



The coastline of Isla Grande near Angra dos Reis, RJ, Brazil.



An array of surface longlines that hold lantern nets for scallop culture.



Juvenile lion's paw scallops.



*Nodipecten nodosus* broodstock.

## CURRENT STATUS OF SCALLOP CULTURE IN BRAZIL

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Among seventeen species of scallop found along the extensive 7,400 km Brazilian coastline, the lion's paw scallop *Nodipecten nodosus*, the largest of all, has been identified as the best scallop candidate for mariculture in Brazil. This scallop can attain a shell length of up to 18 cm. It is commonly found along the southern coastline of Rio de Janeiro state in a depth range of 10-25 m, mainly affixed to hard substrates, usually rocks. It is occasionally also found on sandy sea bottoms in close proximity to island or mainland shorelines. The lion's paw scallop is by far the most abundant scallop. The species has excellent attributes for domestication. It is relatively easy to manage using common scallop lantern net culture systems and husbandry techniques. Scallops grow fast in the warm, clean coastal waters of the southeastern coast of Brazil, reaching 80-100 mm shell length within 12 months of culture (Lovatelli *et al.* 2008; Sühnel *et al.* 2012).

The culture techniques employed have low environmental impact and scallop filter-feeding habits makes this bivalve very attractive for culture because it does not require external food input. The live, fresh-from-the-farm, sustainable shellfish product, continues to have positive consumer acceptance, stimulating the development of good and growing market demand (Lovatelli *et al.* 2008). A government initiative was launched in 1994 to promote regional shellfish culture as a means to reduce the risk of extinction from overfishing and to promote marine resource conservation.

The southeast region of Brazil has a very special coast, full of cut shorelines and many nearshore islands, most without urban pressure or polluting runoff. The region has many sheltered areas including bays and inlets, but also many open areas with greater circulation influenced by open ocean dynamics. This diverse coastal morphology, combined with strong oceanographic influences, results

in a variety of environments suitable for diverse mariculture practices and approaches. In addition, the tropical climate, with an average surface water temperature of 23-25 C, is ideal for scallop production, allowing year-round production.

Most scallop farming in Brazil is concentrated at Ilha Grande Bay, near the municipality of Angra dos Reis. This region has a rich marine biodiversity, ranging from benthic organisms to top trophic predators. Such biodiversity, combined with the unique coastal geomorphology, make this region very attractive to ecologists and nature lovers and for ecotourism and diving.

This region is strategically located between two big economic centers, São Paulo to the south and Rio de Janeiro to the north, which are the main urban consumer markets for mariculture production from the region. The local communities in the region are mostly represented by artisanal fishermen families, whose family and cultural connections with the ocean extend back many generations. The beautiful and relatively un-spoiled coastal environments and social and cultural factors have combined to allow this region to become a major scallop mariculture producing area, with a focus on sustainable production. The sector has the support of and is integrated well with the local community and is also supported by guidance provided by local and Federal Brazilian government oversight.

Scallop production fits well into the social and physiographic context of this region and presents an opportunity for development of a highly profitable mariculture sector. Many former fishermen have adopted scallop culture as their new full-time occupation. Interest from the local community to become scallop producers is increasing rapidly, given that the activity is deeply rooted in their culture and ancestral life practices, and presents a new and modern way to earn a healthful living from the sea. A bonus is the timeliness of integrating sustainable aquafarming practices into the new and developing industry. This trend will promote long-term ecosystem protection and regeneration, benefiting the biodiversity of the natural marine resources in this region.

Because fresh scallops command high prices in the marketplace, scallop mariculture provides a greatly needed source of increased income for local fisherfolk, their families, and the community at large. In addition, as health awareness and the root causes of devastating diseases such as heart disease and arteriosclerosis become better understood by the general public in Brazil and by coastal populations in particular, there is an increasing demand for seafood, including scallops, to replace other forms of animal protein in diets and on menus. This is especially true for fresh, locally-produced seafood products that, in addition to their noted health benefits, can command a price premium in the marketplace.

Federal government incentives and the private sector and producer associations have been supporting scallop culture through research activities, seed production, social programs and facilitating regulatory pathways to further develop the activity. In addition, the local Department of Fisheries and Aquaculture has agreements in place with a large regional hatchery (IED-BIG) and has played a major role in monitoring and assisting local producers with farm siting advice, assistance with production methodology and husbandry techniques, monitoring and biometrics, harvesting techniques, and even commercialization and marketing. This government support and interaction has helped to ensure that the nascent scallop

mariculture industry of the region will have a better chance for survival, with long-term and sustainable growth.

## SEED PRODUCTION

The first attempts of spawning under controlled conditions in the region occurred about 20 years ago. Hatchery capacity has grown slowly and currently stands at about 20 million spat per year. This number is sufficient to meet the needs of all current scallop producers and government research centers. In addition to seed production, hatcheries are involved with social projects, including “how-to” workshops, specialized training, and environmental educational programs for producers.

Larviculture methods are based on industry-standard, well-practiced protocols, starting with obtaining fertilized eggs from broodstock scallops collected from the wild that are greater than 75 mm in shell length and older than 18 months. Gravid broodstock are first exposed to increased water temperature in the laboratory, i.e. from 20 to 24 C (Rupp *et al.* 2004, Stühnel *et al.* 2014). Because scallops are hermaphrodites, the process is closely monitored to avoid self-fertilization and decrease stock inbreeding. Spawning embryos are then transferred to larviculture tanks and fed initially with a mixture of cultured microalgal species, mostly *Isochrysis galbana*, *Pavlova lutheri* and *Nannochloropsis oculata*. After the fifth day, four additional species (*Chaetoceros calcitrans*, *C. gracilis*, *C. muelleri*, and *Bellerochea polymorpha*) are blended with the first three species to form the larval diet.

After the larval rearing period, pediveligers are transferred to settlement tanks. Once settlement occurs, larvae are culled to specific densities, with continued feeding of the seven-species microalgal mixture. After 30 days, shell formation starts to occur and the tiny scallops are transferred to the sea in settling lantern nets for another 30 days to allow continued growth on natural feeds and for shell hardening, facilitated by the natural bicarbonate titers of the coastal seawater. Finally the mature seed scallops are transferred to nursery lantern nets, and after an additional 30-d nursery period (now approximately 90-95 days total in the nursery phase), the young scallops are ready to be stocked into lantern net systems for grow-out.

## PRODUCTION SYSTEMS

The most common production system is longlines affixed at regular intervals with lantern nets at 5-10 levels. Generally, longlines are 50 m long and lantern nets are attached with a minimum of 80 cm between each other to avoid tangling and to maintain good water circulation within the arrays. The distance between arrays can change according to ocean dynamics such as tidal regimes, wind fetch intensity and sea currents. The distance between longlines is usually set at about 5 m and is based on vessel traffic intensity to avoid damage to the longline arrays and for reduction of vessel-induced stress on the scallops below.

There are basically two types of lantern net culture systems: surface arrays and submerged, water column arrays (Lodeiros *et al.* 1998, Mendonza *et al.* 2003). The surface culture system is mostly implemented by smaller producers, given their lower operating cost. In this system lantern nets are located at 3-5 m depth and a string of buoys for flotation is located at the water surface. In

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*Rubber bands are used to prevent scallops from opening and releasing liquid.*



*Fresh scallops ready for shipment to consumers.*



*Lion's paw scallop with sea cucumber.*



*Fresh scallops ready for shipment to consumers.*

this arrangement, lantern net handling and maintenance can be accomplished easily with a canoe or small vessel. Notwithstanding the advantages of the surface system for smaller-scale producers, the biggest disadvantage is its vulnerability to excessively warm surface waters during the summer, which can kill scallop spat and juveniles and reduce productivity and profitability for the mariculture farmers.

The second system – totally submerged lantern net arrays – are placed in deeper water (10-20 m). It is a more sophisticated and complex system that requires scuba diver capability for tending the crop and managing harvests. The main advantage of this system is avoidance of crop loss from overly-warm surface waters in the summer, given that deeper waters maintain a cooler and more uniform temperature regime throughout the year.

Production grow-out management consists of managing the crop through six distinct culture phases, with the duration of each phase usually about 60 days and stocking density determined by shell size. Despite this general scheme, producers often develop their own culture strategies in which the duration of each culture phase varies slightly to coincide with local micro-oceanographic conditions. Lantern nets with different mesh sizes (4-21 mm) are used for the different culture stages. Stocking density decreases with culture time and culture phase from 300 to 12 scallops per level of lantern net. In the first phase, post-nursery spat are commonly cultured to a shell size of approximately 10 mm. The last (sixth) phase will result in the production of marketable scallops of 65-70 mm shell lengths or greater, attained after 12-15 months in culture (Table 1).

## COMMERCIALIZATION AND MARKET

Consumer demand from the local market has been gradually increasing and is now supporting regional scallop production. Scallops are marketed fresh or frozen without processing. Restaurants from São Paulo and Rio de Janeiro absorb approximately 70 percent of the current production of about 350,000 scallops per year. Due to proximity to the major consumer markets in Rio de Janeiro, the product can be delivered very fresh to restaurant buyers weekly or bi-weekly, with each scallop individually wrapped with rubber bands (to keep oxygenated water trapped within the bivalve shell) and packaged in foam boxes packed with filtered ice. As this is a high-quality specialty product, still with relatively small production, it is common for restaurant buyers to source directly from producers on a one-to-one basis. However, with an increasing nationwide demand attracting new scallop farmers and greater production areas and volumes, producers are beginning to form organized associations to increase production, self-police their industry and meet the growing market demand. Attending to the restaurant market during the summer months, local producers are focused on local tourism, selling scallops directly to consumers or seasonal restaurants at a high price.

One very popular tourist destination is the beautiful Ilha Grande Bay. This large bay attracts visitors from all over the world and especially summer visitors and boaters from Rio de Janeiro and São Paulo. Locally the tourists are treated to the opportunity to experience and interact with mariculture activities, contributing to increased awareness and appreciation for preservation of the marine environment and seafood-producing ecosystem that occurs in this region. In addition, of course, they have the opportunity to consume very fresh scallops directly from the harvest, and in so doing,

are willing to pay a premium for the experience and the product. This practice of catering to the influx of summer tourists has been given the label “Boutique Mariculture Farming” and is growing increasingly popular in the region, driven by the higher prices obtainable from the direct-to-consumer supply chain, which lowers costs, including eliminating the transportation costs of driving the product to urban markets.

Overall, the increasing demand for scallops and for seafood in general in the region is a great opportunity to further develop regional mariculture production, expanding it to the next level. Fortunately the availability of seed is no longer a bottleneck for local scallop producers, although as production grows, more hatchery capacity will be needed to keep pace. This is predicted to occur with government financial and extension support to hatchery operators. In addition to the gradually increasing production, scallop producers are also learning to intensify production with new and improved practices and equipment and new producers are taking up the activity each year to satisfy increasing demand. A production growth of more than 15 percent/yr over the last five years is a very impressive accomplishment and further growth is expected for 2016 and beyond.

## Notes

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## References

- Lodeiros, C.J., J.J. Rengel, L. Freites, F. Morales and J.H. Himmelman. 1998. Growth and survival of the tropical scallop *Lyropecten (Nodipecten) nodosus* maintained in suspended culture at three depths. *Aquaculture* 165:41-50.
- Lovatelli, A., A. Farías and I. Uriarte. 2008. Estado actual del cultivo y manejo de molusco bivalvos y su proyección futura: factores que afectan su sustentabilidad en América Latina. FAO Actas de Pesca y Acuicultura n12. FAO, Roma.
- Mendoza, Y., L. Freites, C.J. Lodeiros, J.A. López and J.H. Himmelman. 2003. Evaluation of biological and economical aspects of the culture of the scallop *Lyropecten (Nodipecten) nodosus* in suspended and bottom culture. *Aquaculture* 221:207-219.
- Rupp, G.S., R.J. Thompson and G.J. Parsons. 2004. Influence of food supply on postmetamorphic growth and survival of hatchery-produced lion's paw scallop, *Nodipecten nodosus* (Linnaeus, 1758). *Journal of Shellfish Research* 23:5-13.
- Sühnel, S., F. Lagreze, G. Zanette, A.R.M. Magalhães and J.F. Ferreira. 2012. Effect of the fatty acid EPA and DHA in the conditioning of the scallop *Nodipecten nodosus* (Linnaeus, 1758). *Aquaculture* 330-333:167-171.
- Sühnel, S., F. Lagreze, A. Pereira, F.C. Da Silva, H. Gurney-Smith, M. Bercht, M. Maraschin, A.R.M. Magalhães and J.F. Ferreira. 2014. Effects of astaxanthin on reproductive success in the tropical scallop *Nodipecten nodosus* (Linnaeus, 1758). *Journal of Shellfish Research* 33:89-98.



*Hatchery-produced scallop seed.*



*Scallop "meat" (adductor muscle) with gonad.*



*Lantern nets are attached to surface longlines.*



*Sorting scallops for marketing.*



*Harvest from a lantern net for sorting and restocking.*



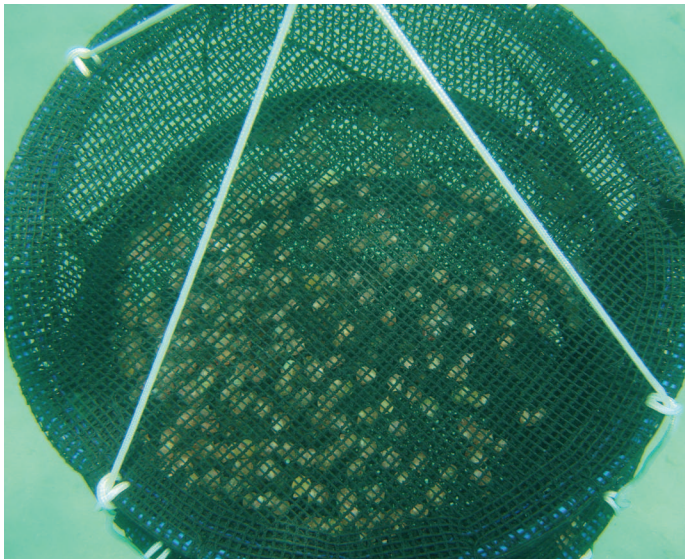
*A rack for holding lantern nets for stocking and harvest.*



*Stocking a lantern net.*



*Floating work barge for sorting, culling and harvesting scallops.*



*A lantern net with scallop seed.*



*The large adductor muscle and gonad of the lion's paw scallop is attractive to consumers.*