ACIAR research programme

International blacklip pearl oyster project under way

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James Cook University is the commissioned organisation for a project funded by the Australian Centre for International Agricultural Research (ACIAR) concerned with pearl oyster resource development in the Pacific. It involves collaboration between James Cook University, the Queensland Department of Primary Industries' Oonoonba Veterinary Laboratory, Kiribati Fisheries Division, the South Pacific Commission and the International Centre for Living and Aquatic Resources Management (ICLARM).

While the project primarily seeks to assist Kiribati, research findings will be equally applicable to other Pacific nations and will have broad application. The three-year project began in mid-1993 and has three major research areas:

- assessment of pearl oyster stocks and spat settlement in Kiribati;
- improvement of pearl production and husbandry practices; and
- development of simplified larval/nursery rearing techniques.

Assessment of pearl oyster stocks in Kiribati is being undertaken by the Fisheries Division of the Ministry of Environment and Natural Resource Development in Kiribati, and is assisted by an Australian Volunteer Abroad, Jamie Whitford, based in Kiribati for the duration of the project. Research on improved pearl production and husbandry practices is being conducted by Dr John Norton at Queensland DPI's Oonoonba Veterinary Laboratory in Townsville.

Research at James Cook University is focused on developing simplified larval and nursery rearing techniques for pearl oysters. Hatchery production of bivalves is technically demanding and inappropriate for small Pacific nations which may lack the necessary technical and human resources.

Clearly, development of simpler culture systems which demand fewer skilled personnel and less labour input would facilitate the establishment of cultured pearl industries throughout the region. This article outlines aspects of this research.

Culture systems

In general, the methods used for hatchery rearing of pearl oysters are based on those developed for other bivalves such as table oysters. This protocol involves rearing larvae in static-water culture systems where the water is changed every 1 to 2 days. Larvae must be removed from the tanks for water changes, and they are usually drained onto mesh before being placed back into clean water.

Previous bivalve research at James Cook University developed simple larval-rearing techniques for giant clam larvae by using a flow-through culture system. In this system, water flows through the larval-rearing tanks continuously, and larvae are prevented form leaving the tanks by a mesh screen (100 μm) placed over a central standpipe (Fig. 1) (Braley, 1992). This system makes larval culture considerably simpler, as water in the culture tanks is exchanged without removing the larvae. This system has a number of advantages over conventional static culture systems, including reduced larval stress. The system was used very successfully with giant clam larvae and was an obvious contender when addressing the problem of simplifying rearing methods for pearl oyster larvae.

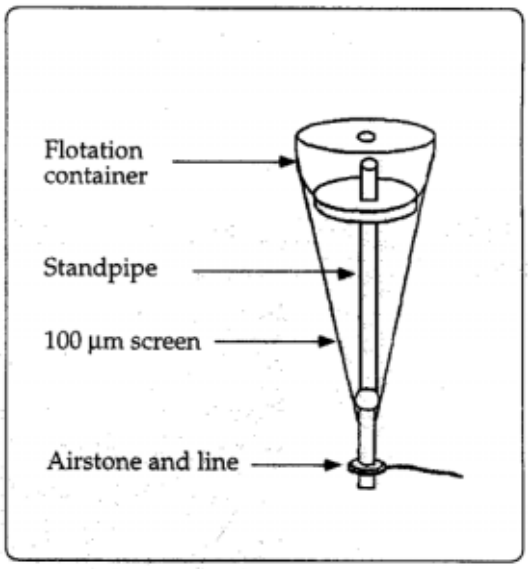

Figure 1: Flow-through cone used for giant-clam culture

However, initial use of this system with pearl oyster larvae resulted in a build-up of debris on tank bottoms. This can lead to bacterial and protozoan infestation and blooms of micro-algae and zooplankton. The zooplankton compete with the oyster larvae for space and food. This problem was not encountered with giant clam larvae, and is thought to result from the smaller mesh size (37 μm) required to retain pearl oyster larvae and the significantly longer larval life (20–24 days) of pearl oysters compared to giant clams (8–14 days). The problem was overcome by periodic (once a week) cleaning of larval rearing tanks. The system developed for *P. margaritifera* larvae is as follows:

Rearing tanks were fitted with a central stand-pipe to which a 37 μm nylon mesh cone and a polystyrene float were attached. A flexible air tube placed at the base of the cone produced air bubbles, which helped prevent the larvae from being forced against the mesh. The size of the mesh was increased as the larvae grew (Table 1).

Three species of tropical micro-algae were used to feed the larvae: *Isochrysis* clone T-SO, *Pavlova salina* and *Chaetoceror simplex*. Micro algae were introduced to the tanks at 09:00 hr each morning after water flow into the tanks had been turned off. Water flow was resumed at 21:00 hr each evening at a rate of 50 l per hr. This flow rate resulted in a 100 per cent water change in the larval rearing tanks in each 24 hr cycle.

Culture tanks were completely drained, washed and re-filled on day seven, day 14 and day 21 in order to minimise the build-up of debris on the tank bottom. The protocol developed for larval rearing in flow-through tanks is detailed in Table 1.

Larval growth and survival in the flow-through system compared favourably with those in similar studies using more conventional static larval-rearing systems. Umbone larvae were first seen on day nine and 'eyed' larvae on day 16. Around five per cent of the D-stage larvae initially stocked into the rearing tanks reached settlement by day 28, and approximately 20 per cent of these larvae survived to become spat.

Clearly, this system is a viable method for rearing pearl oyster larvae. Improvements to growth rates and survival are expected once conditions such as flow-rate, feeding rate and larval-stocking density are optimised. Further research will address these aspects.

Larval nutrition

Major technical and labour inputs for bivalve hatcheries are associated with culture of micro-algae as the larval food source. Algal culture requires skilled personnel and specialised culture facilities, and has been estimated to make up 30 to 50 per cent of hatchery running costs (Jeffrey & Garland, 1987). As such, a major factor in the simplification of hatchery procedures is to reduce reliance on micro-algae.

Research is continuing into optimising the feeding procedure. Research efforts have been directed into three main areas:

- Evaluation of single algal species for their nutritional value. It is usual for bivalve larvae to be reared on diets composed of a mixture of different species of micro-algae. Successful use of a single species would greatly simplify larval rearing.

Table 1: Protocol for rearing pearl oyster larvae in flow-through system

Larval density	1 larva per mL (D-stage)
Water	1 μm cartridge filtered
Water flow	12 hr on. 12 hr off — 100% water exchange in 12 hr
Screen size	Day 1-7 ... 37 μm; day 7–14 ... 53 μm;
	Day 14-21 ... 74 μm; day 21 + ... 105 μm
Tank clean	Every 7 days
Feeding	Mixed micro-algae — fed in morning when water turned off
Water temperature	27–29°C
Aeration	Constant

- Assessment of species of tropical micro-algae. Outdoor culture of micro-algae substantially reduces the need for the specialised facilities normally associated with algal culture. Clearly, tropical species are more suited to culture under these conditions and, despite the availability of stock cultures, little is known of the nutritional value of these species.

- Assessment of artificial or "off the shelf" alternatives.

A number of products, including dried micro-algae, yeast-based products and micro-encapsulated diets, are now available commercially, and may have potential as alternative larval diets. Some of these products, together with some experimental artificial diets (e.g. Southgate et al. 1992), have shown promise as either partial or total replacement for micro-algal diets, and will be investigated for pearl-oyster larvae.

Extension

Two fisheries officers from Kiribati recently visited the University's Orpheus Island Research Station for five weeks, and were familiarised with the culture techniques described above. They will put this training into practice later this year when the first attempt will made to produce *P. margaritifera* spat in Kiribati. A small hatchery has been established on Tarawa, the main coral atoll of Kiribati, and local broodstock have been obtained. The first larval rearing experiments using the flow-through system will begin in August/September 1995, with assistance from James Cook University staff. (Ed.—see following article).

The techniques developed could have considerable economic benefits for Kiribati and for Pacific nations such as Fiji and the Solomon Islands.

References

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Hatchery spat production of *Pinctada margaritifera* in Tarawa, the Republic of Kiribati

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Introduction

Existing black pearl industries in the Oceania region are based on the collection of wildstock pearl oysters or spat, and declining wildstocks are a major concern. A stock survey conducted by the Fisheries Division of the Ministry of Natural Resources Development in the Republic of Kiribati has shown that the natural stocks have almost been wiped out in many atolls over the past 100 years. Thus, establishing a cultured pearl industry is not possible if it depends upon traditional wildstock collection methods. Utilising hatchery-produced spat and subsequent ocean-culture stock is a promising approach for renewing regional cultured pearl industries by rebuilding and sustaining severely-depleted natural stocks without heavy pressure on natural stocks.

Techniques for artificial propagation of pearl oysters in commercial hatcheries have been improved over the last two decades following various experiments carried out on broodstock conditioning, spawning induction, and larval and spat culture.

Commercial hatchery spat production of *Pinctada margaritifera* has currently been undertaken in French Polynesia and Japan. As part of the ACIAR/JCU Blacklip Pearl Oyster Project, a small and inexpensive pilot hatchery was set up at Tarawa, Republic of Kiribati, in August 1995, and