# Australia's first commercial sea cucumber culture and sea ranching project in Hervey Bay, Queensland, Australia

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## Introduction

The sea cucumber *Holothuria scabra*, commonly called sandfish, yield one of the largest sea cucumber catches worldwide (Brookes and Shannon 2004). *H. scabra* also forms an important fishery in Torres Strait and the east coast of Queensland, Australia. In Queensland, the beche-de-mer fishery is probably one of the oldest commercial fisheries, with harvesting of wild stocks beginning in the early 1800s (Breen 2001). Although the fishery was interrupted during the world wars and gradually declined thereafter, it experienced a new boom period in the 1980s (Breen 2001).

During the late 1980s, state government fisheries introduced new measures to ensure that fisheries resources were used in an ecologically sustainable way (Breen 2001). Most recently, the Great Barrier Reef regions were progressively restricted to fishing for beche-de-mer on a quota system to comply with the Marine Park protected area zoning arrangements. During the last two decades, a considerable number of research and commercial hatcheries have been established worldwide, producing sea cucumber juveniles for stock enhancement or for commercial purposes.

Australia's first commercial sea cucumber culture hatchery, Bluefin Seafoods Hatchery officially started operations in May 2003 and is currently fully operational. Bluefin Seafood's Hatchery is in the Great Sandy Strait in Hervey Bay on Queensland's mid-north coast. The hatchery is owned by Ross Meaclem and Theresa Rimmer, Managing Directors of Bluefin Seafood Pty. Ltd., Hervey Bay, Queensland.

The present commercial sea cucumber project arose from the current limited beche-de-mer fishery in Queensland and also the increased demand for the product in Asian markets. The hatchery was built under the federal government's Farm Innovation Program to produce sea cucumber juveniles. The aim of the hatchery is to commercially produce sea cucumbers (sandfish *H. scabra* and golden sandfish *H. scabra versicolor*) to supply the industry as an alternative to harvesting wild populations.

## Development of the program

The sea cucumber culture program's two phases (hatchery and grow-out) is guided by more than 10 years of commercial sea cucumber culture experience (larval rearing, settlement and grow-out) acquired in India and the Republic of Maldives by the authors of this paper. The purpose of the hatchery is to routinely mass-produce sea cucumber juveniles in three stages: larval culture (i.e. fertilisation, embryonic development, larval growth, and settlement of juvenile), juvenile rearing (nursery phase in flow through system) and farming of hatchery produced juveniles in the natural habitat (seeding area approved by the Department of Primary Industries, Queensland) for grow-out and harvesting.

The future scope of the project is well designed to enhance and refine technologies for mass production of *H. scabra* and *H. scabra* var. *versicolor*, with increased survival rate in the hatchery and field. Our ongoing research on white teatfish (*H. fuscogilva*) and black teatfish (*H. whitmaei*) should allow us to better understand these species. In addition to this, the project will benefit the sea cucumber industry by improving techniques for processing the gut of harvested sea cucumbers ("konowata"), plus developing value-added products from the gonad and body wall.

### *Hatchery*

The hatchery building consists of a 300 $m^2$ area with more than 50, 1000-L fibreglass tanks for spawning and larval rearing. The incoming water inside the hatchery is passed through a series of cartridge filters and UV disinfection chambers, at a rate of 80,000 L $day^{-1}$. Air is supplied by two blowers.

### *Microalgal culture facility*

The microalgal mass culture facility consists of a 40 $m^2$ temperature controlled room for culturing six species of algae and four species of benthic diatoms. The microalgal species are cultured in 44-L transparent bins set upon the racks. Luminescent lights

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are fixed to provide enough light needed for microalgal growth. Around 5000 L of pure microalgal cultures can be produced using this setup (Fig. 1).

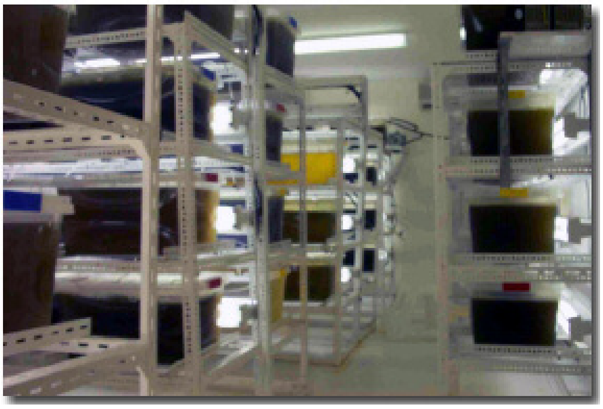

**Figure 1.** Indoor microalgae culture

### *Other facilities*

The hatchery has a temperature controlled stock culture room for maintaining microalgal species. The laboratory has full water-quality testing equipment, microscopes and computers for processing water quality and larval development data.

### *Broodstock collection and maintenance*

For successful spawning, it is essential to use healthy sea cucumbers with mature gonads (Hamel et al. 2001). Therefore, a selected number of adult specimens (breeders) are collected during the spawning season (November to January) from Hervey Bay waters. The broodstock are collected by diving and are transported to the hatchery with considerable care in order to avoid any damage. The animals are spawned on the day of collection and a few animals are dissected in order to effectively assess the maturation stage of their gonads. Normally, specimens weighing 350–500 g and measuring 12–15 cm are preferred breeders. The sea cucumbers are maintained in the hatchery at constant water temperature (26°C) and the quality of the water is maintained with sufficient water exchange.

### *Spawning*

About 35 breeders are induced to spawn in a one-tonne tank by thermal stimulation. Several trials are carried out during the spawning season from November to January. *H. scabra* spawning occurs generally between 17:00 and 23:00; a quiet environment and dark conditions are preferred conditions for spawning. Generally, males spawn first, which then induce the females to release their eggs. Only a few males are allowed to spawn in a tank to maintain the water quality.

### *Egg collection*

Fertilisation occurs inside the spawning tank. After spawning, sea cucumbers are removed from the spawning tanks and the fertilised eggs are collected using 65-μ sieve. The collected eggs are washed gently for 15 minutes to remove impurities, and transferred to 1-μ filtered UV sterilised seawater. The hatching rate is generally 75 to 90 per cent.

### *Larval rearing*

The following microalgae are suitable for the sea cucumber larvae: *Chaetoceros mulleri, C. calcitrans, Rhodomonas salina,* and *Pavlova lutheri.* For better larval development, using a mix of microalgae species is important. The algae such as diatoms and *Rhodomonas salina* can be used as the main food, supplemented with *Pavlova* sp. and *Isochrysis* sp. The algae are given twice a day in increasing concentrations as larvae develop from early auricularia to late auricularia. For the early-stage auricularia, the feeding regime should be 15,000–20,000 cells $ml^{-1}$ while for late auricularia it can be increased to 30,000–40,000 cells $ml^{-1}$.

### *Water exchange and aeration*

The water in the larval tank is exchanged once a day, in the morning. Debris such as dead algae, faeces and dead larvae that have settled to the bottom of the tanks are removed in the evening by siphoning. During larval rearing, the water is aerated continuously but gently. The optimum water temperature ranges from 26–29°C and the dissolved oxygen is maintained above 5.5 mg $L^{-1}$. The optimum salinity ranges from 33–37‰ and pH is 8.2.

### *Larval settlement*

After 10–12 days the auricularia larvae metamorphoses into doliolaria, the non-feeding stage. The doliolaria transforms into pentacula and starts to settle on the tank bottom or in the settlement substrates. For a better survival rates, the density of the larvae on the substrate is maintained between 1–3 individuals $cm^{-2}$. Benthic diatoms and Algamac 2000 are given as food for the early settled juveniles.

### *Nursery rearing*

Juveniles measuring more than 5 mm are transferred to outside nursery tanks. Twenty-five 3900-L tanks and ten 10,000-L tanks fitted with flow through system are used for nursery rearing of juveniles. The water exchange in these tanks is above 250 per cent per day. In the early stages, Algamac 2000 and benthic diatoms are used as food and in the later stages, extracts of seaweeds and seagrass mixed with fine sand forms the primary food. Differential growths of juveniles are common in all the tanks and the juveniles are thinned out with the removal of well-grown juveniles in separate tanks. Initial production of juvenile sea cucumbers, which began in November 2003, has led to the production of more than 530,000 sandfish juveniles. We have successfully bred the golden sandfish *Holothuria scabra* var. *versicolor* (Fig. 2) for the first time and produced more than 33,500 juveniles, well suited for seeding in lagoons and bays with rubble bottoms.

### *Sea ranching*

Sea ranching of sea cucumbers has become very popular in recent years. Results suggest that the substrata of the seeding area play an important role in the survival of released juveniles, as they need protection from predators and require an abundance of natural feed (Jiaxin 2003). The present seeding area at Hervey Bay has been selected because of its sheltered nature and availability of seagrass beds and preferred habitats such as small pools and channels.

The hatchery-produced juveniles were transferred to the 62-ha seeding area allocated by the Department of Primary Industries, Queensland, and released into a habitat comprising mostly mudflats and seagrass beds. Ongoing monthly observations show better survival and good growth rates in the wild (Fig. 3). The completion of one full year of continuous monitoring will provide some interesting ideas about the success of sea cucumber sea ranching in Australia, as there is a lack of data on the survival and success of seeding hatchery-produced juveniles in the wild.

## Acknowledgements

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**Figure 2.** **Marine biologist Grisilda Ivy holding a golden sandfish**

**Figure 3.** **Monitoring released juveniles at the seeding area**