Responsible sourcing of wild-seeds for aquaculture: spat collection in natural mussel beds along Karnataka coast

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Mussel farming is a rapidly expanding coastal mariculture enterprise, being widely adopted by fish farmers in India. Unlike other mariculture practices, mussel farming is less capital intensive and hence offers great potential for creating livelihood and employment opportunities to the coastal communities. During the year 2015, the mussel farming sector contributed 68% of the farmed bivalve production of 11,435 tonnes in the country.

The most widely adopted mussel farming practice is suspended farming on ropes. It involves the collection of young mussels (spat) from natural mussel beds, seeding them onto ropes, and growing in shallow, unpolluted coastal or estuarine waters with moderate flow. The mussel farming sector at present is entirely reliant on spat collected from natural mussel beds (wild), where the density and time of spat settlement is largely dependent on the biological spawning processes and environmental parameters. The farmers collect wild-spat that are settled on hard substratum by manual scrapping directly from the intertidal and sub-tidal zones of natural mussel beds in coastal areas during low-tide. Though the hatchery technology of mussels is established, mussel farmers mostly resort to wild collected spat, since hatchery produced spat is relatively expensive. With the rapid growth of the farming activities, hatcheries that produce mussel spat on a large scale is expected to become increasingly important. In China, mussel farming largely depends on blue mussel spats produced in hatcheries.

Collection of wild spat

Successful spat collection in an area relies on the information on the reproductive cycle of the local mussel population and knowledge on their larval development and settlement process. Along Karnataka coast, the settlement of wild spat follows the reproductive cycle commencing primarily during post-monsoon from August to September followed by a secondary spawning spell from March to April. Collection of wild-spat from sub-tidal mussel beds by skin-diving is considered perilous during the latter part of the southwest monsoon (August to September). A viable option for meeting the increasing seed requirements of the mussel industry from the wild is deployment of spat collectors in the natural mussel beds. Such artificial spat-collectors are effectively employed in temperate waters. Collectors which comprise of a variety of artificial substrates are placed in, 'Mussel Parks' (protected farming areas where mussels breed and grow) during peak spat-fall period. The spat collectors are later retrieved and the attached spat stripped off and used for seeding on ropes for growing. In some instances, seed collection and grow-out is carried out on the same collector with the mussels being left there itself for the entire duration of the grow-out period.

The intertidal and sub-tidal coastal waters off Karnataka are important fishing areas for the green mussel, *Perna viridis* during the period from October-May. Enclosed shallow lagoons suitable for mussel mariculture are limited along the Karnataka

coast and hence most of the mussel farming is in protected estuarine habitats adjoining the sea. Though there will be good spat fall in the region during post-monsoon months, the collection of wild spat is difficult as the mussel beds in the intertidal and subtidal areas are exposed to rough wave action. Skin-diving and scrapping mussel spat from subtidal mussel beds at 2-5 m water depth is risky and requires exceedingly skilled labour. Besides, the difficulty in retaining the scrapped tiny and fragile spat under water reduces the efficiency of operation. Further, fishing of wild-spat from mussel beds in large quantities for commercial farming operations has created resentment within the local fishermen groups. This is due to the possible physical damage of mussel beds by the wild-spat harvest from subtidal areas.

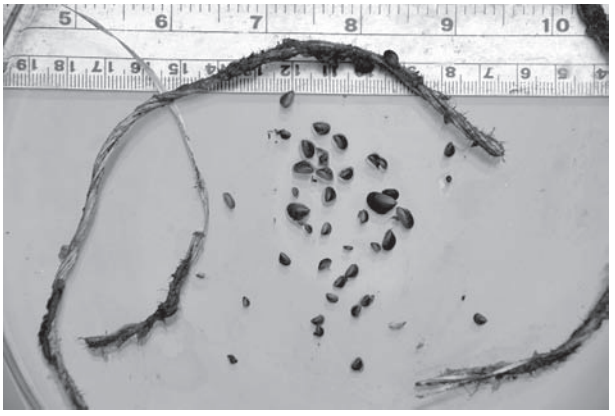
Wild-spat collection trials

Experiments for collecting wild-spat using artificial collectors were initiated along Karnataka coast. The sub-tidal zones off Someshwara, Gangolli, Byndoor and Karwar with dense settlement of mussel spat in the mussel beds were selected. Various types of spat collectors of different construction were tested to identify the most suitable material and construction for effective spat collection. The spat-collectors were placed above the natural mussel beds during spat-fall from September. Initially, panels comprising of mussel grow-out ropes fastened to bamboo frames were used off Someshwara, with little success. The major problem encountered with this type of construction was its floatation. Mussel spat collectors were subsequently fabricated using Poly Propylene (PP) ropes of 16 mm diameter and untwisted strands from a PP rope of 32-36 mm diameter. The untwisted strands (30 cm length and 2-3 mm width) were arranged in length and tied in the middle, parting 15 cm on either side of the knot. Each bundle was fastened to thinner PP ropes of 8 mm diameter at 50 cm intervals to form a 3m long spat collector (6 bundles). They were vertically suspended from long-lines with 500 g weight at distal end. The long-lines were moored in the natural mussel beds at 6 m water depth during low-tide using floats and anchors. The uppermost bundle was place 50 cm below the water surface. Such artificial spat collectors were suspended from long lines off Someshwara, Gangolli and Byndoor. However, the spat-collectors placed off Gangolli and Byndoor were washed away in heavy rains and turbulence developed due to inclement weather during the experiment period.

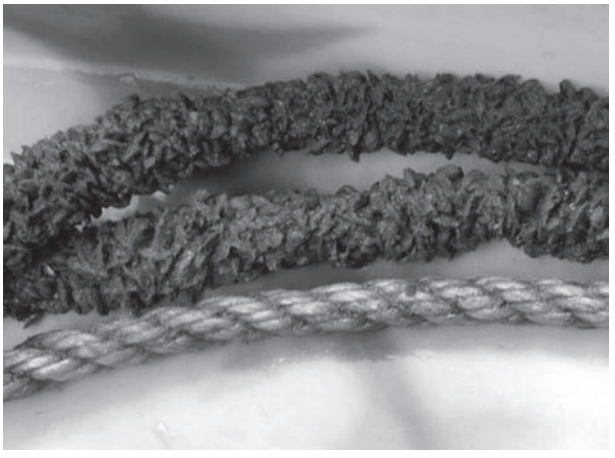
In Someshwara, mussel spat settlement was observed from October on untwisted PP ropes and twisted PP ropes. By first week of November, the average spat-settlement density on untwisted strands was 17 mussel-spat/m whereas, good settlement of 5,640 mussel-spat/m was observed on the twisted ropes of 16 mm diameter. The spat size varied between 2 and 5 mm, with 48% measuring about 2 mm in November (Fig. 1). The average weight of the mussel spat was 6.45 mg.

Spat collector deployment (untwisted PP rope)

Mussel spat on untwisted PP rope



Mussel spat separated from PP rope strands



Spat settlement on twisted collector ropes

The depth-wise spat-settlement on the untwisted PP ropes was monitored. The average spat settlement ranged from 7 to 94 numbers/ untwisted PP rope bundle in different depths. The highest settlement was observed at 2.5m (48%) from the surface (Fig. 2). 84% of the spat settlement was between 1.5 and 2.5 m depth. While there was depth-wise difference in spat settlement on untwisted strands, the spat settlement on twisted ropes were uniform.

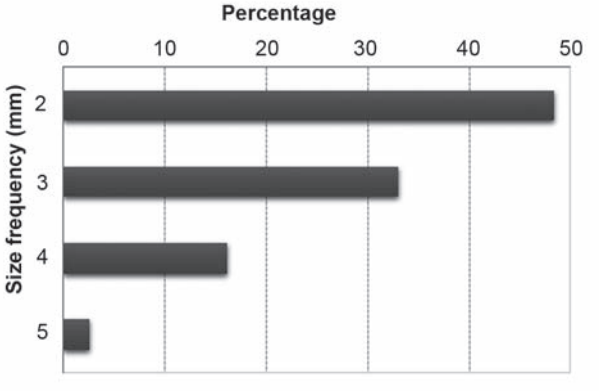


Fig. 1 Mussel-spat size in spat collector

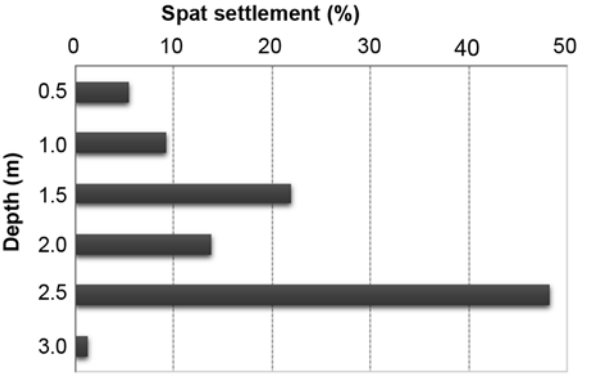


Fig. 2. Mussel-spat settlement percentage on untwisted rope strands at different depth

The surface area of the two types of collectors are not comparable for a given length since the twisted rope provides a greater surface area than an untwisted PP rope strand. While the spat attached to the loose untwisted strands were subjected to water movements and resulting changes in the collector, those attached to the stretched twisted strands were relatively stable. In natural mussel beds, the spat prefer firm substratum, allowing the mussels to get a safe foothold, having potential to reduce post-settlement dislodgment due to physical disturbances. Though, further studies are necessary it was observed that spat settlement on untwisted unfastened rope strands have higher potential of post-settlement mortality due to physical disturbances/ dislodgments.

Conclusion

The mussel spat settle on a substrate and attach themselves using byssus threads, on clean, silt-free irregular surfaces that range from filamentous algae stone, wood, concrete, dead shell and shells of their own species. Deployment of artificial collectors are considered as the most practical, economical and sustainable method to collect spat. Artificial substrates have the advantage over natural materials in possessing a relatively constant surface

area and textural composition. This facilitates easy retrieval of spat from the collectors with minimal stress on the seeding material. The twisted PP ropes were successful in collecting large numbers of spat of green mussels, from open-sea waters off Someshwara. Such artificial substrates can be effectively utilized in open-sea for sourcing spats from mussel beds without relying on physical harvesting techniques. The collectors placed in other mussel beds were lost due to failure to withstand rough weather. Therefore, such protocols need to be fine-tuned further for their feasibility based on engineering, environmental and economical perspectives.