels ≥5 mg/L.
- **Control Turbidity**: To prevent gill clogging, keep turbidity low to moderate.
- **Frequent Water Testing**: Every week, check the temperature, turbidity, ammonia, DO, and pH.
- **Water Exchange**: To cut down on pollutants, replace 10–20% of the water every 15–20 days.
- **Use Lime Wisely**: To stabilize pH and alkalinity, apply 50–100 kg of agricultural lime per hectare.

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- **Prevent Organic Overload**: Get rid of dead mussels and stay away from too much manure or feed
- **Encourage natural plankton** without triggering algae blooms by maintaining a balance.

Feed management

Feeding habit:

L.marginalsis is a filter feeder.It feeds on microalgae, phytoplankton, bacteria, detritus, and organic particles suspended in water.They can filter 2-5 liters of water per hour depending on size and age.

- *Natural feed* is the primary feed given to the animal in the pond such as plankton, diatoms, and bacteria.
- *Supplementary feed* includes algal paste of chlorella and spirulina, yeast suspension, rice bran water, groundnut cake water.

Challenges

1. Surgical complications in nucleus implantations
2. Slow growth and long culture period
3. Biofouling and sedimentation
4. Pollution and agrochemical sensitivity
5. Market and economic barriers
6. Lack of skilled workforce

Overcoming strategies

1. Skilled training
2. Regular monitoring and water exchange
3. Periodic brushing and cleaning to prevent biofouling
4. Integrated multitrophic aquaculture implementation

Live demonstration of IMTA in CFSc, Muthukur

Integrated multitrophic aquaculture

IMTA involves the **co-culture of fed species** (e.g., fish or shrimp), **extractive species** like **filter feeders** (e.g., mussels, oysters) and **deposit feeders or aquatic plants** (e.g., seaweeds) to utilize the **waste/nutrients** from one species as

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input for another.

Suitable combination in India: **Carp+ Carb+ freshwater mussels (L.marginalis) + aquatic weeds**

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